

# ArmorStart LT Distributed Motor Controller Specifications

Bulletin Numbers 290, 291, 294

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## Product Description

The ArmorStart® LT controller is a compact, integrated, pre-engineered, On-Machine™ motor-starting solution. Bulletin 290 devices provide full-voltage, nonreversing motor control, Bulletin 291 devices provide full-voltage reversing motor control, and Bulletin 294 devices provide variable-speed motor control.

The controllers are equipped with a UL Listed at-motor disconnect that supports a lockout/tagout (LOTO) provision. ArmorStart LT controllers are Listed as suitable for group installations per UL and can be applied with either branch circuit breaker protection or fuse protection. It provides an IP66/UL Type 4/12<sup>(a)</sup> enclosure suitable for water washdown environments in a single box construction that minimizes inventory needs. All external connections are made from the bottom of the unit, which minimizes accidental contact with moving equipment. ArmorStart LT controllers come standard with quick disconnect receptacles for the I/O and network connections.

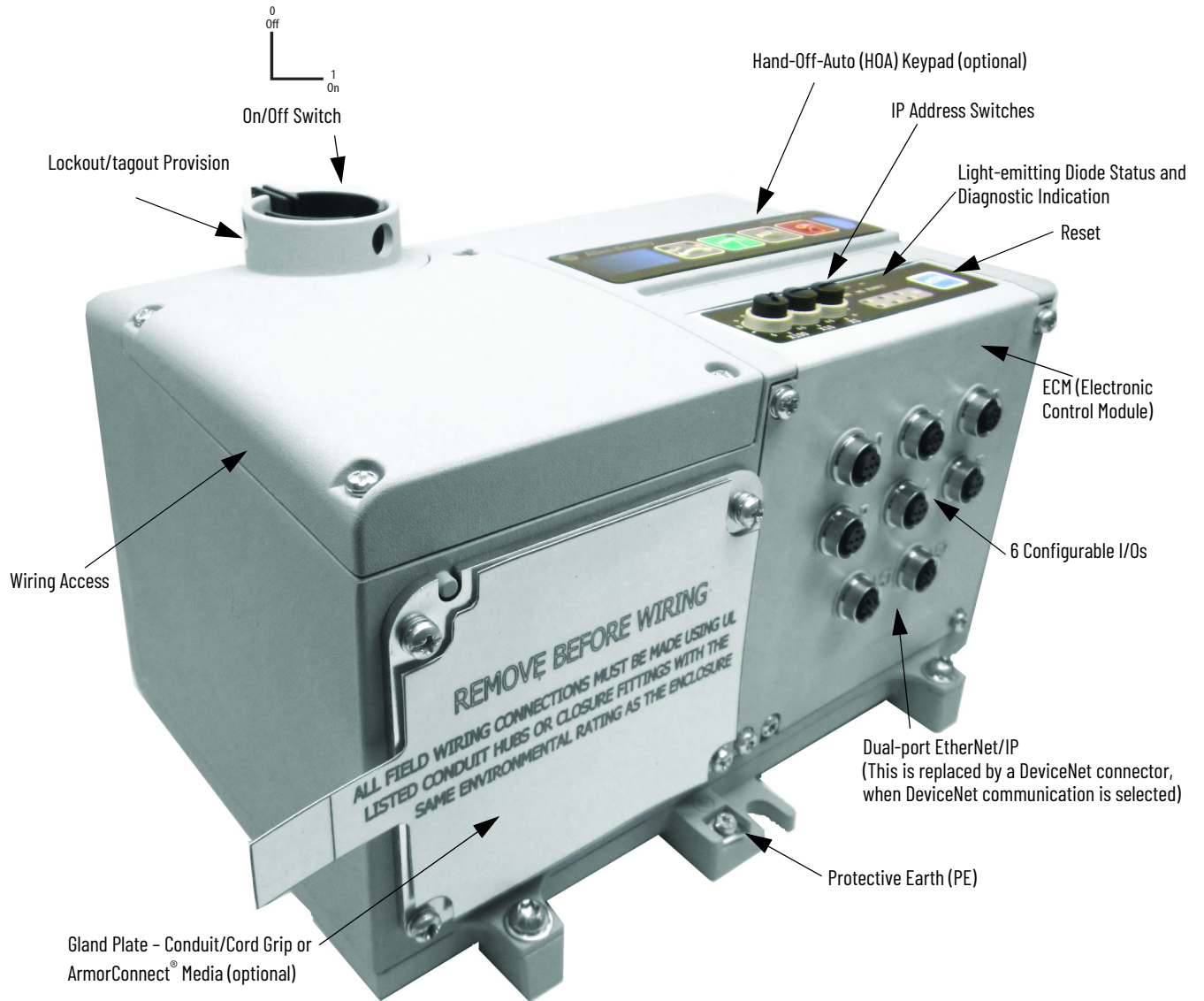
ArmorStart LT controllers include DeviceLogix™, a high-performing local logic engine that is used when a fast I/O response is critical to the application. The controllers also include either DeviceNet® communication capability or an embedded dual-port EtherNet/IP™ switch that supports Device Level Ring (DLR) topology.

(a) The G2 gland option is rated IP66/ UL Type 4

## Bulletin 290/291 ArmorStart LT Distributed Motor Controller

The ArmorStart LT catalog number 290D/E-\* and 291D/E-\* controllers are used for applications that require full-voltage, across-the-line starts. They have full inrush current and locked-rotor torque when initially started. They use DeviceNet or EtherNet/IP network communication. The catalog number 290D/E-\* controllers are used for nonreversing motor applications and the catalog number 291D/E-\* controllers are used for reversing motor applications.

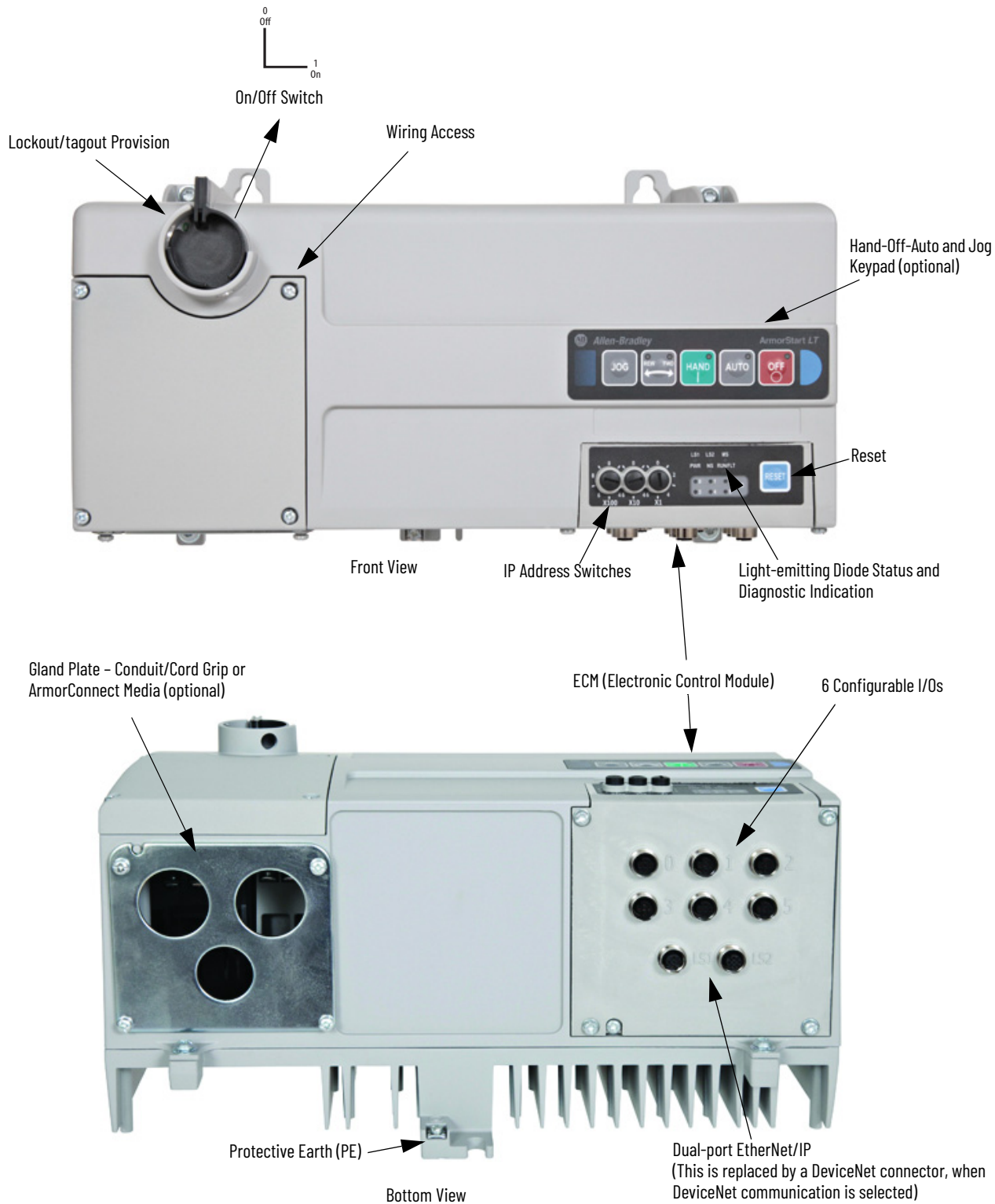
### Bulletin 290/291 Controller



## Bulletin 294 ArmorStart LT Distributed Motor Controller




The ArmorStart LT catalog number 294D/E-\* controllers are used for applications that require variable-speed motor control. They use DeviceNet or EtherNet/IP network communication.

### Bulletin 294 Controller

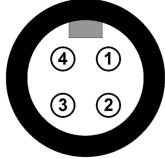
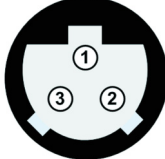




## Receptacle Pinouts

### EtherNet/IP, DeviceNet, and I/O Connections

EtherNet/IP Connector D-coded (M12)		I/O Connector (M12)	
	Pin 1: Tx+ Pin 2: Rx+ Pin 3: Tx- Pin 4: Rx-		Pin 1: Sensor source voltage Pin 2: Not used Pin 3: Common Pin 4: Input or Output Pin 5: Not used
DeviceNet Connector (M18)			
	Pin 1: Drain (no connection) Pin 2: +VDNET Pin 3: -VDNET Pin 4: CAN_H Pin 5: CAN_L		

### Power Connections<sup>(1)</sup>

Motor Connector		Source Brake Connector	
	Pin 1: T1 (black) Pin 2: T2 (white) Pin 3: T3 (red) Pin 4: Ground (green/yellow)		Pin 1: Ground (green/yellow) Pin 2: B1 (black) Pin 3: B2 (white)
Incoming Control Power— 24V DC only		Incoming 3-phase Power	
	Pin 1: (+V) Unswitched (A3)(red) Pin 2: (-V) Common (A2)(black) Pin 3: Not used (green) Pin 4: Not used (blank) Pin 5: (+V) Switched (A1)(blue) Pin 6: Not used (white)		Pin 1: L1 (black) Pin 2: L2 (white) Pin 3: L3 (red) Pin 4: Ground (green/yellow)

(1) ArmorStart LT controllers use a male receptacle for power inputs and a female receptacle for motor or motor brake output. These connectors are optional depending on your system wiring configuration.

## Bulletin 290/291 Controllers

This section provides selection and specification information for the Bulletin 290 and Bulletin 291 motor controllers.

### Catalog Number Explanation

Examples that are given in this section, are not intended to be used for product selection. This basic explanation should not be used for product selection; not all combinations produce a valid catalog number.

These tables explain what the product catalog number represents.

290   
 E - F   
 A   
 Z - G1   
 Option 1 - Option 2  
a    b    c    d    e    f    g    h

a	
Bulletin Number	
Code	Description
290	Full-voltage Starter
291	Reversing Starter

b	
Communication	
Code	Description
E	EtherNet/IP
D	DeviceNet

c	
Enclosure Type	
Code	Description
F	UL Type 4/12 <sup>(1)</sup>

d	
Overload Selection	
Code	Description
A	0.25...3.5 A
B	1.1...7.6 A

(1) IP66/UL Type 4 is available with all gland options. UL Type 4/12 is available with G1 and G3 gland option.

e	
Control Voltage	
Code	Description
Z	External 24V DC control power
p <sup>(2)</sup>	Internal power supply



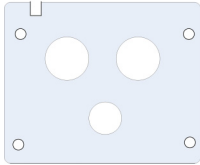
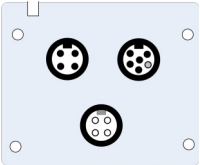
f	
Gland Plate Options (Power and Motor)	
Code	Description
G1	Conduit entry
G2	ArmorConnect
G3	Gland Kits <sup>(3)</sup>

g	
Option 1	
Code	Description
3	Hand/Off/Auto selector keypad
3FR	Hand/Off/Auto selector keypad with Forward/Reverse

h	
Option 2	
Code	Description
blank <sup>(1)</sup>	No option

- (1) Leave blank unless there is a customer-specific option defined by the factory.
- (2) Internal power supply requires 3-phase line power of 400Y/230V...480Y/277V, 50/60 Hz.
- (3) See [User-installed Options – G3 Gland on page 6](#) for gland configurations.

**Factory-installed Options**

	<b>Description</b>	<b>Cat. No. Modification</b>
	Hand/Off/Auto selector keypad	-3
	Hand/Off/Auto selector with Forward/Reverse function keypad	-3FR
	Conduit/Cord-ready gland plate	-G1 <sup>(1)</sup>
	ArmorConnect power media connectivity gland plate	-G2 <sup>(1)</sup>

(1) See [ArmorStart LT Gland Plate Matrix on page 27](#) for additional details.

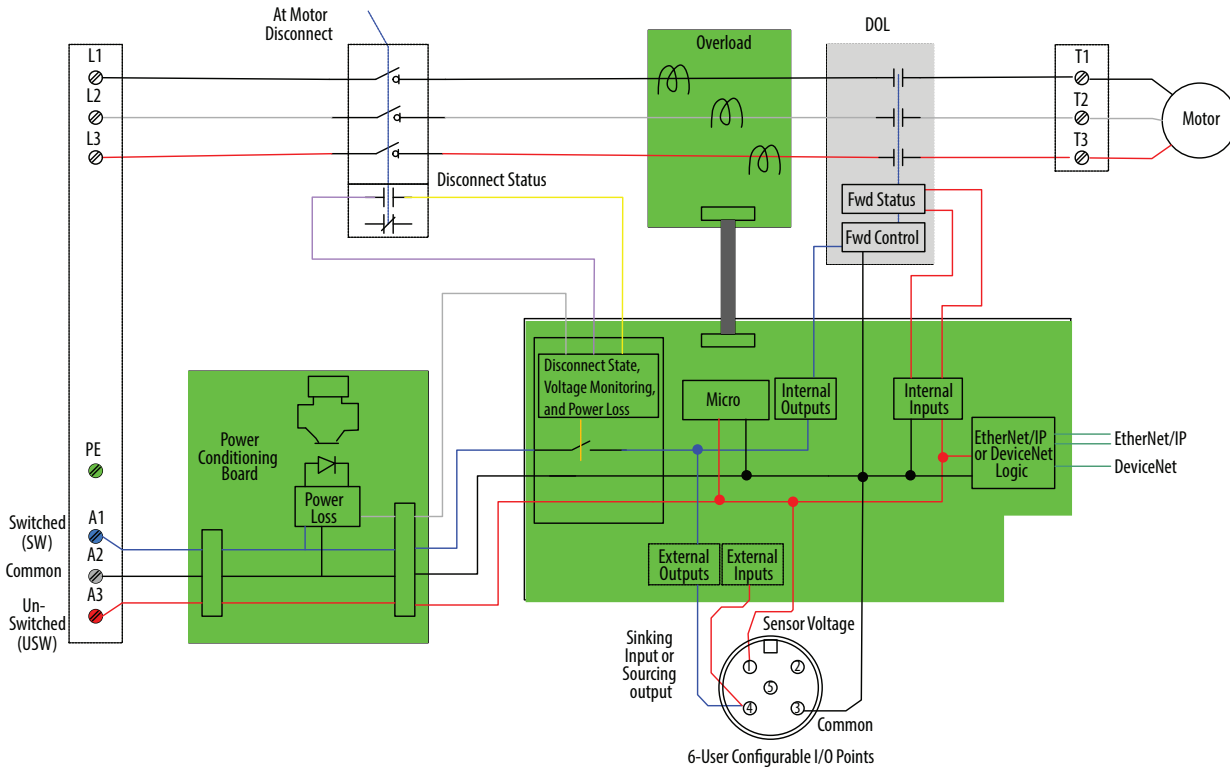
**User-installed Options – G3 Gland<sup>(1)</sup>**

	<b>Description</b>	<b>Pkg. Quantity</b>	<b>Cat. No.</b>
Alternative Gland Plates for Daisy Chain Power	Use when punching custom gland.	5 each (screws included)	290-G3-A1
	Use when no IPS and no SB options are selected.		290-G3-A2
	Use when IPS option is selected and no SB option is selected.		290-G3-A4

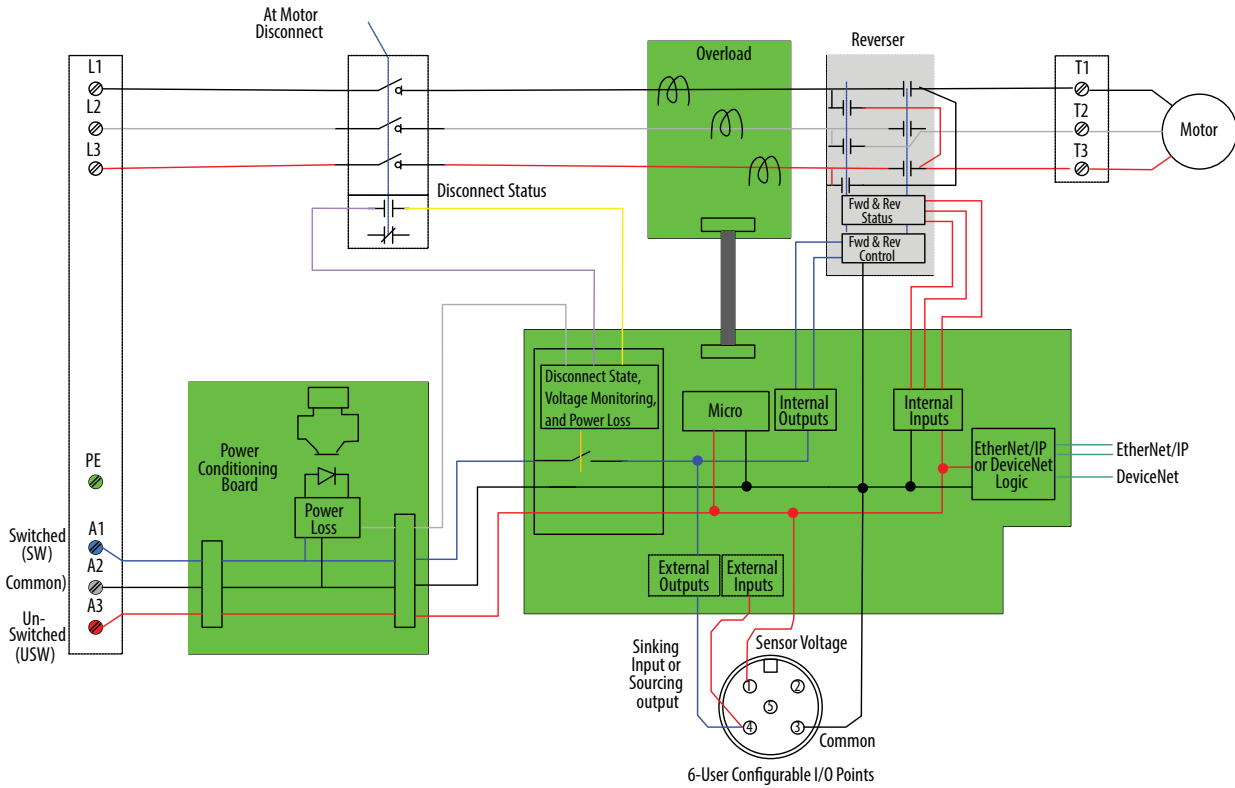
(1) See [ArmorStart LT Gland Plate Matrix on page 27](#) for additional details.

## Typical Wiring Diagrams

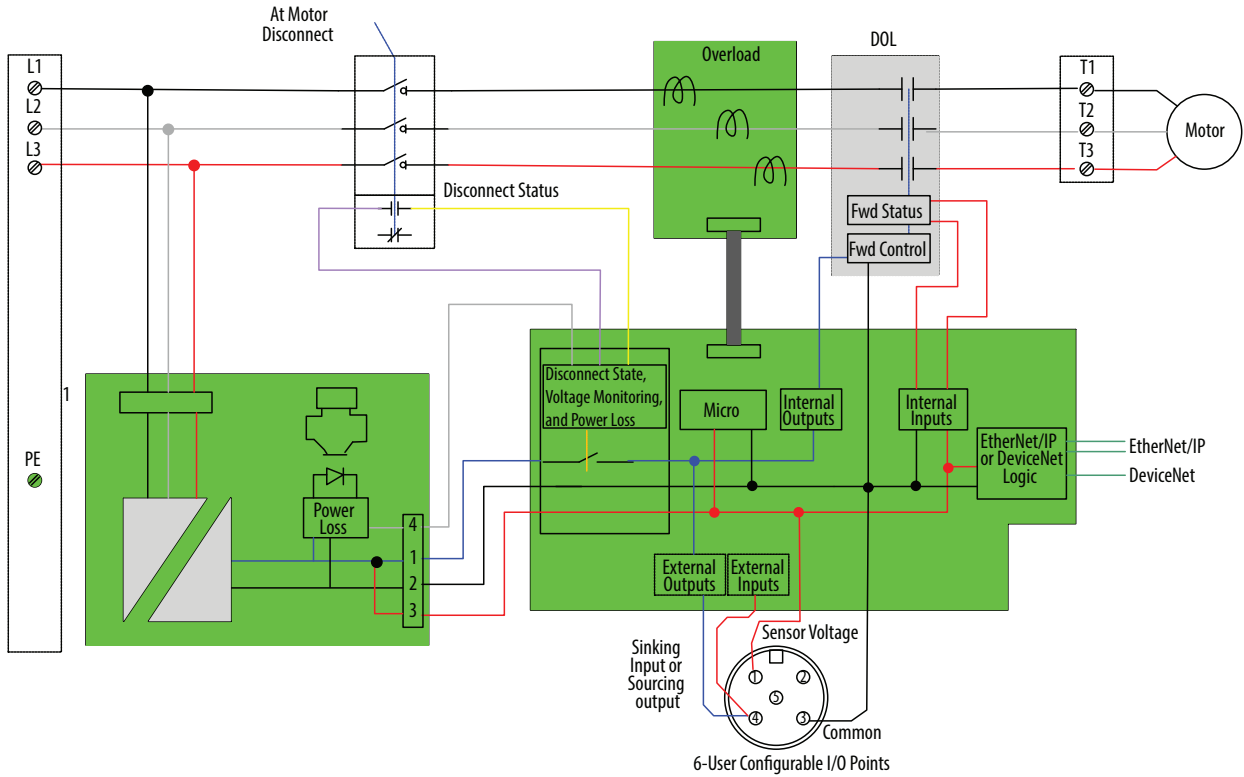
### Bulletin 290 Full-voltage, Nonreversing



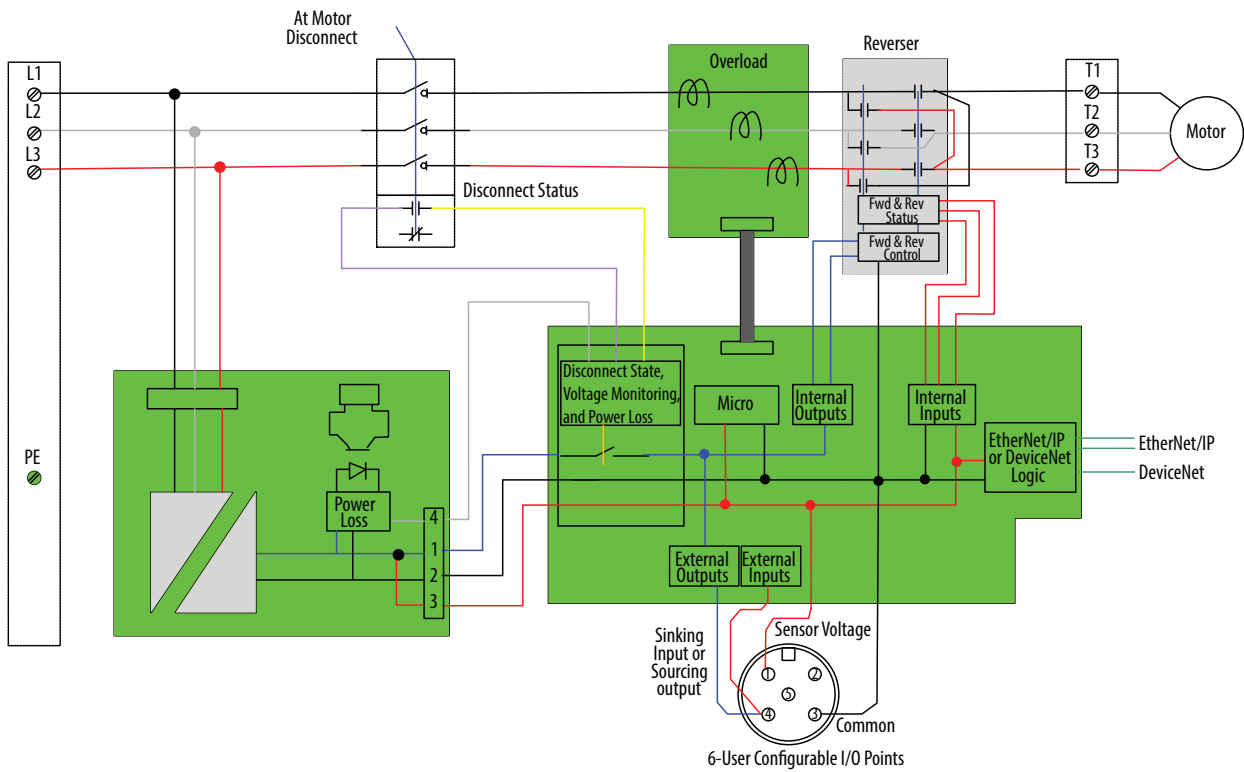
### Bulletin 291 Full Voltage, Reversing



**Bulletin 290 Full-voltage, Nonreversing with -IPS**



**Bulletin 291 Full Voltage, Reversing with -IPS**





## Specifications

### Electrical Ratings – Power Circuit

Attribute	Bulletin 290/291 Controllers		
Application	Three-phase		
Number of Poles	3		
Input Power Terminals	L1, L2, L3		
Motor Power Terminals	T1, T2, T3		
PE (Earth Ground) Terminal	4 PE terminals		
Rated Operating Voltage max	400Y/230...480Y/277 (-15%, +10%)		
Rated Impulse Voltage ( $U_{imp}$ )	4 kV		
Dielectric Withstand	UL: 1960V AC, IEC: 2500V AC		
Operating Frequency	50/60 Hz ( $\pm 10\%$ )		
Rated Operating Current max	Cat. No.	Hp (kW)	Overload Range
	290_--A-* 291_--A-*	2 (1.5)	0.24...3.5 A
	290_--B-* 291_--B-*	5 (3)	1.1...7.6 A
	–	–	–
Overload Type	Solid-state $I^2t$		
Trip Class	Class 10 (default), 15, 20 with thermal memory retention (see Motor Overload Trip Curves)		
Trip Rating	120% of FLC		
Reset Mode	Automatic or manual		
Overload Reset Level	1...100% TCU		
Overvoltage Category	III		

### Short-circuit Ratings

Attribute	Bulletin 290/291 Controllers			
Short Circuit Current Rating (SCCR)	Cat. No.	Sym. Amps RMS	Circuit Breaker	Fuse
	290/1_*-G1 or -G3	10 kA @ 480Y/277	When used with Allen-Bradley® Cat. No. 140U-D6D3-C30	CC, J, or T fuse (45 A, max)
	290/1_*-G1 or -G3	5 kA @ 480Y/277		UL Class fuse (45 A, max)
	290/1_*-G2	10 kA @ 480Y/277		CC, J, or T fuse (40 A, max)
Short Circuit Coordination	–			
	Type 1			
Size per NFPA 70 (NEC) or NFPA 79 for Group Motor Applications				

**Electrical Ratings – Control Circuit**

Attribute		Bulletin 290/291 Controllers	
External Source	Power Supply	NEC Class 2	
	Rated Operating Voltage	24V DC (+10%, -20%)	
	Overvoltage Protection	Reverse-polarity protected	
	Unswitched Power Supply Requirements	Voltage	19.2...26.4V DC
		Current, nom	150 mA
		Power	3.6 W
		Input Current (each) <sup>(1)</sup>	50 mA
		Current, max	450 mA
		Power, max	14.4 W
		Peak Inrush <sup>(2)</sup>	<5 A for 35 ms
	Switched Power Supply Requirements	Voltage	19.2...26.4V DC
		Current, nom	125 mA
		Power	3 W
		Output Current (each) <sup>(1)</sup>	500 mA
		Current, max	1.625 A
		Power, max	42 W
		Peak Inrush <sup>(2)</sup>	<5 A for 35 ms
	Switched and Unswitched Power Supply Requirements	Voltage	19.2...26.4V DC
		Current, nom	275 mA
		Power	6.6 W
		Number of Inputs (x 50 mA)	user defined
		Number of Outputs (x 500 mA)	user defined
		Current, max	275 mA + user defined
		Power, max	6.6 W + (24V DC x user defined)
		Peak Inrush <sup>(2)</sup>	<10 for 35 ms
	Internal Source (IPS option)		An internal 50 W power supply sources 24V DC for input, outputs, and logic control (3-phase line power of 400Y/230V...480Y/277V, 50/60 Hz is required)

(1) I/O is configurable to either input or output.

(2) Assumes zero wire resistance. Wire impedance reduces current inrush.

## Input Ratings

Attribute	Bulletin 290/291 Controllers
Supply Voltage	Unswitched power A3/A2
Type of Inputs	24V DC current sinking
Connection Type	Single keyed M12, quick disconnect
Input per Connection	1/each
Rated Operating Voltage	24V DC
On-State Input Voltage (pin 4)	10...26.4V DC, 24V DC, nom
Off-State Input Voltage	5V DC
On-State Input Current (pin 4)	1...3.7 mA, 2.6 mA @ 24V DC
Off-State Input Current	<1.5 mA
Sensor Leakage Current, max	<2.5 mA
Number of Input Devices, max	6
Sensor Sourcing Current (pin 1), max	50 mA per point (max 300 mA total for sourcing one device)
Sensor Operating Voltage Range	19.2...26V DC
Input Bounce Filter <sup>(1)</sup> (Software Configurable)	Off-On or On-Off: 0.5 ms + 64 ms
Filtering	100 $\mu$ s
DeviceLogix I/O Response	2 ms (500 Hz)

(1) Input ON-to-OFF delay time is the time from a valid input signal to recognition by the module.

## Output Ratings<sup>(1)</sup>

Attribute	Bulletin 290/291 Controllers
Supply Voltage (Switched Power)	A1/A2
Type of Outputs	DC sourcing
Load Types	Resistive or light inductive
Utilization Category (IEC)	DC-1, DC-13
Output State	Normally Open (N.O.)
Connection Type	Single keyed M12, quick disconnect
Output per Connection	1/each
Overcurrent Protection <sup>(2)</sup>	1.5 A (the sum of all outputs cannot exceed this value)
Rated Insulation Voltage ( $U_i$ )	<b>UL:</b> 1500V AC, <b>IEC:</b> 2000V AC
Rated Operating Voltage ( $U_o$ )	19.2...26.4V DC
Blocking Voltage, max	35V DC
Operating Current ( $I_o$ ), nom	500 mA per point
Thermal Current ( $I_{the}$ ), max	500 mA per point
Off-state Leakage Current, max	1 $\mu$ A
Number of Outputs, max	6
Surge Suppression	Integrated diode to help protect against switching loads

(1) Do not use as a power supply.

(2) If an output exceeds 1.5 A for greater than 7 ms, a fault is generated.

**Communication Ratings**

Attribute		Bulletin 290/291 Controllers
	Rated Insulation Voltage	250V
	Operating Dielectric Withstand	<b>UL/NEMA:</b> 1500V AC, <b>IEC:</b> 2000V AC
DeviceNet	DeviceNet Supply Voltage Rating	11...25V DC, 24V DC, nom
	DeviceNet Input Current	50 mA @ 24V DC
	DeviceNet Input Current Surge	500 mA peak inrush
	Communication rate	125, 250, 500 Kbps
	Distance, max	500 m (1630 ft) @ 125 Kbps 200 m (656 ft) @ 250 Kbps 100 m (328 ft) @ 500 Kbps
	Supported Features	<ul style="list-style-type: none"> <li>• Auto-Baud Rate Identification</li> <li>• "Group 2 - Slave Only" Device Type</li> <li>• Polled I/O Messaging</li> <li>• Change of State Messaging</li> <li>• Cyclic Messaging</li> <li>• Explicit Messaging</li> <li>• Full Parameter Object Support</li> <li>• Group 4 - Offline Node Recovery Messaging</li> <li>• Configuring Consistency Value</li> <li>• Unconnected Messaging Manager (UCMN)</li> </ul>
	EtherNet/IP	EtherNet/IP ODVA - Conformance Testing
Ethernet Communication Rate		10/100 Mbps, half or full-duplex
Ethernet Ports		2 (embedded switch)
Ethernet Network Topologies Supported		Star, Tree, Linear, and Ring
Device Level Ring Support		Beacon Performance, IEEE 1588 Transparent Clock
Ethernet Connector		M12, D code, female, with Ethernet keying, 4 Pin
Ethernet Cable		Category 5e: Shielded or unshielded
IP Configuration		Static, DHCP, or BOOTP
DHCP Timeout		30 s
Data		Transported over both TCP and UDP
Packet Rate (pps)		500 packets-per-second (2000 µs), Tx 500 packets-per-second (2000 µs), Rx
Consume Instance (Command)		Default of 3 words (Instance 150)
Produce Instance (Status)		Default of 14 words (Instance 152)
Message Support		Unicast or Multicast
Address Conflict Detection (ACD)		IP v4 Address Conflict Detection for EtherNet/IP devices
Sockets		150, max
Web Server	Security	Login and password configurable
	Email	Support Simple Mail Transfer Protocol (SMTP)
	Webpage Features	Status, diagnostics, configuration
	Concurrent Sessions	20
	Web Server	HTTP 1.1

**Communication Ratings (Continued)**

Attribute		Bulletin 290/291 Controllers
Network Connections	Concurrent TCP Connections	Maximum of 15 encapsulated messages over both TCP and UDP
	I/O Connections, max (CIP Class 1)	Supports up to 2 Class 1 CIP connections [Exclusive owner (data) or listen-only]. One connection per PLC. Listen only connection requires a data connection to be established.
	Concurrent Explicit Messages, max (CIP Class 3)	6
	Class 1 Connection API	2...3200 ms
	Class 3 Connection API	100...10 000 ms
	Request Packet Interval (RPI)	20 ms default (2 ms, min)

**Mechanical Ratings**

Attribute		Bulletin 290/291 Controllers			
Resistance to Shock	Operational	30 G, exceeds IEC 60947-1			
	Non-Operational	50 G, exceeds IEC 60947-1			
Resistance to Vibration	Operational	2.5 G, tested to MIL-STD-810G, exceeds IEC 60947-1			
	Non-Operational	5 G, tested to MIL-STD-810G, exceeds IEC 60947-1			
Disconnect Lock Out		Maximum of 3/8 in. (9.5 mm) diameter lock shackle or hasp			
Disconnect LOTO Locks		Up to 2 locks or hasps are supported			
Disconnect Mechanical Life		200 000 operations			
Contactor Utilization Category (IEC)		AC-1, AC-3, AC-4 (refer to Life Load Curves)			
Contactor Opening Delay		8...12 ms			
Contactor Closing Delay		18...40 ms			
Off Time, min		200 ms			
Contactor Mechanical Life		15 million operations			
		<b>Power Terminals</b>	<b>Motor Terminals</b>	<b>Control Terminals</b>	<b>PE/Ground</b>
Wire Size <sup>(1)</sup>		(2) #18 ...#10 AWG (0.8...5.2 mm <sup>2</sup> ) per terminal	#18...#10 AWG (0.8...5.2 mm <sup>2</sup> ) per terminal	(2) #18 ...#10 AWG (0.8...5.2 mm <sup>2</sup> ) per terminal	(2) #16 ...#10 AWG (1.3...5.2 mm <sup>2</sup> ) per terminal
Tightening Torque		10.6 ± 2 lb•in (1.2 ± 0.2 N•m)			18 ± 2 lb•in (2 ± 0.2 N•m)
Power Rating		600V AC, 25 A	600 V AC, 10 A	600V AC, 10 A	–
Wire Type		Multi-strand copper wire			
Wire Strip Length		0.35 ± 0.01 in. (9 ± 2 mm)			

(1) When two wires are used in a terminal block, both wires must be the same wire size (AWG).

**Environmental Ratings**

Attribute	Bulletin 290/291 Controllers
Operating Temperature Range <sup>(1)</sup>	-20...+50 °C (-4...+122 °F) <sup>(2)</sup>
Storage and Transportation Temperature Range	-25...+85 °C (-13...+185 °F)
Altitude	2000 m (6562 ft)
Humidity	5...95% (noncondensing)
Pollution Degree	3
Enclosure Ratings	IP66/UL Type 4/12 <sup>(3)</sup>
Shipping Weight, approx	4,6 kg (10 lb)

(1) Operation at -20...0 °C (-4...+32 °F), requires that 3-phase and control power be applied for a minimum of 180 s, before operation to run is commanded.

(2) Derating is not required when the unit is operating at 50° C (122° F) or less ambient temperature and the supply transformer is 120 kVA or less.

(3) IP66/UL Type 4 is available with gland options G1-3. IP66/UL Type 4/12 available with G1 and G3 gland option

**Emission and Immunity Ratings**

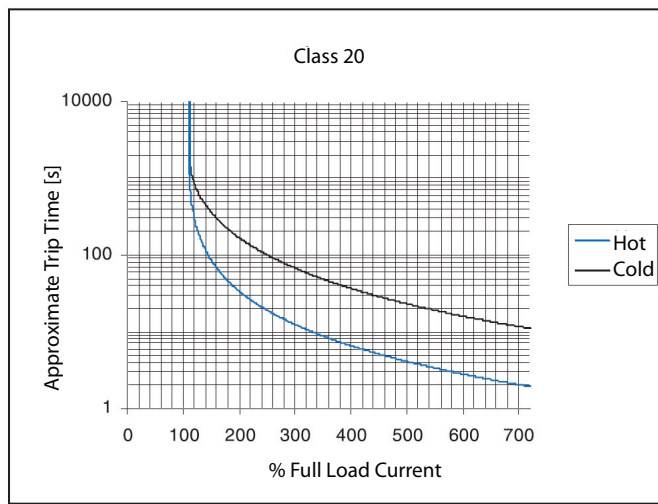
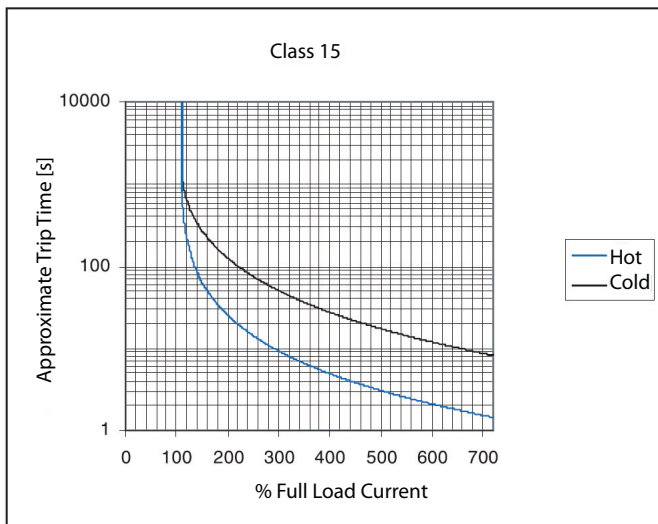
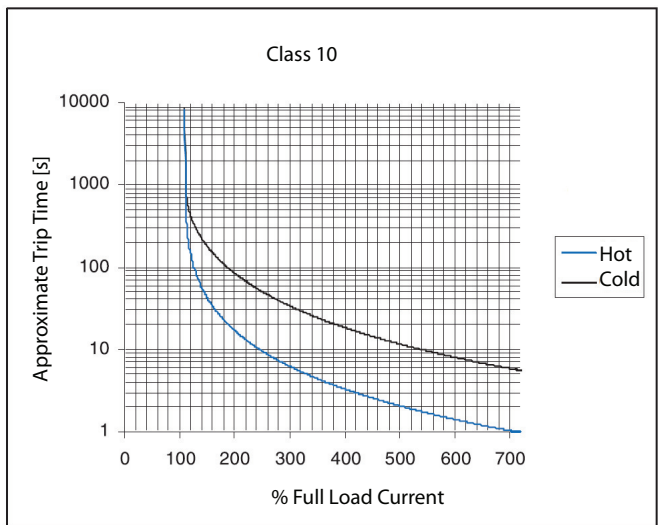
Attribute		Bulletin 290/291 Controllers
Emission	Conducted	EN 60947-4-1 Class A
	Radiated	
	Electrostatic Discharge	4 kV contact, 8 kV air
	Radio Frequency Electromagnetic Field	EN 60947-4-1 10V/m, 80 MHz...1 GHz 10V/m, 1.4 GHz...2 GHz
Immunity	Fast Transient	2 kV (Power) 2 kV (PE) 1 kV (Communication and control)
	Surge Transient	1 kV (12) <sub>L-L</sub> , 2 kV (2) <sub>L-N</sub> (earth)
	Radio Frequency Conducted Disturbance	10V, 150 kHz...80 MHz

**Standards Compliance and Certifications**

	Bulletin 290/291 Controllers		
	UL/CSA	EN/IEC	Other Agencies
Standards Compliance	<ul style="list-style-type: none"> <li>UL 508 Industrial Control Equipment - Suitable for Group Installation</li> <li>CSA C22.2, No. 14</li> </ul>	<ul style="list-style-type: none"> <li>EN 60947-4-1 Low Voltage Switchgear</li> <li>CE Marked per Low Voltage Directive 2006/95/EC and EMC Directive 2004/108/EC</li> </ul>	<ul style="list-style-type: none"> <li>CCC</li> <li>KCC</li> <li>C-Tick</li> <li>ODVA for EtherNet/IP and DeviceNet</li> </ul>
Certifications	cULus (File No. E3125, Guide NLDX, NLDX7)		

# Motor Overload Trip Curves

## Trip Curves for Bulletin 290/291

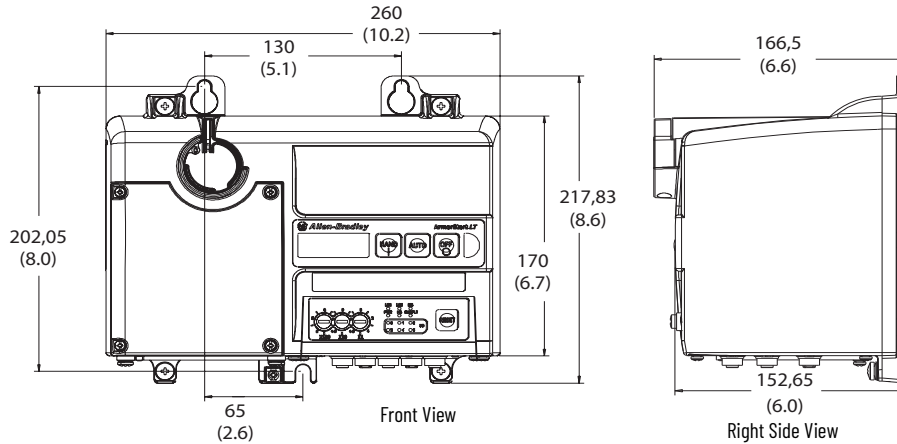


Also see [Bulletin 100-K Miniature Contactor Life-Load Curves on page 28](#).

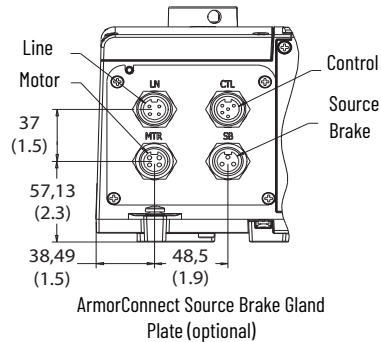
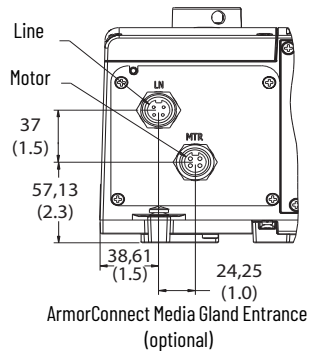
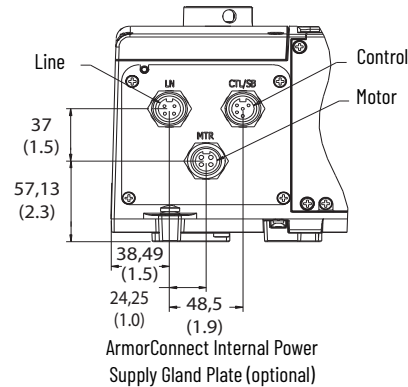
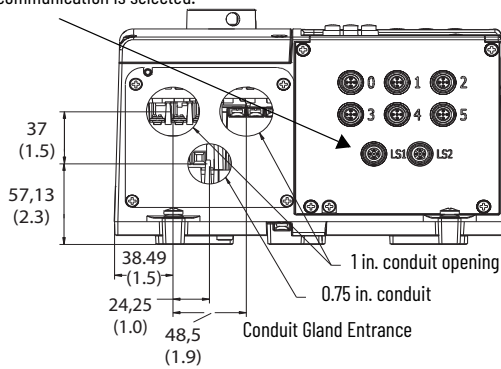
## Approximate Dimensions/Mount Orientation

Dimensions in millimeters (inches). Dimensions are not intended to be used for manufacturing purposes. All dimensions are subject to change.

### Bulletin 290/291 Dimensions

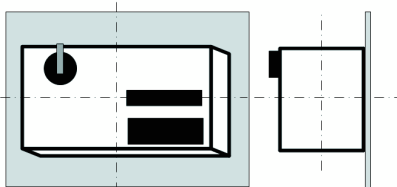


Dual-port EtherNet/IP is replaced by a DeviceNet connector when DeviceNet communication is selected.



See [ArmorStart LT Gland Plate Matrix on page 27](#) for gland plate dimensions.

### Bulletin 290/291 Acceptable Mount Orientations



**IMPORTANT** For proper heat dissipation and product operation, mount the ArmorStart LT controller in the vertical orientation that is shown or at a 180° position from this orientation.



## Bulletin 294 Controllers

This section provides selection and specification information for the Bulletin 294 motor controller.

### Catalog Number Explanation

Examples that are given in this section, are not intended to be used for product selection. This basic explanation should not be used for product selection; not all combinations produce a valid catalog number.

These tables explain what the product catalog number represents.

<b>294</b>	<b>E</b>	-	<b>F</b>	<b>DIP5</b>	<b>Z</b>	-	<b>G1</b>	<b>Option 1</b>	-	<b>Option 2</b>
a	b		c	d	e		f	g		h

a	
Bulletin Number	
Code	Description
294	VFD Starter

b	
Communication	
Code	Description
E	EtherNet/IP
D	DeviceNet

c	
Enclosure Type	
Code	Description
F	UL Type 4/12 <sup>(1)</sup>

d	
Output Current	
Code	Description
DIP5	1.5 A (0.4 kW), 0.5 Hp
D2P5	2.5 A (0.75 kW), 1.0 Hp
D4P2	3.6 A (1.5 kW), 2.0 Hp

(1) IP66/UL Type 4 is available with all gland options. UL Type 4/12 is available with G1 and G3 gland option.

e	
Control Voltage	
Code	Description
Z	External 24V DC control power
p <sup>(1)</sup>	Internal power supply

f	
Gland Plate Options (Power and Motor)	
Code	Description
G1	Conduit entry
G2	ArmorConnect
G3	Gland Kits <sup>(3)</sup>

g	
Option 1	
Code	Description
3	Hand/Off/Auto selector keypad with Jog function


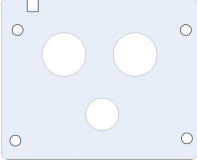
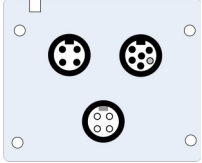
h	
Option 2	
Code	Description
SB	Source Brake
blank <sup>(2)</sup>	No option

(1) Internal power supply requires 3-phase line power of 400Y/230V...480Y/277V, 50/60 Hz.

(2) Leave blank unless there is a customer-specific option defined by the factory.

(3) See [User-installed Options – G3 Gland on page 18](#) for gland configurations.

**Factory-installed Options**

	Description	Cat. No. Modification
	Hand/Off/Auto Selector and Jog Keypad	-3
	Source brake (electromechanical)	-SB
	Conduit/Cord-Ready Gland Plate	-G1 <sup>(1)</sup>
	ArmorConnect Power Media Connectivity Gland Plate	-G2 <sup>(1)</sup>

(1) See [ArmorStart LT Gland Plate Matrix on page 27](#) for additional details.

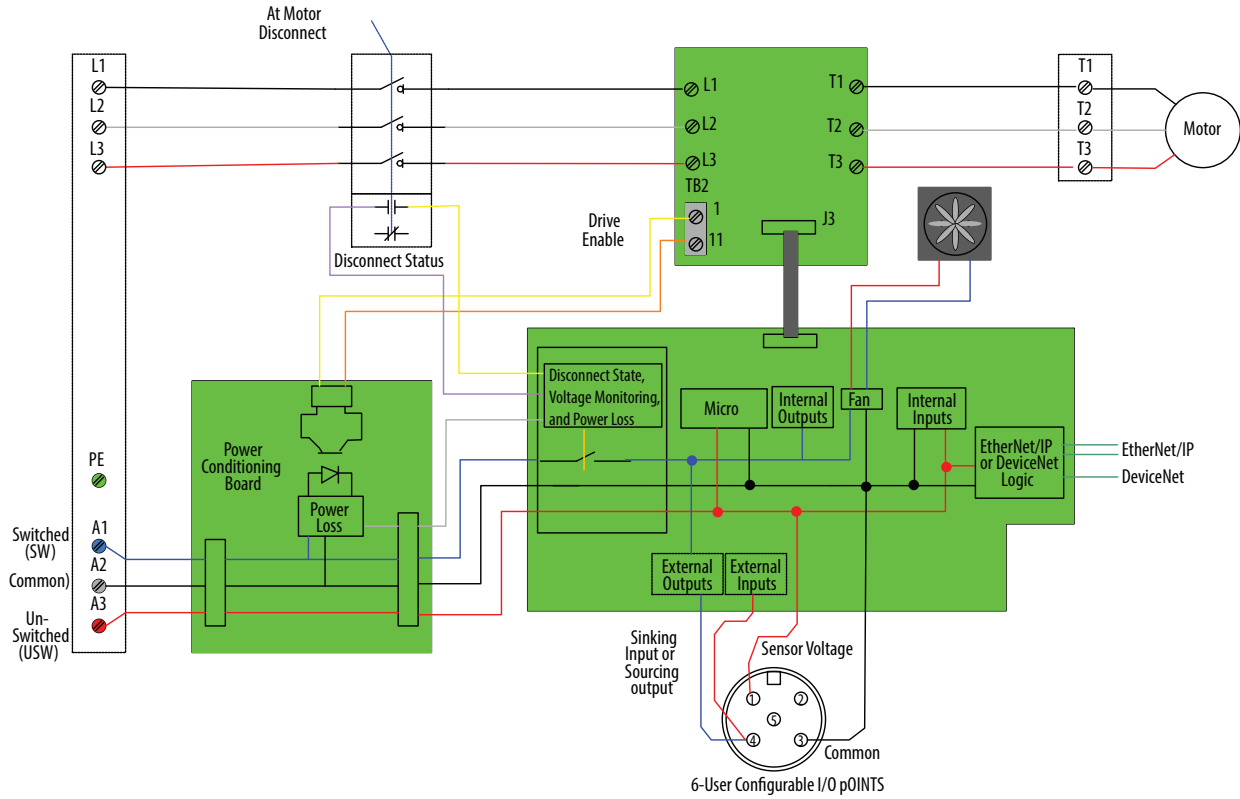
**User-installed Options – G3 Gland<sup>(1)</sup>**

	Description	Pkg. Quantity	Cat. No.
Alternative Gland Plates for Daisy Chain Power	Use when punching custom gland.	5 each (screws included)	290-G3-A1
	Use when no IPS and no SB options are selected.		290-G3-A2
	Use when SB option is selected and no IPS option is selected.		290-G3-A3
	Use when IPS option is selected and no SB option is selected.		290-G3-A4
	Use when IPS and SB options are selected.		290-G3-A5

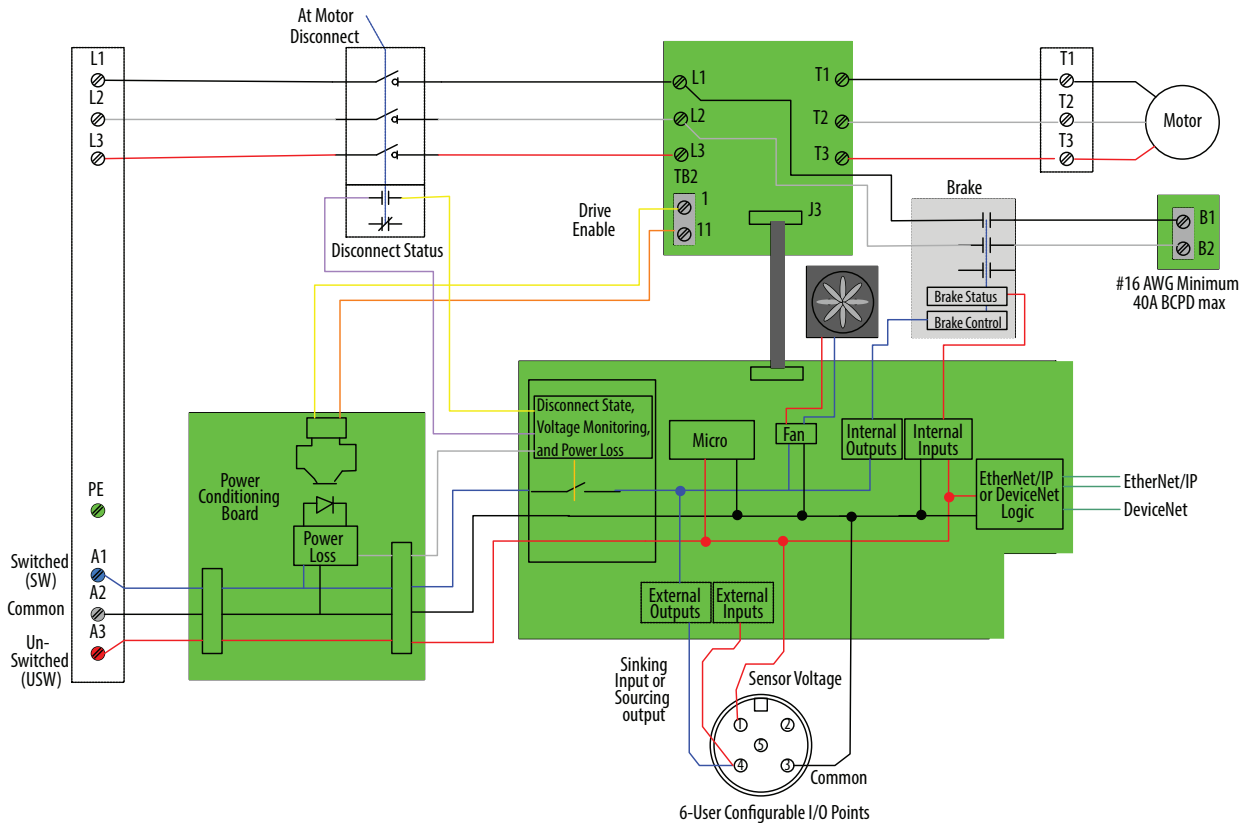
(1) See [ArmorStart LT Gland Plate Matrix on page 27](#) for additional details.

# Typical Wiring Diagrams

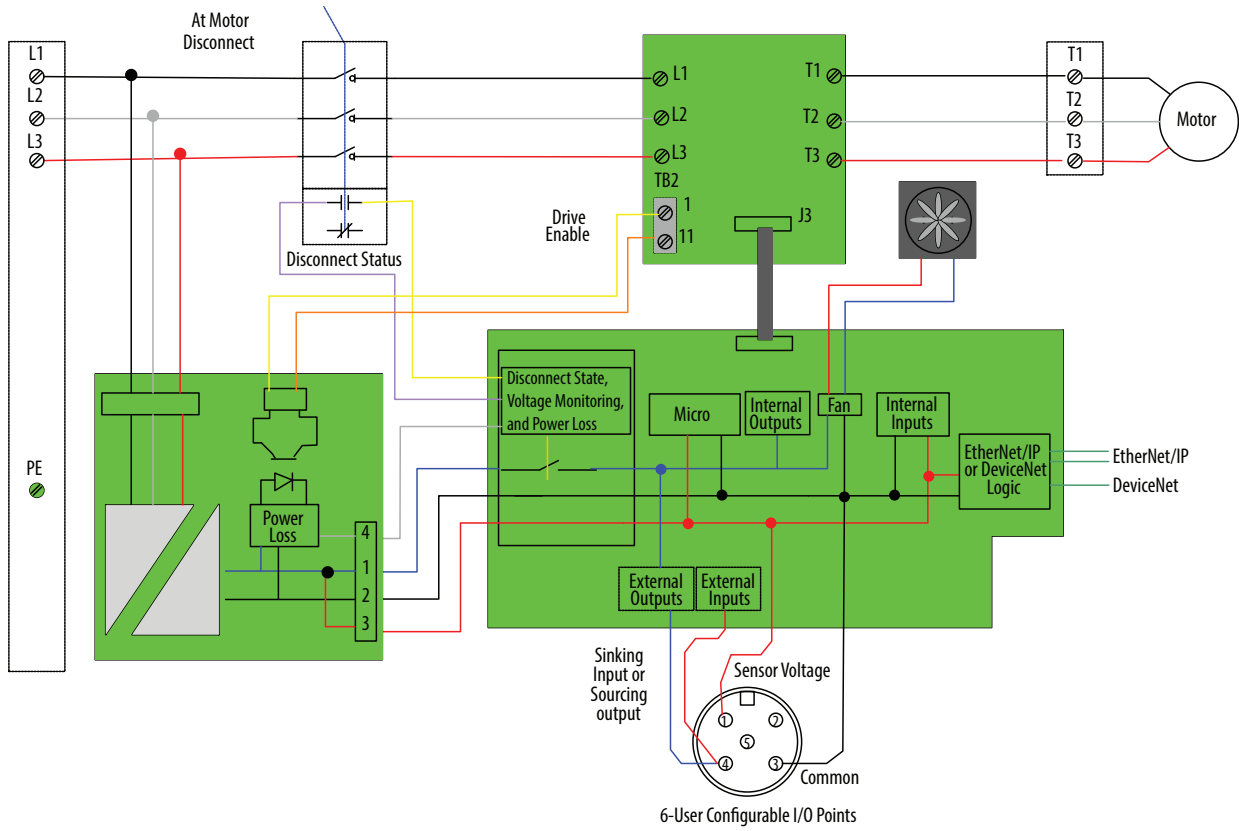
## Bulletin 294 VFD



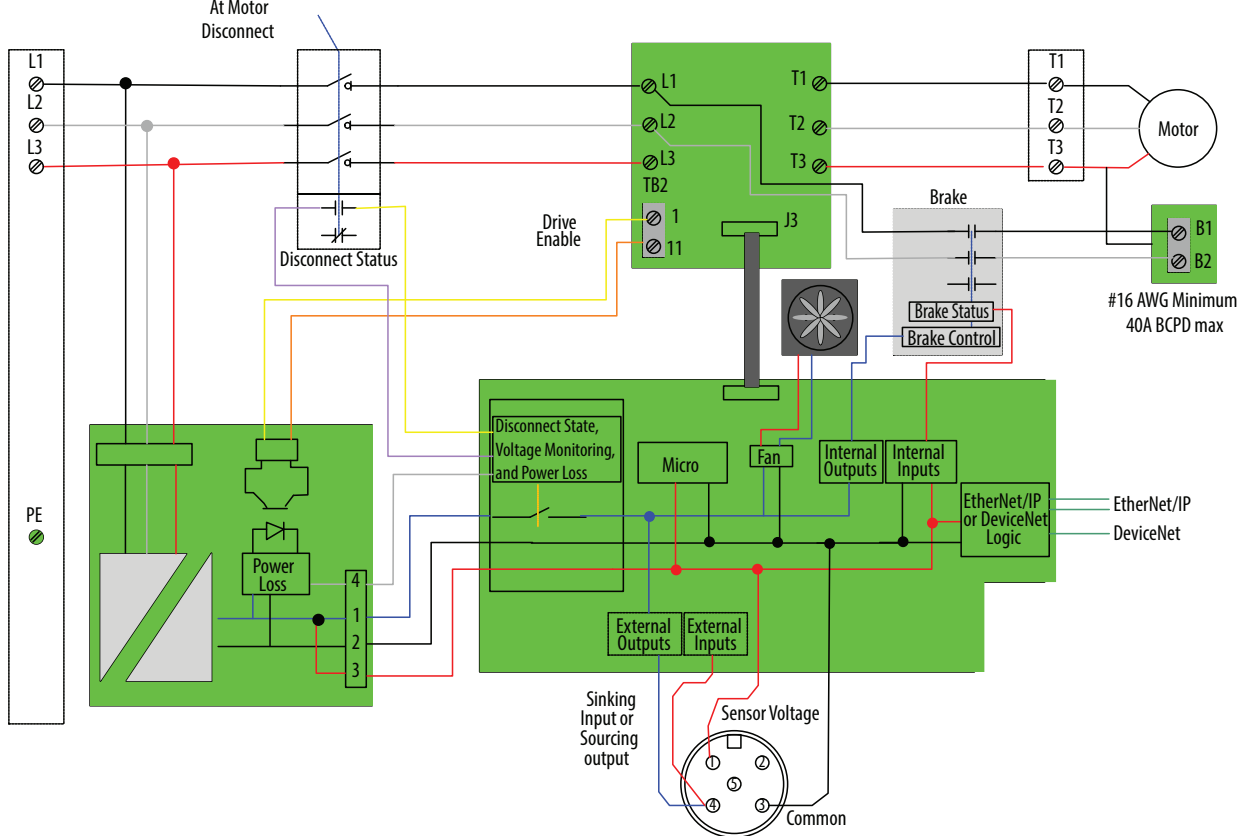
## Bulletin 294 VFD with -SB



**Bulletin 294 VFD with -IPS**



**Bulletin 294 VFD with -IPS, -SB**



## Specifications

### Electrical Ratings – Power Circuit

Attribute	Bulletin 294 Controller				
Application	Three-phase				
Number of Poles	3				
Input Power Terminals	L1, L2, L3				
Motor Power Terminals	T1, T2, T3				
PE (Earth Ground) Terminal	4 PE terminals				
Rated Operating Voltage, max	400Y/230...480Y/277 (-15%, +10%)				
Rated Impulse Voltage ( $U_{imp}$ )	4 kV				
Dielectric Withstand	UL: 1960V AC, IEC: 2500V AC				
Operating Frequency	50/60 Hz ( $\pm 10\%$ )				
Rated Operating Current, max	Cat. No.	Hp (kW)	Input Current 400V AC, 50 Hz	Input Current 480V AC, 60 Hz	Output Current
	294_-FD1P5*	0.5 (0.37)	2.0 A	1.8 A	1.5 A
	294_-FD2P5*	1.0 (0.75)	3.7 A	3.0 A	2.5 A
	294_-FD4P2*	2.0 (1.5)	6.5 A	5.5 A	3.6 A
Electronic Motor Overload Protection	Provides Class 10 motor overload protection according to NEC article 430 and motor over-temperature protection according to NEC article 430.126 (A)(2). UL 508C File 29572.				
Overload Type	Solid-state $I^2t$ : 150% for 60 s or 200% for 3 s				
Trip Class	Class 10 protection with speed sensitive response and power-down overload retention function				
Trip Rating	200% hardware limit, 300% instantaneous fault				
Reset Mode	Automatic or manual				
Overvoltage Category	III				
Output Frequency	0...400 Hz (programmable)				
Efficiency	97.5% typical				
Overvoltage	380...480V AC Input – Trip occurs at 810V DC bus voltage (equivalent to 575V AC incoming line)				
Undervoltage	380...480V AC Input – Trip occurs at 390V DC bus voltage (equivalent to 275V AC incoming line)				
Control Ride Through	Minimum ride through is 0.5 s – typical value is 2 s				
Faultless Power Ride Through	10 ms				
Carrier Frequency	2...10 kHz, drive rating based on 4 kHz				
Motor Control Features	Flying start, V/F ratio, bus regulator, 4 preset speeds				
Motor Control Type	Slip compensation (Volts/Hz)				
Speed Regulation – Open Loop with Slip Compensation (Volts/Hz)	$\pm 2\%$ of base speed across a 40:1 speed range				
Acceleration/Deceleration	Two independently programmable acceleration and deceleration times. Each time can be programmed from 0...600 s, in 0.1 s increments.				
Motor Cable Lengths, max (Reflected Wave Protection) <sup>(1)</sup>	10 m (32 ft) (CE application) <sup>(2)</sup> 14 m (45.9 ft) (non-CE application)				
Stop Modes	Multiple programmable stop modes including: Ramp, Coast, DC-brake, Ramp to Hold, and S-curve				
Source Brake (EM Brake) Current	Maximum load current of 3 A				

(1) The reflected wave data applies to all frequencies 2...10 kHz.

(2) For CE compliant installations, refer to the recommended EMI/RFI cord grip accessory. For availability of the quick disconnect three-phase shielded power and motor cable, contact your local sales representative for details.

**Electrical Ratings – Control Circuit**

Attribute		Bulletin 294 Controller		
External Source	Power Supply	NEC Class 2		
	Rated Operating Voltage	24V DC (+10%, -20%)		
	Overvoltage Protection	Reverse-polarity protected		
	Unswitched Power Supply Requirements	Voltage	19.2...26.4V DC	
		Current, nom	150 mA	
		Power	3.6 W	
		Input Current (each) <sup>(1)</sup>	50 mA	
		Current, max	450 mA	
		Power, max	14.4 W	
		Peak Inrush <sup>(2)</sup>	<5 A for 35 ms	
	Switched Power Supply Requirements	Voltage	19.2...26.4V DC	
		Current, nom	125 mA	
		Power	3 W	
		Output Current (each) <sup>(1)</sup>	500 mA	
		Current, max	1.625 A	
		Power, max	42 W	
		Peak Inrush <sup>(2)</sup>	<5 A for 35 ms	
	Switched and Unswitched Power Supply Requirements	Voltage	19.2...26.4V DC	
		Current, nom	275 mA	
		Power	6.6 W	
		Number of Inputs (x 50 mA)	user defined	
		Number of Outputs (x 500 mA)	user defined	
		Current, max	275 mA + user defined	
Power, max		6.6 W + (24V DC x user defined)		
Peak Inrush <sup>(2)</sup>		<10 for 35 ms		
Internal Source - IPS option		An internal 50 W power supply sources 24V DC for input, outputs, and logic control (3-phase line power of 400Y/230V...480Y/277V, 50/60 Hz is required)		

(1) I/O is configurable to either input or output.

(2) Assumes zero wire resistance. Wire impedance reduces current inrush.

**Short-circuit Ratings**

Attribute	Bulletin 294 Controller			
	Cat. No.	Sym. Amps RMS	Circuit Breaker	Fuse
Short Circuit Current Rating (SCCR)	294_*-G1 or -G3	10 kA @ 480Y/277	When used with Allen-Bradley Cat. No. 140U-D6D3-C30	CC, J, or T fuse (45 A, max)
	294_*-G1 or -G3	5 kA @ 480Y/277		UL Class fuse (45 A, max)
	294_*-G1-SB	10 kA @ 480Y/277		CC, J, or T fuse (40 A, max)
	294_*-G1-SB	5 kA @ 480Y/277		UL Class fuse (40 A, max)
	294_*-G2*	10 kA @ 480Y/277		CC, J, or T fuse (40 A, max)
Short Circuit Coordination	Type 1			
	Size per NFPA 70 (NEC) or NFPA 79 for Group Motor Applications			

**Input Ratings**

Attribute	Bulletin 294 Controller
Supply Voltage	Unswitched power A3/A2
Type of Inputs	24V DC current sinking
Connection Type	Single keyed M12, quick disconnect
Input per Connection	1/each
Rated Operating Voltage	24V DC
On-State Input Voltage (pin 4)	10...26.4V DC, 24V DC, nom
Off-State Input Voltage	5V DC
On-State Input Current (pin 4)	1...3.7 mA, 2.6 mA @ 24V DC
Off-State Input Current	<1.5 mA
Sensor Leakage Current, max	<2.5 mA
Number of Input Devices, max	6
Sensor Sourcing Current (pin 1), max	50 mA per point (max 300 mA total for sourcing one device)
Sensor Operating Voltage Range	19.2...26V DC
Input Bounce Filter <sup>(1)</sup> (Software Configurable)	Off-On or On-Off: 0.5 ms + 64 ms
Filtering	100 $\mu$ s
DeviceLogix I/O Response	2 ms (500 Hz)

(1) Input ON-to-OFF delay time is the time from a valid input signal to recognition by the module.

**Output Ratings<sup>(1)</sup>**

Attribute	Bulletin 294 Controller
Supply Voltage (Switched Power)	A1/A2
Type of Outputs	DC sourcing
Load Types	Resistive or light inductive
Utilization Category (IEC)	DC-1, DC-13
Output State	Normally Open (N.O.)
Connection Type	Single keyed M12, quick disconnect
Output per Connection	1/each
Overcurrent Protection <sup>(2)</sup>	1.5 A (the sum of all outputs cannot exceed this value)
Rated Insulation Voltage ( $U_i$ )	<b>UL:</b> 1500V AC, <b>IEC:</b> 2000V AC
Rated Operating Voltage ( $U_o$ )	19.2...26.4V DC
Blocking Voltage, max	35V DC
Operating Current, nom( $I_o$ )	500 mA per point
Thermal Current, max( $I_{the}$ )	500 mA per point
Off-state Leakage Current, max	1 $\mu$ A
Number of Outputs, max	6
Surge Suppression	Integrated diode to help protect against switching loads

(1) Do not use as a power supply.

(2) If an output exceeds 1.5 A for greater than 7 ms, a fault is generated.

**Mechanical Ratings**

Attribute		Bulletin 294 Controller				
Resistance to Shock	Operational	30 G, exceeds IEC 60947-1				
	Non-Operational	50 G, exceeds IEC 60947-1				
Resistance to Vibration	Operational	2.5 G, tested to MIL-STD-810G, exceeds IEC 60947-1				
	Non-Operational	5 G, tested to MIL-STD-810G, exceeds IEC 60947-1				
Disconnect Lock Out	Maximum of 3/8 in. (9.5 mm) diameter lock shackle or hasp	Maximum of 3/8 in. (9.5 mm) diameter lock shackle or hasp				
Disconnect LOTO Locks	Up to 2 locks or hasps are supported	Up to 2 locks or hasps are supported				
Disconnect Mechanical Life	200 000 operations	200 000 operations				
		<b>Power Terminals</b>	<b>Motor Terminals</b>	<b>Control Terminals</b>	<b>PE/Ground</b>	<b>Source Brake</b>
Wire Size <sup>(1)</sup>		(2) #18 ...#10 AWG (0.8...5.2 mm <sup>2</sup> ) per terminal	#18...#10 AWG (0.8...5.2 mm <sup>2</sup> ) per terminal	(2) #18 ...#10 AWG (0.8...5.2 mm <sup>2</sup> ) per terminal	(2) #16 ...#10 AWG (1.3... 5.2 mm <sup>2</sup> ) per terminal	#16 ...#10 AWG (1.0...4.0 mm <sup>2</sup> ) per terminal
Tightening Torque		10.6 ± 2 lb•in (1.2 ± 0.2 N•m)			18 ± 2 lb•in (2 ± 0.2 N•m)	4.8 ± 2 lb•in (0.5 ± 0.2 N•m)
Power Rating		600V AC, 25 A	600V AC, 10 A	600V AC, 10 A	—	600V AC, 10 A
Wire Type		Multi-strand copper wire				
Wire Strip Length		0.35 ± 0.01 in. (9 ± 2 mm)				

(1) When two wires are used in a terminal block, both wires must be the same wire size (AWG).

**Environmental Ratings**

Attribute	Bulletin 294 Controller
Operating Temperature Range <sup>(1)</sup>	-20...+40 °C (-4...+104°F) <sup>(2)</sup> up to 50 °C (122 °F) without derating, when properly rated line reactors are installed in branch circuit <sup>(3)</sup>
Storage and Transportation Temperature Range	-25...+85 °C (-13...+185 °F)
Altitude	1000 m <sup>(4)</sup> (3281 ft)
Humidity	5...95% (noncondensing)
Pollution Degree	3
Enclosure Ratings	IP66/UL Type 4/12 <sup>(5)</sup>
Shipping Weight, approx	7.3 kg (16 lb)

- (1) Operation at -20...0 °C (-4...+32 °F), requires that 3-phase and control power be applied for a minimum of 180 s, before operation to run is commanded.
- (2) Derating is not required when the unit is operating at 50 °C (122 °F) or less ambient temperature and the supply transformer is 120 kVA or less.
- (3) We recommend using an 800 µH line reactor when the unit is operating at 41...50 °C (106...122 °F) ambient temperature, to help ensure maximum VFD life.
- (4) Derate -1% for each 100 m (328 ft) above 1000 m (3281 ft), up to a maximum of 2000 m (6562 ft), at 480V AC.
- (5) IP66/UL Type 4 is available with gland options G1-3. IP66/UL Type 4/12 available with G1 and G3 gland option

**Emission and Immunity Ratings**

Attribute		Bulletin 294 Controller
Emission	Conducted	EN 61800-3, C3
	Radiated	
	Electrostatic Discharge	4 kV contact, 8 kV air
	Radio Frequency Electromagnetic Field	EN 55011 Class Group 2 10V/m, 80 MHz...1 GHz
Immunity	Fast Transient	2 kV (Power) 2 kV (PE) 1 kV (Communication and control)
	Surge Transient	1 kV (12) L-L, 2 kV (2) L-N (earth)
	Radio Frequency Conducted Disturbance	10V, 150 kHz...80 MHz



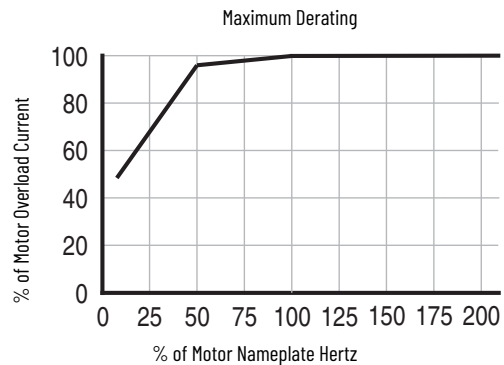
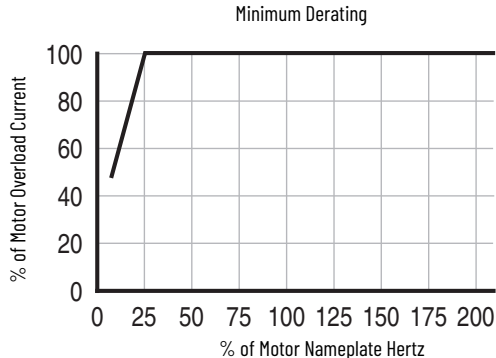
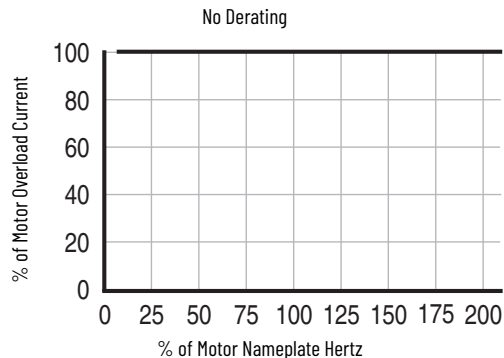
**Standards Compliance and Certifications**

Bulletin 294 Controller			
	UL/CSA	EN/IEC	Other Agencies
Standards Compliance	<ul style="list-style-type: none"> <li>UL 508C Power Conversion Equipment - Suitable for Group Installation</li> <li>CSA C22.2, No. 14</li> </ul>	<ul style="list-style-type: none"> <li>EN 61800 - Adjustable Speed Electrical Power Drive Systems, Part 3: EMC Requirements and Specific Test Methods</li> <li>CE Marked per EMC Directive 2004/108/EC, Part 5-1: Safety Requirements - Electrical, Thermal, and Energy</li> <li>CE Marked per Low Voltage Directive 2005/95/EC</li> </ul>	<ul style="list-style-type: none"> <li>KCC</li> <li>C-Tick</li> <li>ODVA for EtherNet/IP and DeviceNet</li> <li>RoHS</li> </ul>
Certifications	cULus (File No. E207834, Guides NMMS, NMMS7)		

**Motor Overload Trip Curves**

**Trip Curves for Bulletin 294**

Motor overload current parameter provides class 10 overload protection. Ambient insensitivity is inherent in the electronic design of the overload.

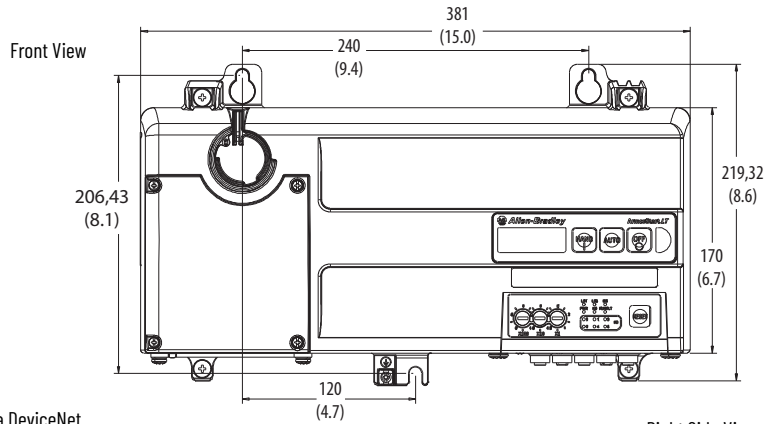


Also see [Bulletin 100-K Miniature Contactor Life-Load Curves on page 28](#).

## Approximate Dimensions/Mount Orientation

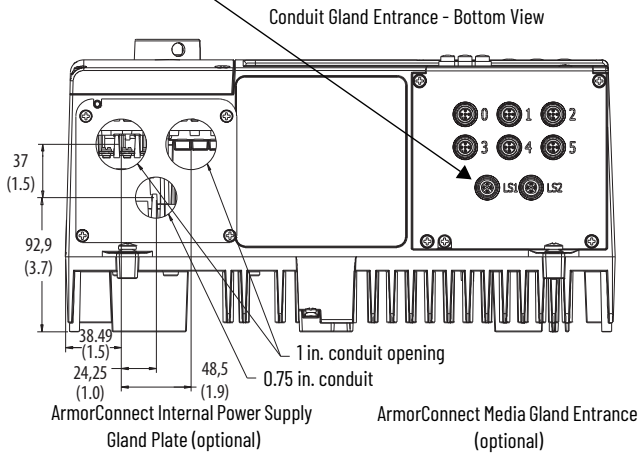
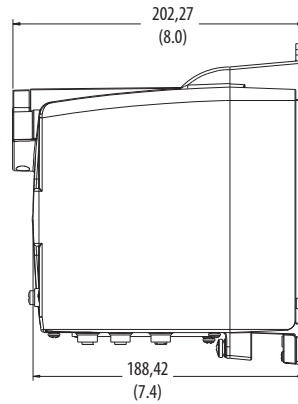
Dimensions in millimeters (inches). Dimensions are not intended to be used for manufacturing purposes. All dimensions are subject to change.

### Bulletin 294 Dimensions



Dual-port EtherNet/IP is replaced by a DeviceNet connector when DeviceNet communication is selected.

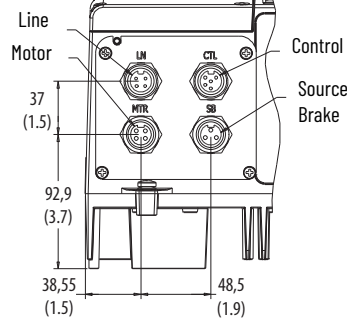
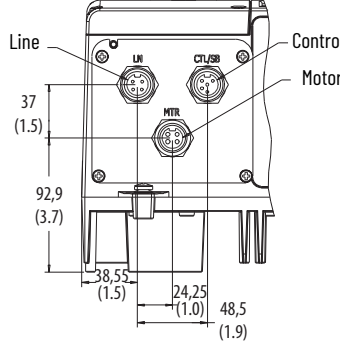
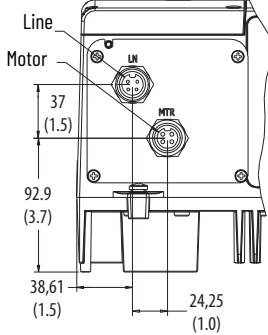
Right Side View



ArmorConnect Internal Power Supply Gland Plate (optional)

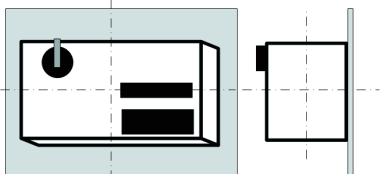
ArmorConnect Media Gland Entrance (optional)

ArmorConnect Gland Entrance with Source Brake (optional)



See [ArmorStart LT Gland Plate Matrix on page 27](#) for gland plate dimensions.

### Bulletin 294 Acceptable Mount Orientations



#### IMPORTANT

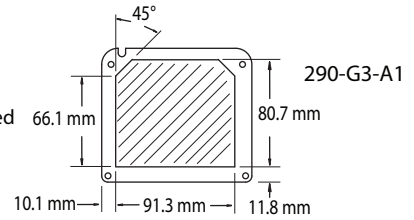
For proper heat dissipation and product operation, mount the ArmorStart LT controller in the vertical orientation that is shown or at a 180° position from this orientation.

# ArmorStart LT Gland Plate Matrix

	G1 Conduit Standard U.S. Trade Knock-outs	G2 Media	G3 Conduit Daisy Chaining IP66 Metric Fittings	Cat. No.
No Internal Power Supply No Source Brake				290-G3-A2
Source Brake No Internal Power Supply				290-G3-A3
Internal Power Supply No Source Brake				290-G3-A4
Internal Power Supply and Source Brake				290-G3-A5

**User Modified**

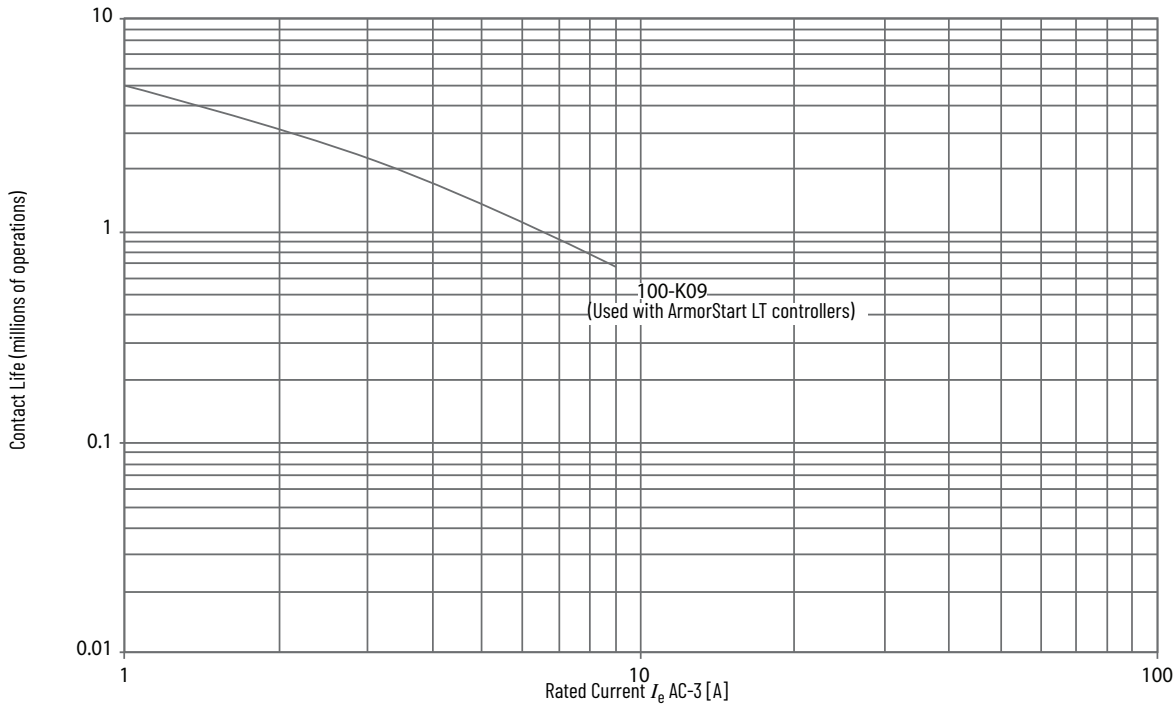
**Gland Plate Clearances**  
 Modifications are not permitted in the keepout region. Fitting(s) should be oriented so that they do not interfere with the enclosure when the gland plate is installed.  
 Torque the gland mounting screws to 12...14 in·lb (1.3...1.6 N·m).



# Bulletin 100-K Miniature Contactor Life-Load Curves

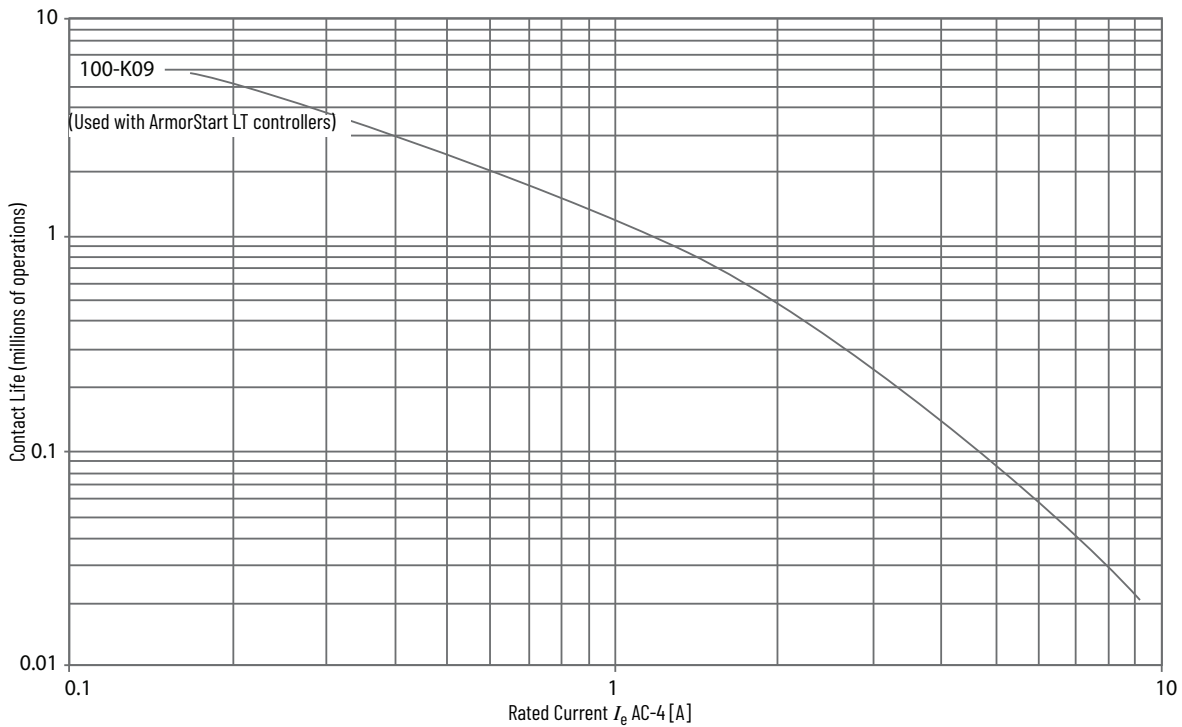
## AC-3: Switching of squirrel-cage motors while starting

Electrical life;  $U_e = 400...460V$  AC



## AC-4: Stepping of Squirrel-cage Motors

Electrical life;  $U_e = 400...460V$  AC



## Additional Resources

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

Resource	Description
ArmorStart Distributed Motor Controllers Selection Guide, publication <a href="#">280-SG002</a>	Provides information on product specifications, ratings, certifications, system interface, wiring diagrams, and dimensions, to aid in product selection.
ArmorStart Distributed Motor Controller and ArmorConnect Power Media Selection Guide, publication <a href="#">280PWR-SG001</a>	Provides information on product specifications, ratings, certifications, system interface, wiring diagrams, and dimensions, to aid in product selection.
ArmoStart LT Distributed Motor Controller (EtherNet/IP version) User Manual, publication <a href="#">290E-UM001</a>	Provides information on how to install, configure, and use ArmorStart LT controllers with EtherNet/IP network communications.
ArmoStart LT Distributed Motor Controller (EtherNet/IP version) User Manual, publication <a href="#">290D-UM001</a>	Provides information on how to install, configure, and use ArmorStart LT controllers with DeviceNet network communications.
Applying More Than One ArmorStart Motor Controller in a Single Branch Circuit on Industrial Machinery, publication <a href="#">280-ATO03</a>	This document explains how to use this Listing to apply the ArmorStart product family of motor controllers in multiple-motor branch circuits.
EtherNet/IP Network Devices User Manual, publication <a href="#">ENET-UM006</a>	Describes how to configure and use EtherNet/IP devices to communicate on the EtherNet/IP network.
Ethernet Reference Manual, publication <a href="#">ENET-RM002</a>	Describes basic Ethernet concepts, infrastructure components, and infrastructure features.
System Security Design Guidelines Reference Manual, publication <a href="#">SECURE-RM001</a>	Provides guidance on how to conduct security assessments, implement Rockwell Automation products in a secure system, harden the control system, manage user access, and dispose of equipment.
Industrial Components Preventive Maintenance, Enclosures, and Contact Ratings Specifications, publication <a href="#">IC-TD002</a>	Provides a quick reference tool for Allen-Bradley industrial automation controls and assemblies.
Safety Guidelines for the Application, Installation, and Maintenance of Solid-State Control, publication <a href="#">SGI-1.1</a>	Designed to harmonize with NEMA Standards Publication No. ICS 1.1-1987 and provides general guidelines for the application, installation, and maintenance of solid-state control in the form of individual devices or packaged assemblies incorporating solid-state components.
Industrial Automation Wiring and Grounding Guidelines, publication <a href="#">1770-4.1</a>	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, <a href="http://rok.auto/certifications">rok.auto/certifications</a> .	Provides declarations of conformity, certificates, and other certification details.

You can view or download publications at [rok.auto/literature](http://rok.auto/literature).

# Rockwell Automation Support

Use these resources to access support information.

<b>Technical Support Center</b>	Find help with how-to videos, FAQs, chat, user forums, and product notification updates.	<a href="http://rok.auto/support">rok.auto/support</a>
<b>Knowledgebase</b>	Access Knowledgebase articles.	<a href="http://rok.auto/knowledgebase">rok.auto/knowledgebase</a>
<b>Local Technical Support Phone Numbers</b>	Locate the telephone number for your country.	<a href="http://rok.auto/phonesupport">rok.auto/phonesupport</a>
<b>Literature Library</b>	Find installation instructions, manuals, brochures, and technical data publications.	<a href="http://rok.auto/literature">rok.auto/literature</a>
<b>Product Compatibility and Download Center (PCDC)</b>	Get help determining how products interact, check features and capabilities, and find associated firmware.	<a href="http://rok.auto/pcdc">rok.auto/pcdc</a>





## Documentation Feedback

Your comments help us serve your documentation needs better. If you have any suggestions on how to improve our content, complete the form at [rok.auto/docfeedback](http://rok.auto/docfeedback).

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EUROPE/MIDDLE EAST/AFRICA: Rockwell Automation NV, Pegasus Park, De Kleetlaan 12a, 1831 Diegem, Belgium, Tel: (32) 2 663 0600, Fax: (32) 2 663 0640

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