Allen-Bradley

ArmorStart ST Distributed Motor Controller Specifications

Bulletin Numbers 281E/281ES/281GS and 284E/284ES/284GS (includes safety versions)

Summary of Changes

This publication has been updated to add and correct various design specifications.

Product Description

The ArmorStart® ST controller is an integrated, pre-engineered, motor-starting solution that implements a safety-related stop function that conforms to Category 0 of IEC 60204-1. The ArmorStart ST controller provides the equivalent of an embedded dual-port EtherNet/IP™ switch. Model 281E/281ES/281GS-*-RRG is used in full-voltage and reverse applications. Model 284E/284ES/284GS-*-RRG-* is used in variable frequency applications where more precise motor control is needed. The ArmorStart ST controller offers IP67/NEMA Type 4/12/13 enclosure design, which is suitable for water wash down environments, with cable connectors or a sealing cap in place.

The ArmorStart ST hard-wired safety version controller is used with an Allen-Bradley® Safety I/O ArmorBlock®, catalog number 1732ES-IB12XOBV2 or 1732ES-IB8XOBV4. Over-molded cables (Allen-Bradley 889N series) connect the ArmorBlock unit to the ArmorStart units. This configuration provides for implementation of a safety-related stop function in machines with the capability of Category 4/PL e, according to EN ISO 13849-1 and SIL 3, according to EN 62061/IEC 61508.

The ArmorStart ST integrated safety version controller provides integrated safe torque-off (STO) over the EtherNet/IP network and safety input and output connections, as well as two options for standard I/O connections:

- Four 24V DC sending/sourcing inputs with two sourcing solid-state outputs.
- Six 24V DC sending inputs and no outputs. Inputs are sourced from A3/A2 control power. Outputs are sourced from A1/A2 control power. Each input and output has its own LED status indicator.

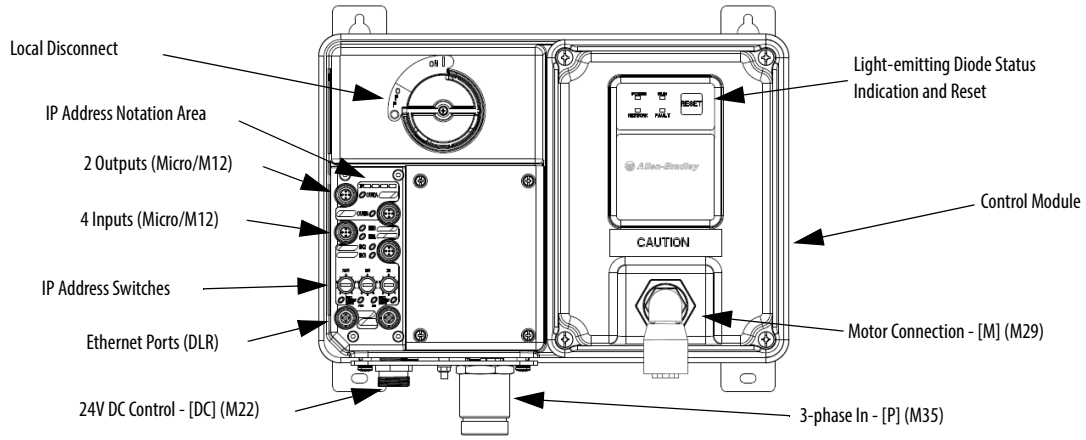
The integrated safety version controller offers one dual-channel safety input that can be used as two single-channel inputs and one bipolar output. The integrated safety version is capable of up to: Category 4, PLe, according to EN ISO 13849-1, up to SIL 3 according to IEC 61508, and SIL CL3 according to EN 62061.

Bulletin 281E/281ES/281GS ArmorStart ST Distributed Motor Controller with RRG Gland

Full-voltage and Reversing Standard Starter

The ArmorStart ST catalog numbers 281E-...**Z**-...-RRG... are the standard version motor controllers and are used in applications that require across-the-line starting. They have full in-rush current and locked-rotor torque when initially started.

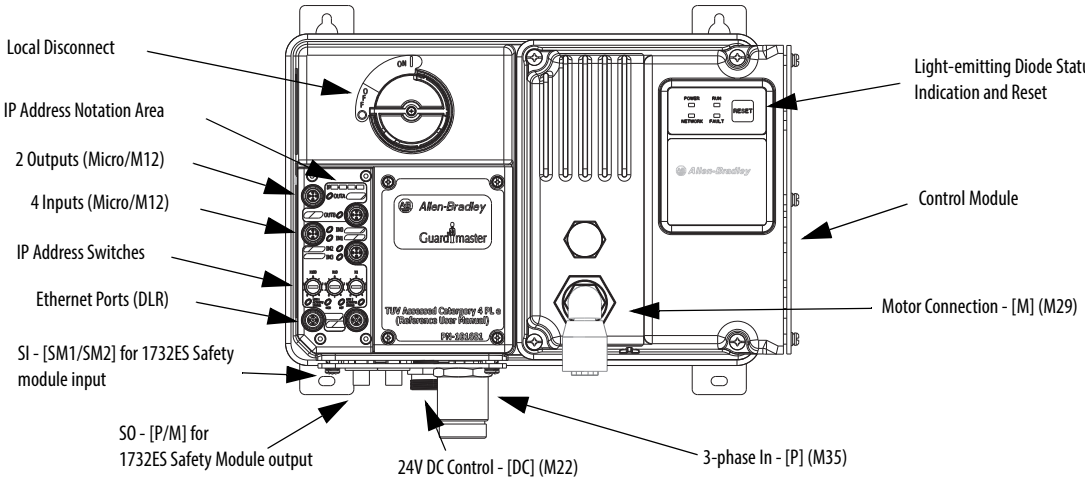
Figure 1 - Standard Version



Full-voltage and Reversing Hardwired Safety Starter (Category 0 Stop)

The ArmorStart ST catalog numbers 281E...**S**-...-RRG... are the hardwired safety version motor controllers and are used in applications that require across-the-line starting and is also key to the overall machine safety compliance based on the risk assessment. This safety system solution can achieve a maximum of Category 4, PLe Safety.

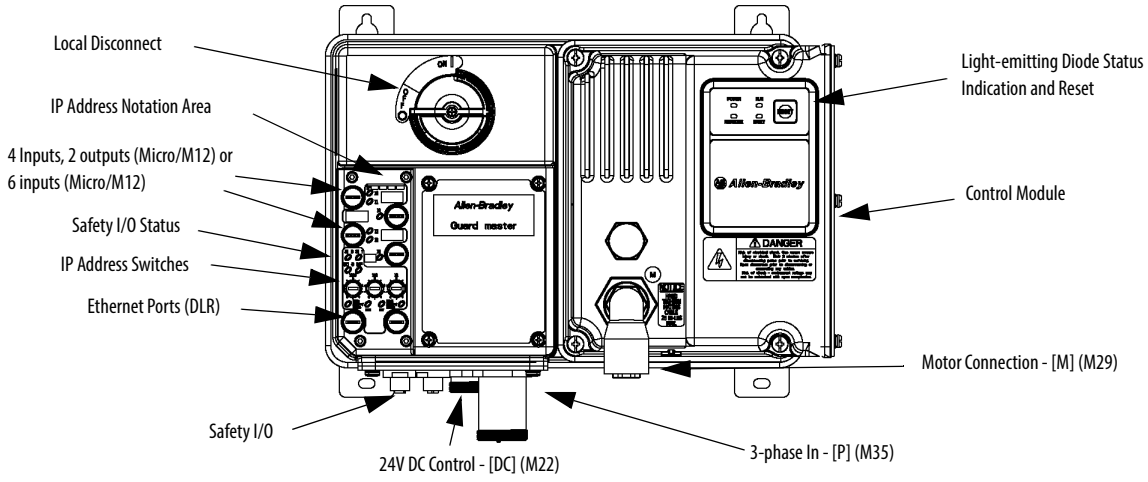
Figure 2 - Hardwired Safety Version



Full-voltage and Reversing Integrated Safety Starter (Category 0 Stop)

The ArmorStart ST catalog numbers 281**ES**-...**S**-...-RRG... or 281**GS**-...**S**-...-RRG... are the integrated safety version motor controllers and are used in applications that require across-the-line starting and is also key to the overall machine safety compliance based on the risk assessment. This safety system solution can achieve a maximum of Category 4, PLe Safety.

Figure 3 - Integrated Safety Version

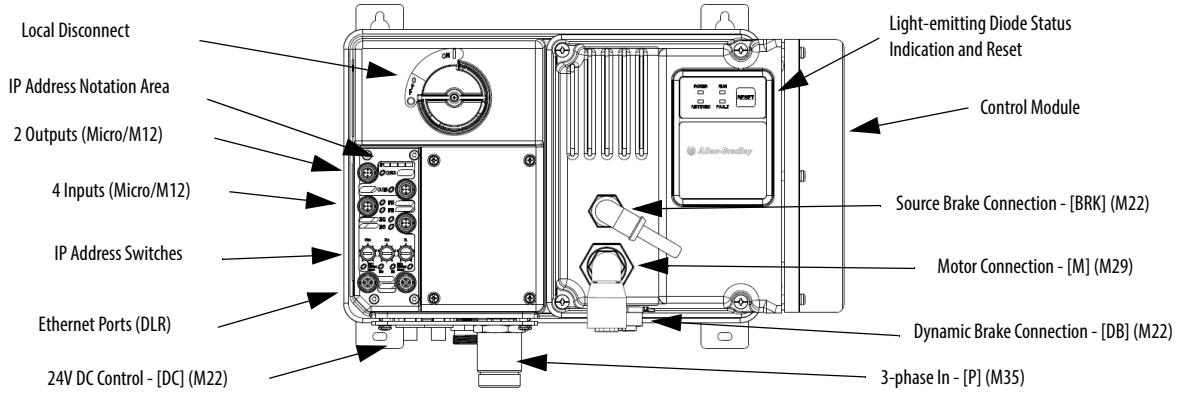


Bulletin 284E/284ES/284GS ArmorStart ST Distributed Motor Controller with RRG Gland

Variable Frequency Drive, Sensorless Vector Control Performance (SVC) Motor Controller

The ArmorStart ST catalog numbers 284E-...**Z**-...-RRG... are the standard version motor controllers and are used in applications that require regulated speed control of AC Motors. Variable speed and control are accomplished through selectable V/Hz or SVC control.

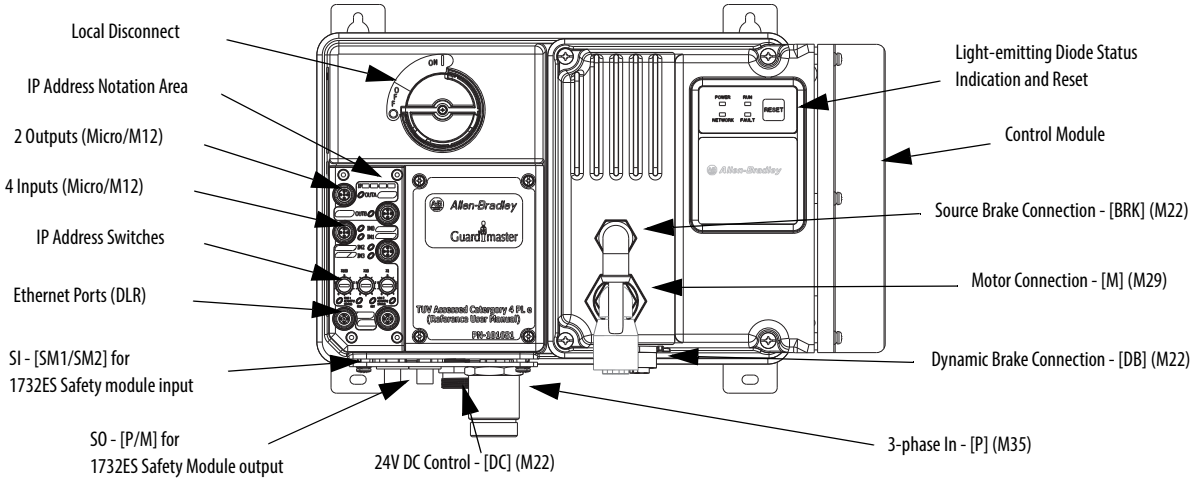
Figure 4 - Standard Version



Variable Frequency Drive, Safety Motor Controller

The ArmorStart ST catalog numbers 284E-...**S**-...RRG... are the hardwired safety version motor controllers and are used in applications that require regulated speed control of AC Motors. Variable speed and control are accomplished through selectable V/Hz or SVC control. This control is key to the overall machine safety compliance based on the risk assessment. This safety system solution can achieve a maximum of Category 4, PLe Safety.

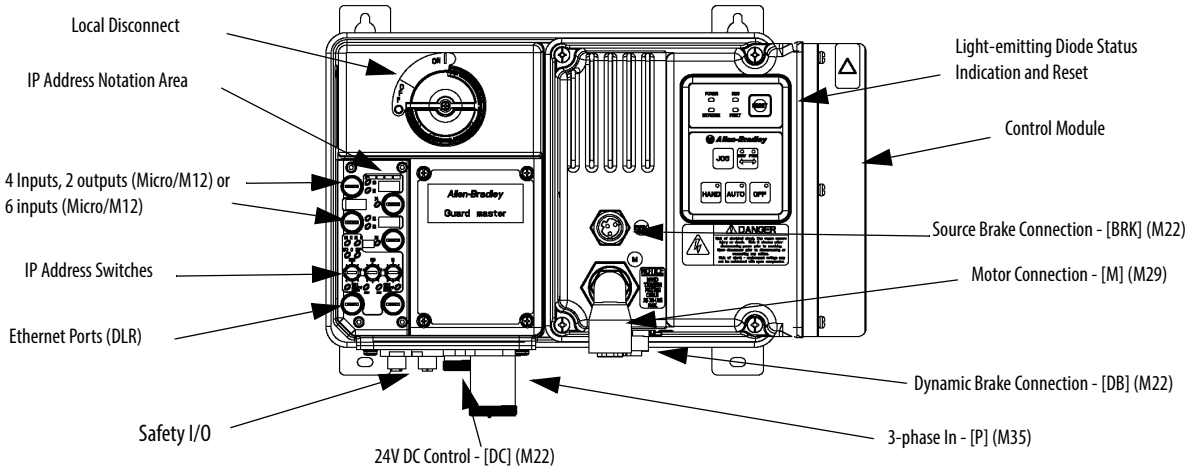
Figure 5 - Safety Version



Variable Frequency Drive, Safety Motor Controller

The ArmorStart ST catalog numbers 284**ES**-...**S**-...-RRG... or 284**GS**-...**S**-...-RRG... are the integrated safety version motor controller and are used in applications that require regulated speed control of AC Motors. Variable speed and control are accomplished through selectable V/Hz or SVC control. This control is key to the overall machine safety compliance based on the risk assessment. This safety system solution can achieve a maximum of Category 4, PLe Safety.

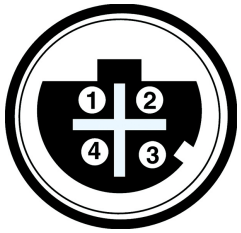
Figure 6 - Safety Version



ArmorStart ST Receptacle Pinouts

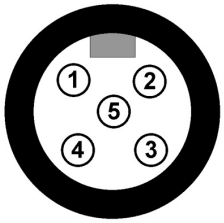
Pinouts are based on view into the connector. The ArmorStart ST motor controller uses a sealed D-coded M12 (micro) style Ethernet connector.

Figure 7 - EtherNet/IP Connector (M12) - Female



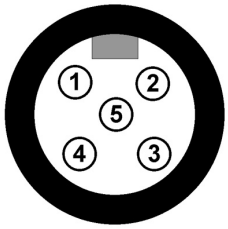
Pin 1 - TxData+ (white/orange)
Pin 2 - RecV Data+ (white/green)
Pin 3 - TxData- (orange)
Pin 4 - RecV Data- (green)

Figure 8 - Standard I/O Receptacle Input Pinout (M12) - Female



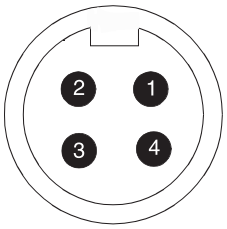
Pin 1 - +24V (A3 pwr)
Pin 2 - Input
Pin 3 - Common
Pin 4 - Input
Pin 5 - NC (no connection)

Figure 9 - Standard I/O Receptacle Output Pinout (M12) - Female



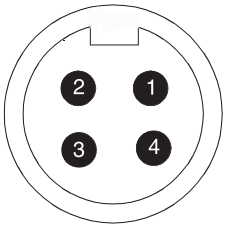
Pin 1 - Not used (+24V DC)
Pin 2 - NC (no connection)
Pin 3 - Common
Pin 4 - Output +24V DC (A1 pwr)
Pin 5 - NC (no connection)

Figure 10 - Safety Output Power (P/M) - Male



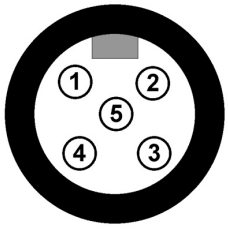
Pin 1 - NC (no connection) (brown)
Pin 2 - M (white)
Pin 3 - NC (no connection) (blue)
Pin 4 - P (black)

Figure 11 - Safety Monitor (SM1/SM2) - Male



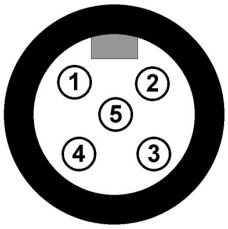
Pin 1 - SM1 (brown)
Pin 2 - SM2 (white)
Pin 3 - NC (no connection) (blue)
Pin 4 - NC (no connection) (black)

Figure 12 - Safety I/O Receptacle Input Pinout (M12) - Female



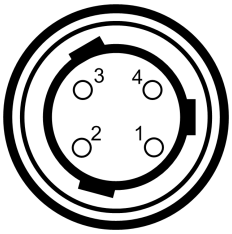
Integrated Safety version only
Pin 1 - Test Output 1
Pin 2 - Safety Input 1
Pin 3 - Common
Pin 4 - Safety Input 0
Pin 5 - Test Output 0

Figure 13 - Safety I/O Receptacle Output Pinout (M12) - Female



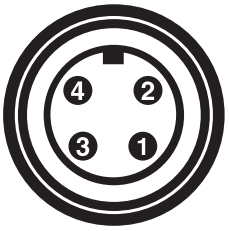
Integrated Safety version only
Pin 1 - NC (no connection)
Pin 2 - Safety Sink Output
Pin 3 - Safety 24V Common
Pin 4 - Safety Source Output
Pin 5 - Safety 24V Common

Figure 14 - Motor Connector Pinout (M29) - Female



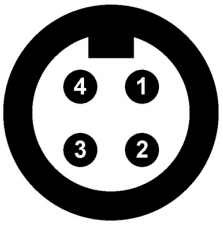
Pin 1 - T1 (black)
Pin 2 - T2 (white)
Pin 3 - T3 (red)
Pin 4 - Ground (green/yellow)

Figure 15 - Incoming Control Power (M22) – 24V DC Only - Male



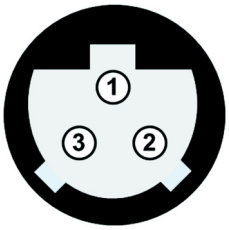
Pin 1 - 24V DC switched (brown)
Pin 2 - 24V DC unswitched (white)
Pin 3 - Common unswitched (blue)
Pin 4 - Common switched (blue)

Figure 16 - Incoming Three-phase Power (M35) - Male



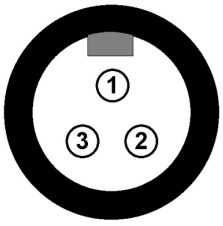
Pin 1 - L1 (black)
Pin 2 - Ground (green/yellow)
Pin 3 - L3 (red)
Pin 4 - L2 (white)

Figure 17 - EM Brake Contactor ALT Key Connector (M22) - Female (Bulletin 284 VFD Only)



Pin 1 - Ground (green/yellow)
Pin 2 - B1 (black)
Pin 3 - B2 (white)

Figure 18 - Dynamic Brake Connection (M22) - Female (Bulletin 284 VFD Only)



Pin 1 - Ground (green/yellow)
Pin 2 - BR+ (black)
Pin 3 - BR– (white)

ArmorStart ST Distributed Motor Controller - Bulletin 281E/281ES/281GS

This section provides selection information for the Bulletin 281E/281ES/281GS motor controller.

Catalog Number Explanation

Examples that are given in this section are for reference purposes. This basic explanation cannot be used for product selection because not all combinations produce a valid catalog number.

These tables explain what the catalog number represents.

281	ES	–	F	12	S	–	10	C	–	RRG	–	3FR	–	00
a	b		c	d	e		f	g		h		i		j

a	
Bulletin Number	
Code	Description
281	Reversing Starter

b	
ArmorStart ST Version	
Code	Description
E	Standard version when Control Voltage Code is **Z** or Hard-wired safety version when Control Voltage Code is **S**
ES[1]	Integrated Safety version with 4 inputs/2 outputs discrete
GS[1]	Integrated Safety version with 6inputs/0 outputs discrete

c	
Enclosure Type	
Code	Description
F	IP67/UL Type 4/12/13

d	
Contactor Size	
Code	Description
12	12 A
23	23 A

(1) Only available when Control Voltage Code **S** is selected.

e	
Control Voltage	
Code	Description
Z	24V DC, standard version
S	24V DC, safety version

f	
Short-circuit Protection (Motor Circuit Protection)	
Code	Description
10	10 A rated device
25	25 A rated device

g	
Overload Selection Current Range	
Code	Description
A	0.24…1.2 A
B	0.5…2.5 A
C	1.1…5.5 A
D	3.2…16 A

h	
Control and 3-Phase Power Connections/Motor Cable Connection[1]	
Code	Description
RRG	Round Media—male receptacle for control and power cables, female receptacle for motor cable

i	
HOA Option	
Code	Description
3FR	Hand/Off/Auto keypad with Forward/Reverse

j	
Safety I/O Option[2]	
Code	Description
00	No Safety I/O
22	Safety I/O

(1) Cables are sold separately.
(2) Only available for ArmorStart ST Version codes **ES** or **GS**.

Wiring Diagrams

Figure 19 - ArmorStart ST Standard Version Internal Wiring Diagram - Bulletin 281E

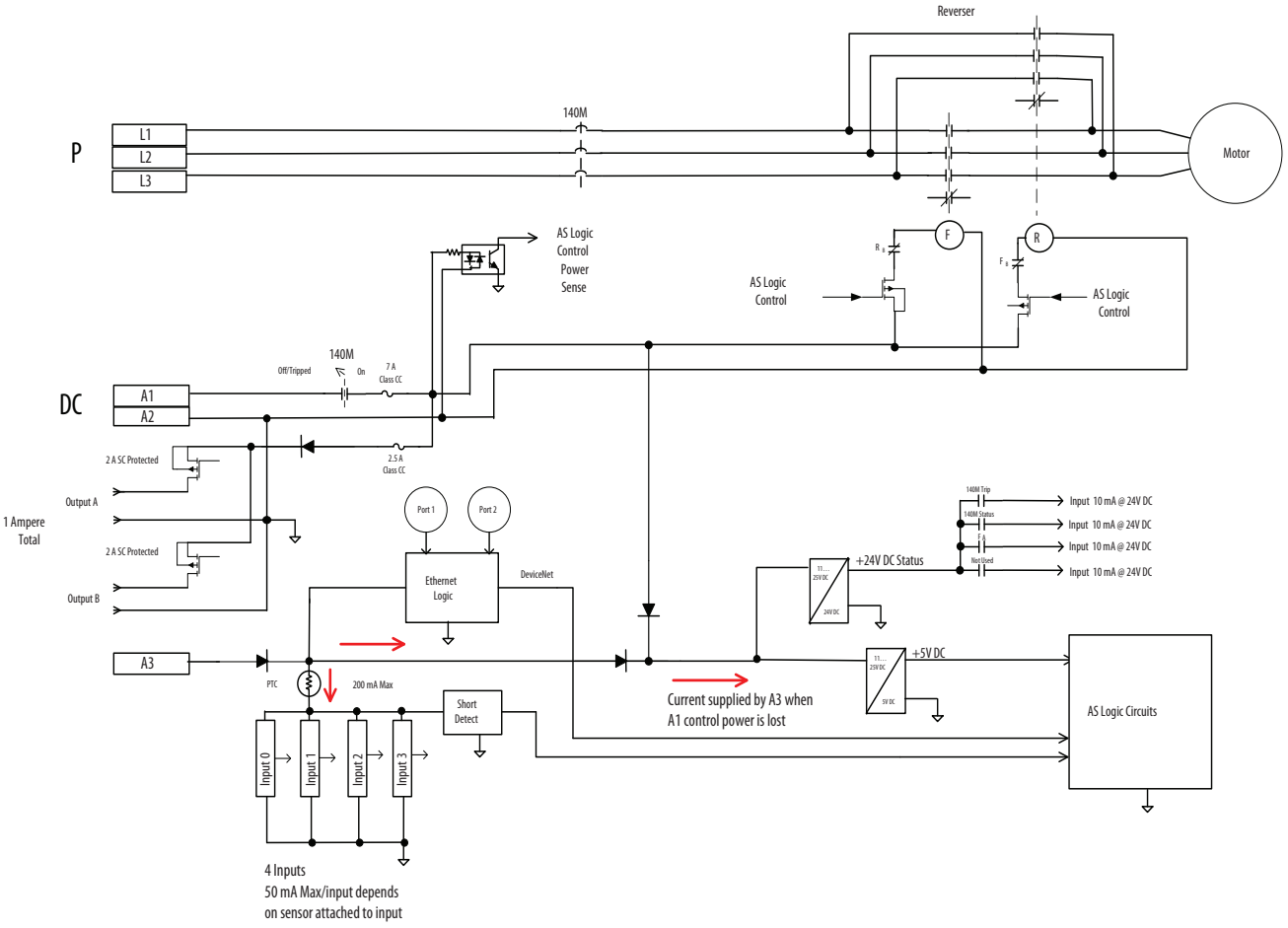


Figure 20 - ArmorStart ST Hard-wired Safety Version Internal Wiring Diagram - Bulletin 281E

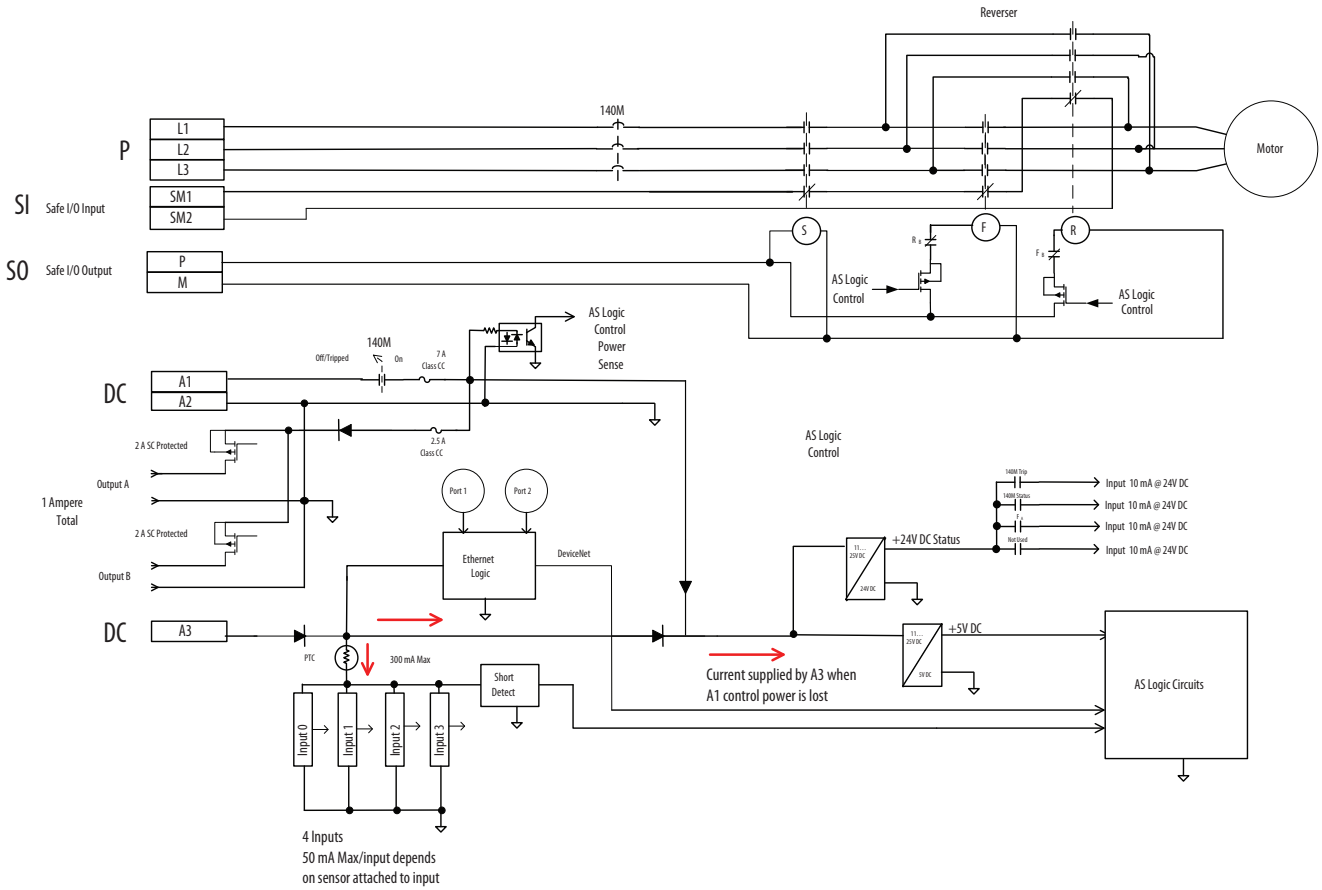
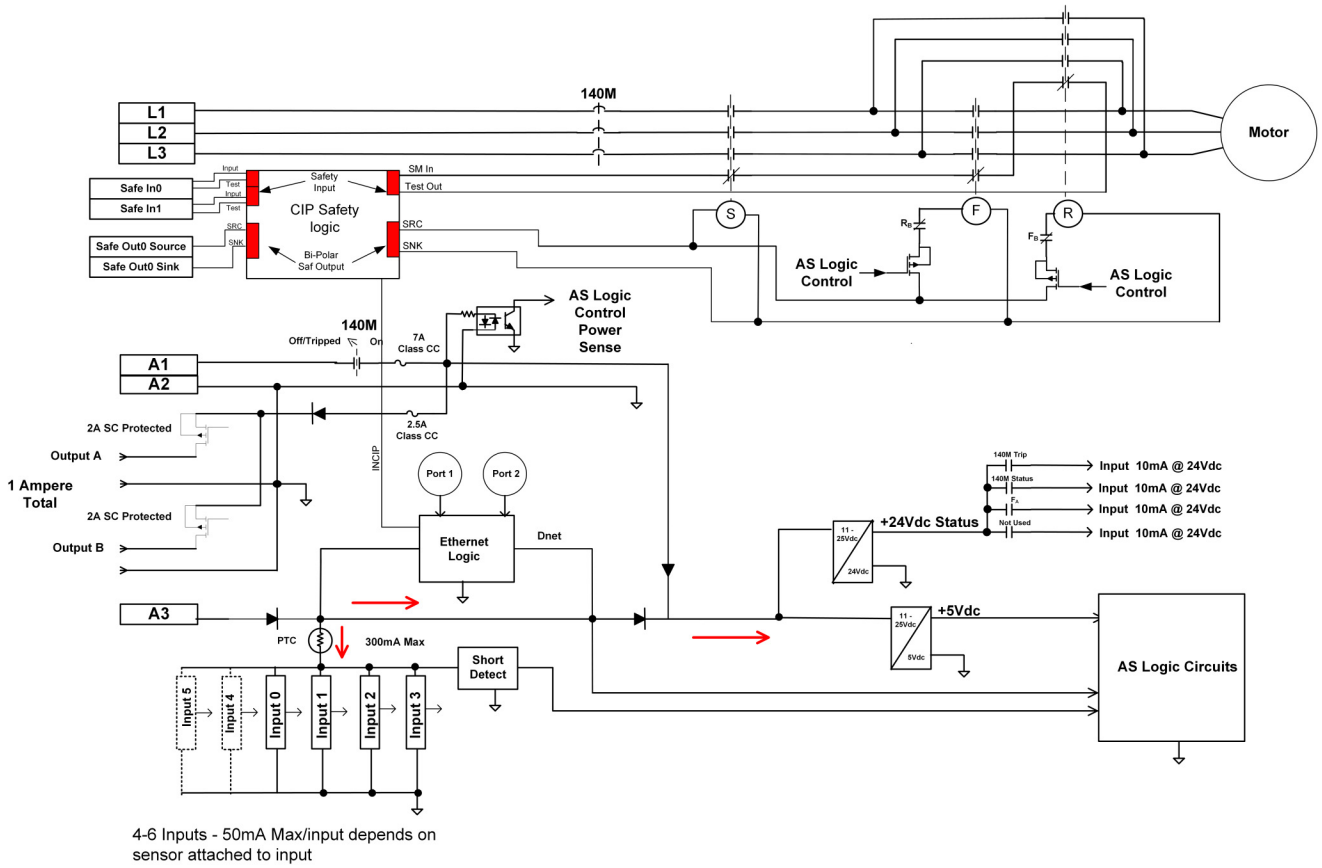


Figure 21 - ArmorStart ST Integrated Safety Version Internal Wiring Diagram - Bulletin 281ES/281GS



Approximate Dimensions

Dimensions are shown in millimeters (inches). Dimensions are not intended to be used for manufacturing purposes.

Figure 22 - ArmorStart ST Standard Version with RRG Gland - Bulletin 281E

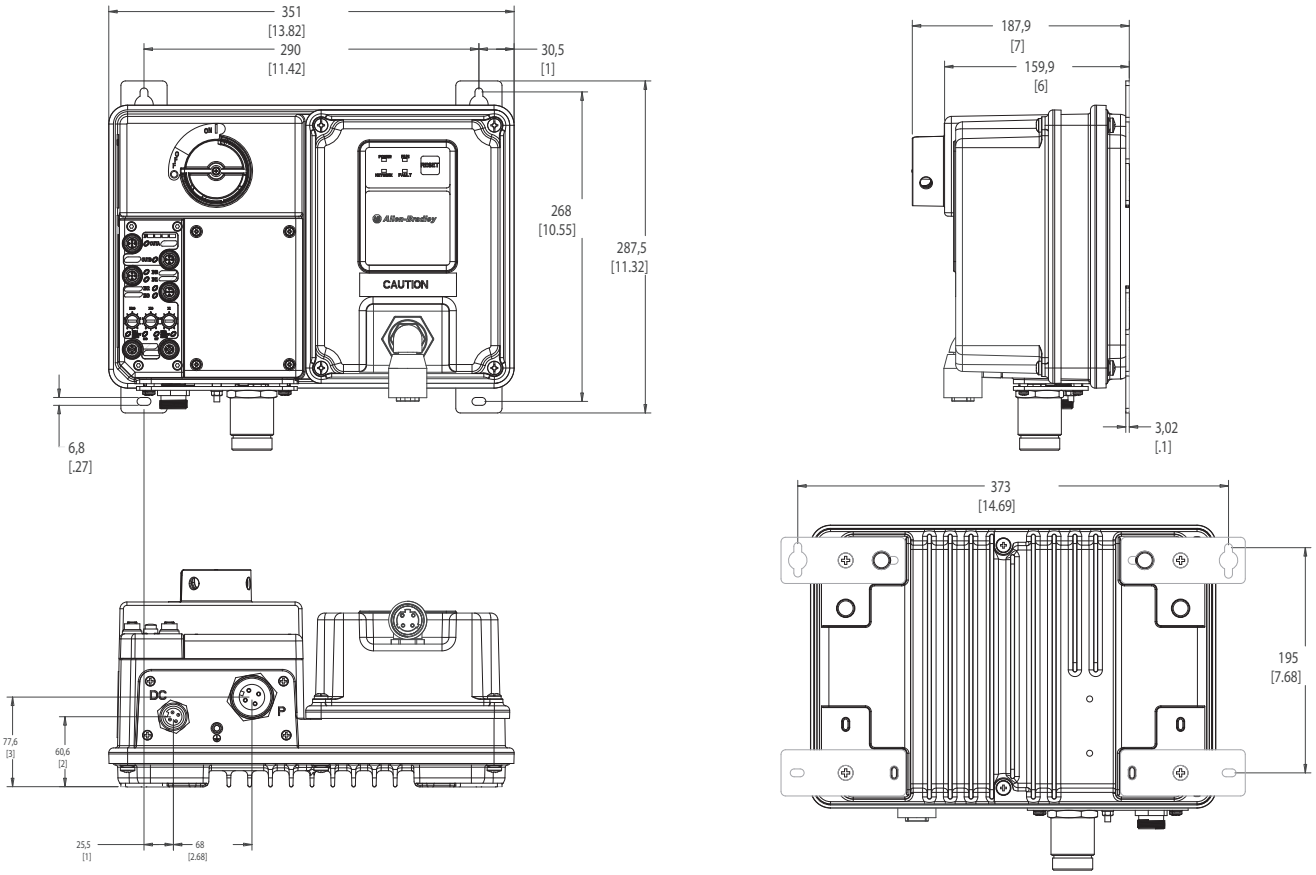
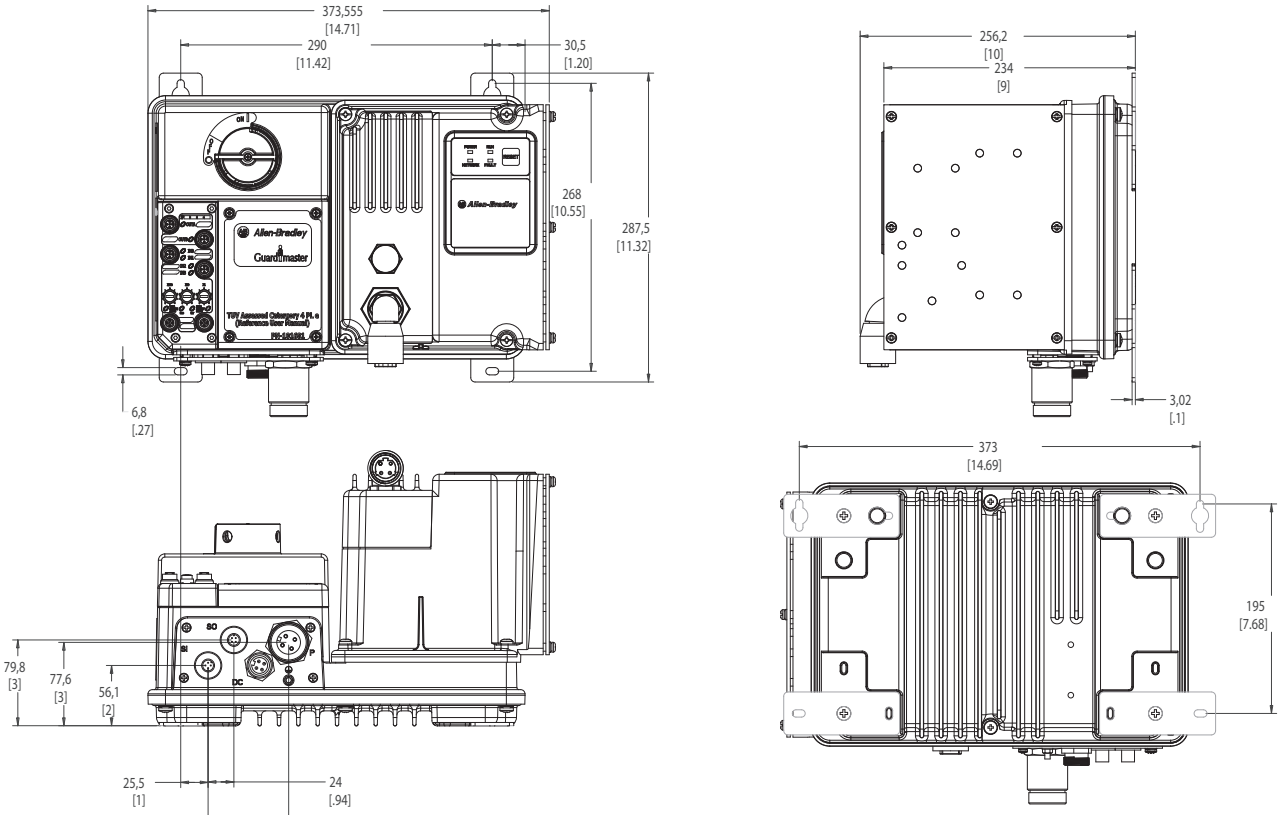


Figure 23 - ArmorStart ST Safety Version with RRG Gland - Bulletin 281E/281ES/281GS

Dimensions are shown in millimeters (inches). Dimensions are not intended to be used for manufacturing purposes.



Technical Specifications - Bulletin 281E/281ES/281GS Full Voltage Starters

For starters with integrated safety, also see Safety Data for ArmorStart ST Motor Controllers with Integrated Safety.

Electrical Ratings

Attribute	UL/NEMA		IEC	
Power Circuit				
Rated Operation Voltage	200…575V		200…575V	
Rate Insulation Voltage	600V		600V	
Rated Impulse Voltage	6 kV		6 kV	
Dielectric Withstand	2200V AC		2500V AC	
Operating Frequency	50/60 Hz		50/60 Hz	
Utilization Category	—		AC-3(4)	
Protection Against Shock	—		IP2X	
Rated Operating Current Max.	281E/281ES/281GS_-_____-10A-*(1)	1.2 A		
	281E/281ES/281GS_-_____-10B-*(1)	2.5 A		
	281E/281ES/281GS_-_____-10C-*(1)	5.5 A		
	281E/281ES/281GS_-_____-25D-*(1)	16 A		
Control Circuit				
Rated Operation Voltage	24V DC (+10%, –15%), SELV or PELV, (A2 must be grounded at voltage source)			
Rate Insulation Voltage	30V		30V	
Rated Impulse Voltage	—		1.5 kV	
Dielectric Withstand	1500V AC		2000V AC	
Overvoltage Category	—		III	
Operating Frequency	DC		DC	
Short Circuit Protection			**480Y/277V**	**600Y/347V**
Short Circuit Protection Device (SCPD) Performance Type 1	10A, 10B, 10C, and 25D	Sym. amps rms	65 kA	65 kA
		Max. Fuse(2)	30 A	30 A
	10A, 10B, 10C, and 25D	Sym. amps rms	30 kA	30 kA
		Max. Circuit Breaker(3)	60 A	60 A

(1) See Contactor Life Load Curves.
(2) Class J, CC, and T fuses only.
(3) Only when used with Cat. No. 140G-H6C3-C60.
(4) IEC 60947-4-1 refers to utilization category AC-3 and is defined as occasional inching (jogging) or plugging for a limited time period. An example of this is machine setup. During this time the number of operations (e.g. one close and then open cycle of the contact) of inching or plugging should not exceed 5 operations per minute or more than 10 operations per 10 minutes. If the application exceeds this, then refer to AC-4 utilization category or the products mixed AC-3/AC-4 utilization category.

Mechanical Ratings

Attribute	UL/NEMA	IEC
Approximate Shipping Weight	10.4 kg (23 lbs)	
Resistance to Shock		
Operational	15 G	
Non-Operational	30 G	
Resistance to Vibration		
Operational	1 G, 0.15 mm (0.006 in.) Displacement	
Non-Operational	2.5 G, 0.38 mm (0.015 in.) Displacement	
Power and Ground Terminals		
Wire Size	Primary/Secondary Terminal: #16…#10 AWG	Primary/Secondary Terminal: 1.0…4.0 mm^2
Tightening Torque	Primary Terminal: 10.8 lb·in Secondary Terminal: 4.5 lb·in	Primary Terminal: 1.2 N·m Secondary Terminal: 0.5 N·m
Wire Strip Length	0.35 in. (9 mm)	
Control Terminals		
Wire Size	#18…#10 AWG	1.0…4.0 mm^2
Tightening Torque	6.2 lb·in	0.7 N·m
Wire Strip Length	0.35 in. (9 mm)	
Disconnect Lock Out	Recommend 8 mm (5/16 in.) lock shackle or hasp. The hasp must not exceed 8 mm (5/16 in.) when closed.	

Contactor Mechanical Life(1)

Cat. No. 100-	Ops	C12 (AC3)	C23 (AC3)
281_-_12*	Mil	13	—
281_-_23*	Mil	—	13

(1) See the contactor life and ops curves on page 19 for additional detail.

Control and I/O Power Requirements

Attributes	Units	A1/A2(2)	A3/A2(3)	A1/A2(2)	A3/A2(3)	A3/A2(4)
		Without Hand Off Auto		With Hand Off Auto		
Control Voltage	Volts	24V DC				
Module Inrush(1)	Amps	0.92	0.30	1.09	0.125	0.295
Module Steady	Amps	0.06	0.30	0.23	0.125	0.295
Total Control Power (Pick Up)	Watts	22.08	7.20	26.16	3.00	7.08
Total Control Power (Running)	Watts	1.44	7.20	5.52	3.00	7.08

(1) Instantaneous capacitive inrush exists for less than 10 ms, which can exceed 20 A. The power supply must have sufficient capacity to support this amount of instant power demand when multiple units are turned ON simultaneously. If supplies are weaker, we recommend applying unswitched power (A3-A2) first and after a 2…4 second delay, apply switched power.
(2) Add power requirements for outputs (1 A max.) to A1/A2.
(3) Add power requirements for inputs (200 mA max.) to A3/A2.
(4) If A1 power is disconnected.

Other Ratings

Attribute	UL/NEMA	IEC
Input Ratings – Sourced from Control Circuit (A3/A2)		
Rated Operation Voltage	24V DC	
Input On-State Voltage Range	10…26V DC	
Input On-State Current	3.0 mA @ 10V DC	
	7.2 mA @ 24V DC	
Input Off-State Voltage Range	0…5V DC	
Input Off-State Current	<1.5 mA	
Maximum Input Frequency Response	200 Hz (DeviceLogix™ response is greater than 200 Hz. Network response depends on control system network performance.)	
Input Filter – Software Selectable		
Off to On	Settable from 0…64 ms in 1 ms increments	
On to Off	Settable from 0…64 ms in 1 ms increments	
Input Compatibility	—	IEC 61131-2
Number of Inputs	4 (6 are optional with 281GS*)	
Sensor Source		
Voltage Status Only	11…26.4V DC from unswitched power (A3-A2)	
Current Available	50 mA max. per input, 200 mA for any single point	
Output Ratings – Sourced from Control Circuit (A1/A2) (Do not use as a power supply source to other devices)		
Rated Operation Voltage	26.4V DC	
Rate Insulation Voltage	250V	
Dielectric Withstand	1500V AC (UL)	2000V AC (IEC)
Type of Control Circuit	Solid-state sourcing output	
Type of Current	24V DC	
Conventional Thermal Current I_{th}	0.5 A each, 1 A, max combined	
Peak Output Current	Current limited 2…8 amps (5 amps, nom) @ 24V DC	
Type of Contacts	Normally open (N.O.)	
Number of Outputs	2 (0 with 281GS*)	
Load Types	Resistive or light inductive	
Surge Suppression	Integrated diode, clamps @ 35V DC	
Thermo-Protection	Integrated short circuit and over current protection	
Maximum Cycle Rate	30 operations/minute capacitive and inductive loads	
Maximum Blocking Voltage	35V DC	
Maximum On-State Voltage @ Maximum Output	1.5V DC	
Maximum Off-State Leakage Current	10 µA	
Ethernet Port		
DHCP Timeout	30 s	
Communication Rate	10/100 Mbps with auto negotiate half-duplex and full-duplex	
Data Rate	• Transported over both TCP and UDP • Min. of 500 I/O packets/second (pps) • Supports up to 150 concurrent TCP sockets	

Other Ratings

Attribute	UL/NEMA	IEC
Network Connections	Supports scheduled (Class 1) and unscheduled (Class 3 and UCMM) connections	
	6 - Class 3 connections are supported simultaneously	
	Supports up to two Class 1 CIP™ connections [Exclusive owner (data) or listen-only]. One connection per PLC. Listen-only connection requires a data connection to be established.	
	Class 1 Connection API: 2…3200 ms, Class 3 Connection API: 100…10 000 ms	
	20 ms Request Packet Interval (RPI) default	
	3 concurrent Encapsulation sessions	
	TCP port supports 5 concurrent incoming connections	
Ratings for Hardwired Safety Version Only		
SI - SM1 and SM2 (24V DC)		
Contact Rating	DC-12 L/R, 1 ms resistive, 6 A	
Contact Type	IEC 60947-5-1 Annex L - mechanically	
SO - P/M	3 W/0.125 A per contactor (Two safety contactors)	
Component Response Time		
1732ES-IB12XOBV2 or 1732ES-IB8XOBV4	See Guard I/O™ EtherNet/IP Safety Modules user manual, publication 1791ES-UM001	
Bulletin 281	20…40 ms	
Average Frequency of a Dangerous Failure (PFH) and MTTF for Uncontrolled Stop(1)		
MTTF	100 years	
Average frequency of a dangerous failure (PFH)	6.0E-9 (1/h)	

(1) ArmorStart Safety controller used in combination with ArmorStart safety-related parts.

Environmental Specifications

Attribute	UL/NEMA	IEC
Environmental		
Operating Temperature Range	–20…+40 °C (–4…+104 °F)(1)	
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	UL Type 4/12/13 NEMA 4/12/13	IP67
EMC Emission Levels		
Conducted Radio Frequency Emissions	10V rms Communications Cables 10V rms (PE) 150 kHz…80 MHz	
Radiated Emissions	Class A, Group 1, Equivalent to C2 emissions	
EMC Immunity Levels		
Electrostatic Discharge	4 kV contact and 8 kV Air	

Environmental Specifications

Attribute	UL/NEMA	IEC
Radio Frequency Electromagnetic Field	10V/m, 80 MHz…1 GHz 3V/m, 1.4 GHz…2 GHz 1V/m, 2.0 GHz …2.7 GHz	
Fast Transient	2 kV (Power) 2 kV (PE) 1 kV (Communications and Control)	
Surge Transient	1 kV (12) L-L, 2 kV (2) L-N (Earth)	

(1) Operating temperature derating available for temperatures above 40 °C (104 °F), see Motor Overload Trip Curves.

Temperature Derating

Derated operation in temperature range >+40 °C...+50 °C (+104 °F...+122 °F).

Adjusted maximum FLA for ambient °C (125% overload)

		Locations that do not require MTW wet rating		Locations that do require MTW wet rating	
	Max. FLA	+41 °C…+45 °C	+46 °C…+50 °C	+41 °C…+45 °C	+46 °C…+50 °C
Bulletin 281* - 10 A rated starter	5.5	5.5	5.5	5.5	4.6 (all amps derate - 16.4%)
Bulletin 281* - 25 A rated starter	16 .0	16.0	15.0 (all amps derate - 6.3%)	16.0	13.9 (all amps derate - 13.1%)

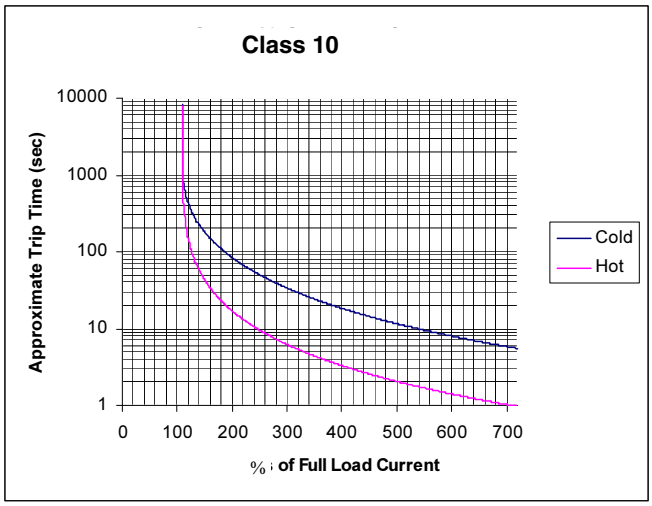
Certifications

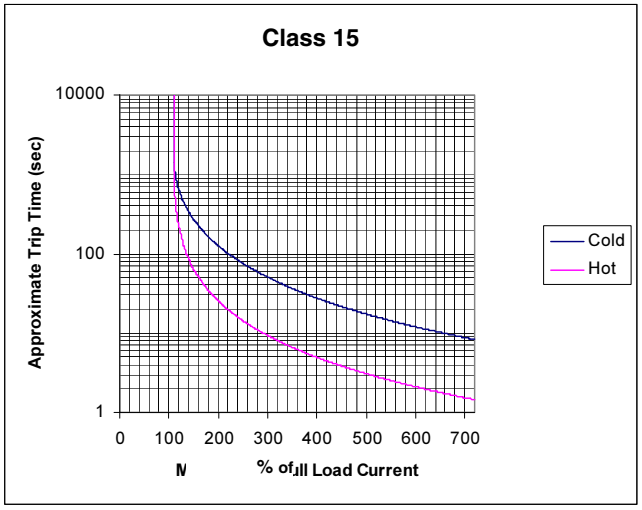
Attribute	UL/NEMA	IEC
Standards Compliance	UL 508 CSA C22.2, No. 14 EN/IEC 60947-4 EN/IEC 60947-4-1 CE Marked per Low Voltage 2014/35/EC EMC Directive 2014/30/EC CCC ODVA for EtherNet/IP	
Certifications	CCC, CE, KC, ODVA, RCM, TÜV, UL	

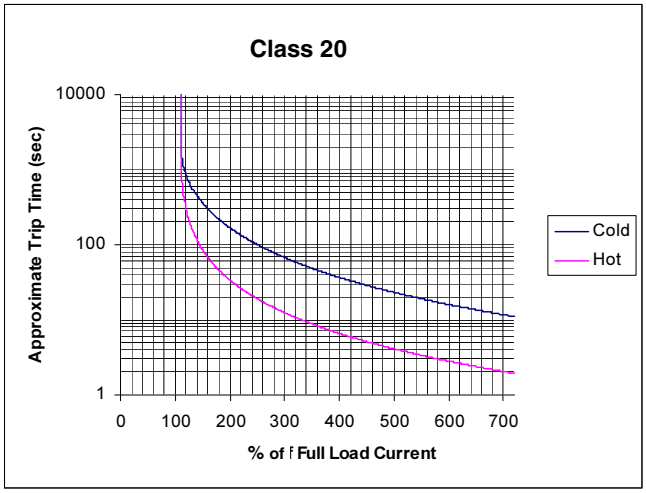
Motor Overload Trip Curves

Motor overload current parameter provides class 10, 15, and 20 overload protection. Ambient insensitivity is inherent in the electronic design of the overload.

Figure 24 - Overload Trip Curves







IMPORTANT If an overload fault occurs, it can require 60 s or more before a fault reset is allowed. See Overload Class Parameter 107, Thermo-Utilization parameter 105, and OL Reset Level parameter 108 to adjust the reset time.

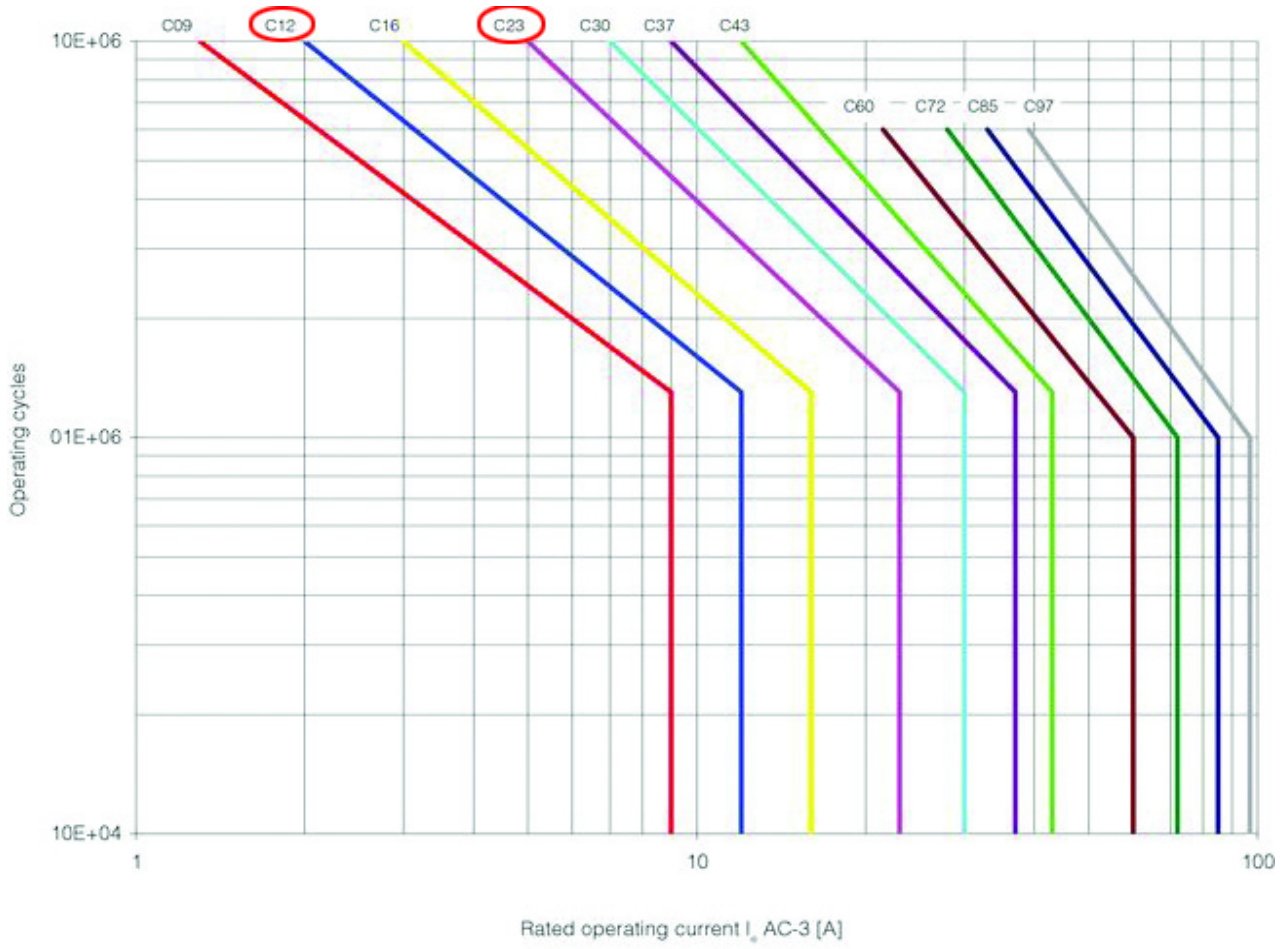
IMPORTANT When the mechanical motor brake voltage is applied by using power from the load side of the ArmorStart controller, the added load current can result in a phase imbalance or overload, if the FLA of the motor and the brake current are similar in scale.

Contactor Life Load Curves

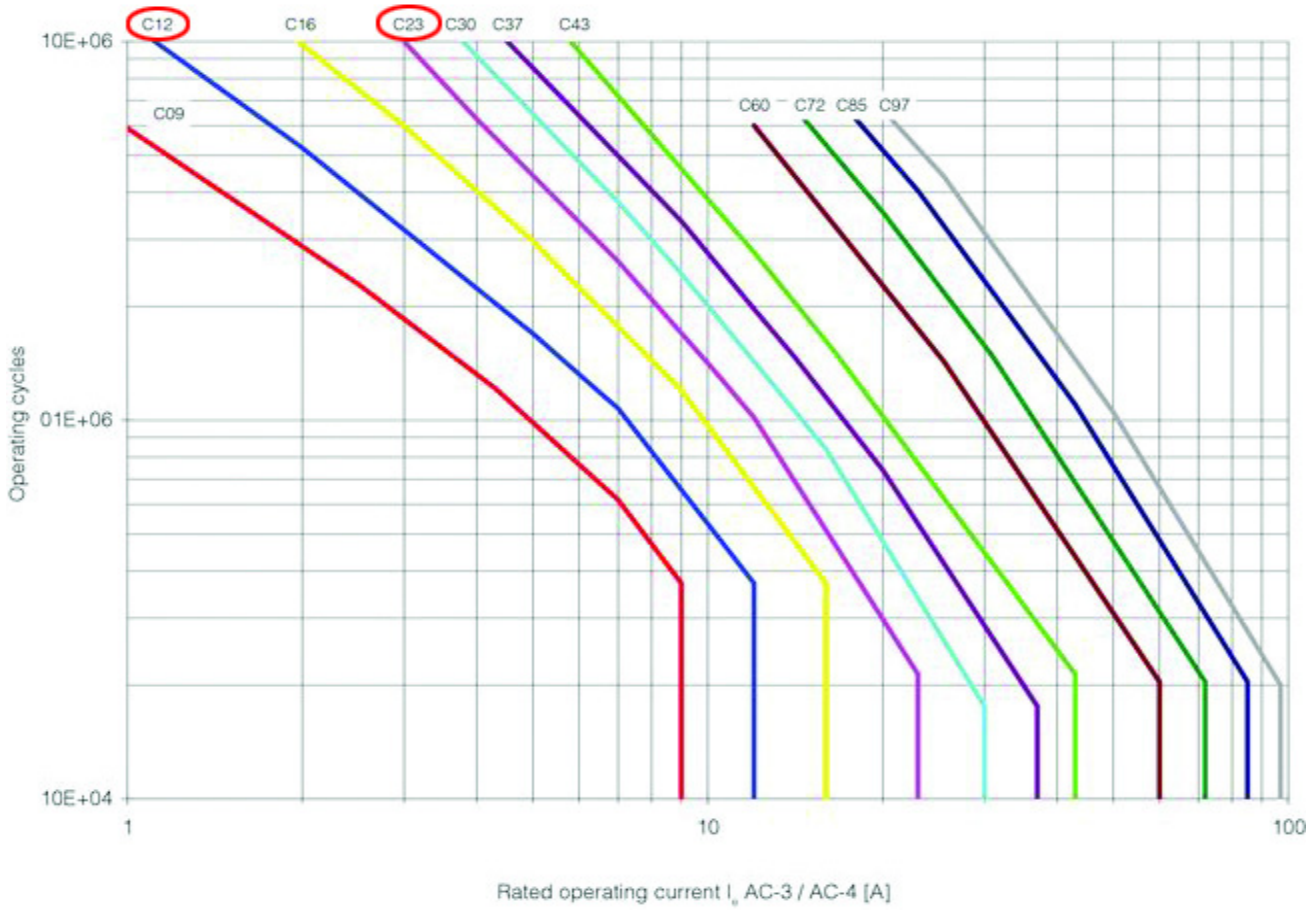
281_-_12* = 100-C12*
281_-_23* = 100-C23*

Life Load Curves:

AC-3 Switching of squirrel-cage motors while starting
U_e = 230...400...460V

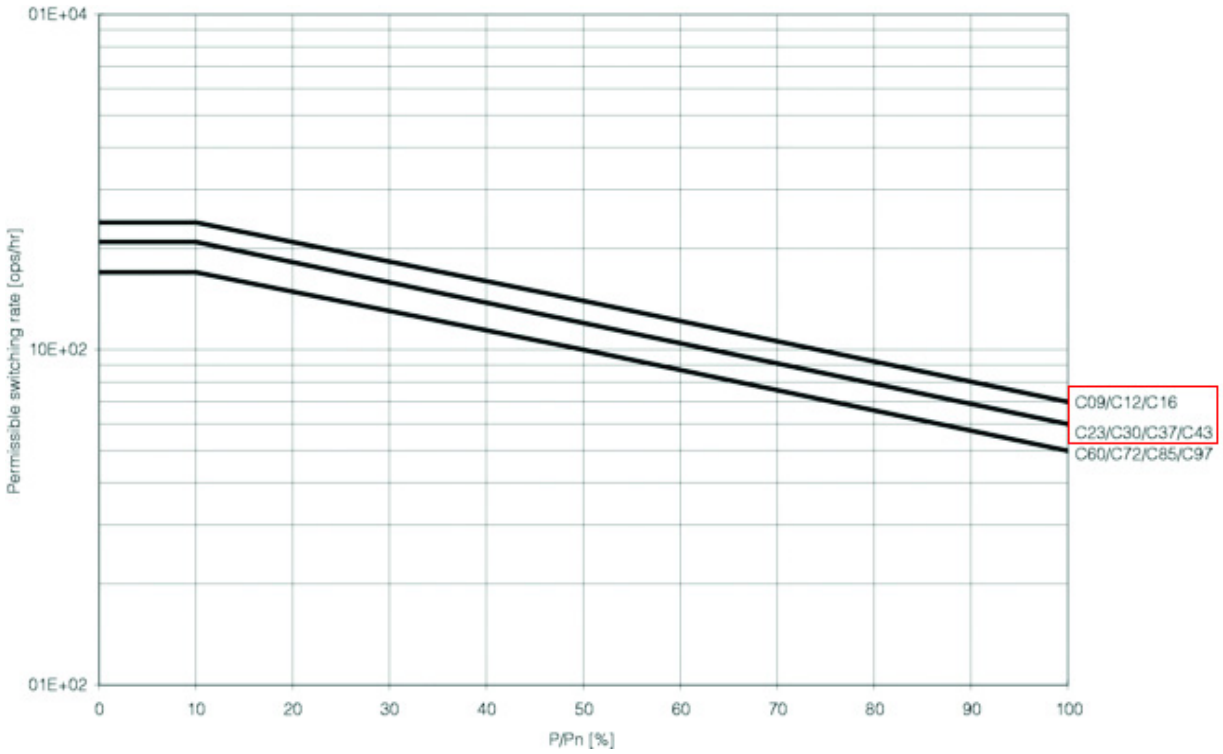


AC-3 & AC-4 10% AC-4 Mixed operation of squirrel-cage motors
U_e = 400...460V

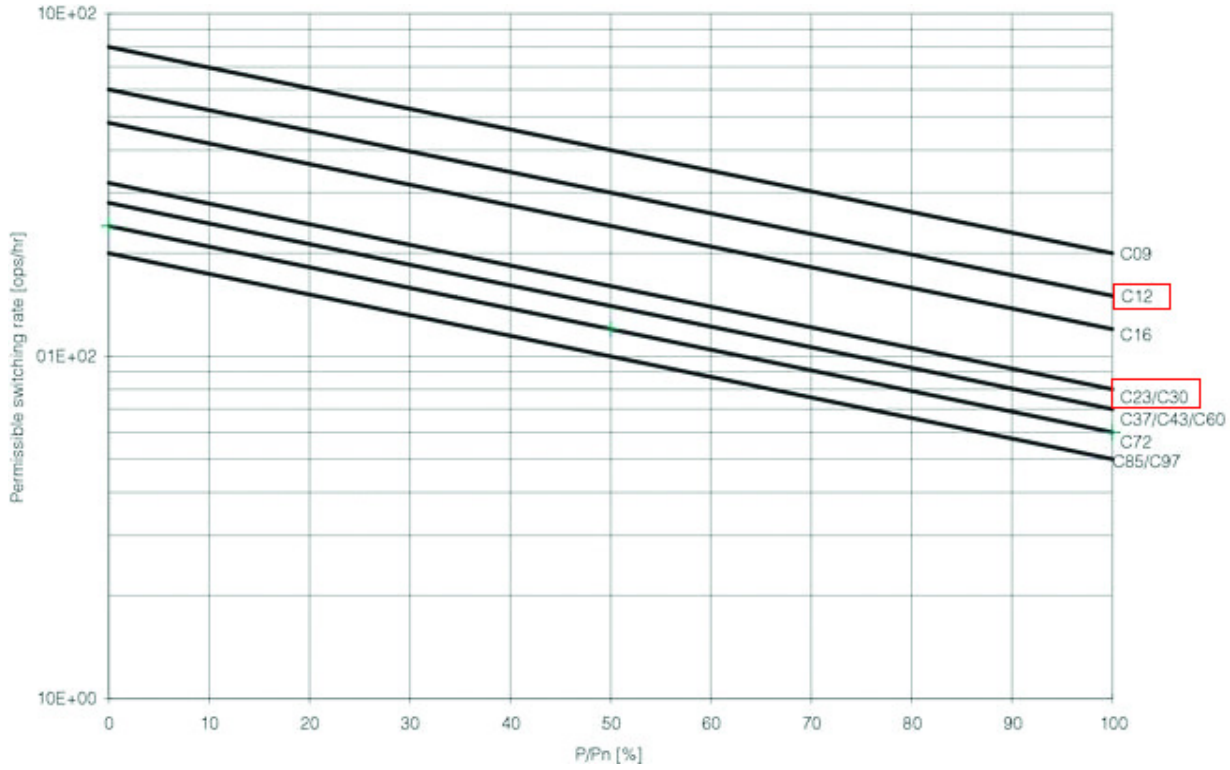

C12
C16
C23
C30
C37
C43
C09
C60
C72
C85
C97
10E+06
01E+06
10E+04
Operating cycles
1
10
100
Rated operating current I_e AC-3 / AC-4 [A]

Maximum Operating Rates:

AC-3 Switching of squirrel-cage motors while starting
U_e = 230...460V, Relative operating time 40%, Starting time tA = 0.25 s



AC-4 Inching of squirrel-cage motors
Ue = 230...460V, Starting time tA = 0.25 s


10E+02
01E+02
10E+00
Permissible switching rate [cps/hr]
0
10
20
30
40
50
60
70
80
90
100
P/Pn [%]
C09
C12
C16
C23/C30
C37/C43/C60
C72
C85/C97

Replacement Parts

These tables list the replacement parts available for the controller.

Bulletin 281E Standard Version Controller

Full Voltage and Reversing Control Replacement Module

Current Rating [A]	kW		Hp			Cat. No.	
	230V AC 50 Hz	400V AC 50 Hz	200V AC 60 Hz	230V AC 60 Hz	460V AC and 575V AC 60 Hz	Without HOA	With HOA
0.24…1.2	0.18	0.37	—	—	0.5	281E-F12Z-NA-RG	281E-F12Z-NA-RG-3FR
0.5…2.5	0.37	0.75	0.5	0.5	1	281E-F12Z-NB-RG	281E-F12Z-NB-RG-3FR
1.1…5.5	1.1	2.2	1	1	3	281E-F12Z-NC-RG	281E-F12Z-NC-RG-3FR
3.2…16	4	7.5	3	5	10	281E-F23Z-ND-RG	281E-F23Z-ND-RG-3FR

Full Voltage and Reversing Base Replacement Module

Current Rating [A]	kW		Hp			Cat. No.
	230V AC 50 Hz	400V AC 50 Hz	200V AC 60 Hz	230V AC 60 Hz	460V AC and 575V AC 60 Hz	
0.24…1.2	0.18	0.37	—	—	0.5	280E-FN-10-RG
0.5…2.5	0.37	0.75	0.5	0.5	1	280E-FN-10-RG
1.1…5.5	1.1	2.2	1	1	3	280E-FN-10-RG
3.2…16	4	7.5	3	5	10	280E-FN-25-RG

Bulletin 281E/281ES/281GS Safety Version Controller

Full Voltage and Reversing Safety Control Replacement Module

Current Rating [A]	kW		Hp			Cat. No.	
	230V AC 50 Hz	400V AC 50 Hz	200V AC 60 Hz	230V AC 60 Hz	460V AC and 575V AC 60 Hz	Hardwired and Integrated Safety without HOA	Hardwired and Integrated Safety with HOA
0.24…1.2	0.18	0.37	—	—	0.5	281E-F12S-NA-RG	281E-F12S-NA-RG-3FR
0.5…2.5	0.37	0.75	0.5	0.5	1	281E-F12S-NB-RG	281E-F12S-NB-RG-3FR
1.1…5.5	1.1	2.2	1	1	3	281E-F12S-NC-RG	281E-F12S-NC-RG-3FR
3.2…16	4	7.5	3	5	10	281E-F23S-ND-RG	281E-F23S-ND-RG-3FR

Full Voltage and Reversing Safety Base Replacement Module

Current Rating [A]	kW		Hp			Cat. No.				
	230V AC 50 Hz	400V AC 50 Hz	200V AC 60 Hz	230V AC 60 Hz	460V AC and 575V AC 60 Hz	Hardwired Safety I/O - 4/2 Safety I/O - none	Integrated Safety I/O - 6/0 Safety I/O - 2/2	Integrated Safety I/O - 6/0 Safety I/O - none	Integrated Safety I/O - 4/2 Safety I/O - 2/2	Integrated Safety I/O - 4/2 Safety I/O - none
0.24…1.2	0.18	0.37	—	—	0.5	280E-FNS-10-RG	280GS-FN-10-RG-22	280GS-FN-10-RG-00	280ES-FN-10-RG-22	280ES-FN-10-RG-00
0.5…2.5	0.37	0.75	0.5	0.5	1	280E-FNS-10-RG	280GS-FN-10-RG-22	280GS-FN-10-RG-00	280ES-FN-10-RG-22	280ES-FN-10-RG-00
1.1…5.5	1.1	2.2	1	1	3	280E-FNS-25-RG	280GS-FN-25-RG-22	280GS-FN-25-RG-00	280ES-FN-25-RG-22	280ES-FN-25-RG-00
3.2…16	4	7.5	3	5	10	280E-FNS-25-RG	280GS-FN-25-RG-22	280GS-FN-25-RG-00	280ES-FN-25-RG-22	280ES-FN-25-RG-00

Replacement Fuses

Fuse Type	Fuse Description	Cat. No.
Output Fuse	Fast-acting, high-interrupting capacity, tubular fuse Rating: 2.5 A, 250V Dimension [mm (in.)]: 20 (0.787) x 5 (0.197)	Littlefuse PN 021602.5
Control Fuse	UL Listed Class CC, CSA HRC-1 Rating: 7 A, 600V Dimensions [in.]: 1.5 x 0.405	Cooper Bussman PN KTK-R-7 or Littlefuse PN KLKR007.T

ArmorStart ST Distributed Motor Controller - Bulletin 284E/284ES/284GS

This section provides selection information for the Bulletin 284E/284ES/284GS motor controllers.

Catalog Number Explanation

Examples that are given in this section are for reference purposes. This basic explanation cannot be used for product selection because not all combinations produce a valid catalog number.

These tables explain what the catalog number represents.

284	ES	–	F	V	D2P3	S	–	10	–	RRG	–	3	–	SBG – DB1	–	EMI	–	00
a	b		c	d	e	f		g		h		i		j		k		l

a	
Bulletin Number	
Code	Description
284	VFD Starter

b	
ArmorStart ST Version	
Code	Description
E	Standard version when Control Voltage Code is **Z** or Hard-wired safety version when Control Voltage Code is **S**
ES(1)	Integrated Safety version with 4 inputs/2 outputs discrete
GS(1)	Integrated Safety version with 6inputs/0 outputs discrete

c	
Enclosure Type	
Code	Description
F	IP67/UL Type 4/12/13

d	
Torque Performance Mode	
Code	Description
V	Sensorless Vector Control and Volts per Hertz

(1) Only available when Control Voltage Code **S** is selected.

e	
Output Current	
Code	Description
D2P3	2.3 A, 0.75 kW, 1.0 Hp
D4P0	4.0 A, 1.5 kW, 2.0 Hp
D6P0	6.0 A, 2.2 kW, 3.0 Hp
D7P6	7.6 A, 3.3 kW, 5.0 Hp

f	
Control Voltage	
Code	Description
Z	24V DC, standard version
S	24V DC, safety version

g	
Short-circuit Protection (Motor Circuit Protection)	
Code	Description
10	10 A rated device
25	25 A rated device

h	
Control and 3-Phase Power Connections/Motor Cable Connection(1)	
Code	Description
RRG	Round Media—male receptacle for control and power cables, female receptacle for motor cable

i	
HOA Option	
Code	Description
3	Hand/Off/Auto keypad with Forward/Reverse and Jog

j	
Brake	
Code	Description
DB1	Connectivity to IP67 DB Resistor
SBG	Source (EM) Brake

k	
Filter	
Code	Description
EMI	EMI Filter

l	
Safety I/O Option(2)	
Code	Description
00	No Safety I/O
22	Safety I/O

(1) Only available for ArmorStart ST Version codes **ES** or **GS**.
(2) Cables are sold separately.

Wiring Diagrams

Figure 25 - ArmorStart ST Standard Version Internal Wiring Diagram - Bulletin 284E

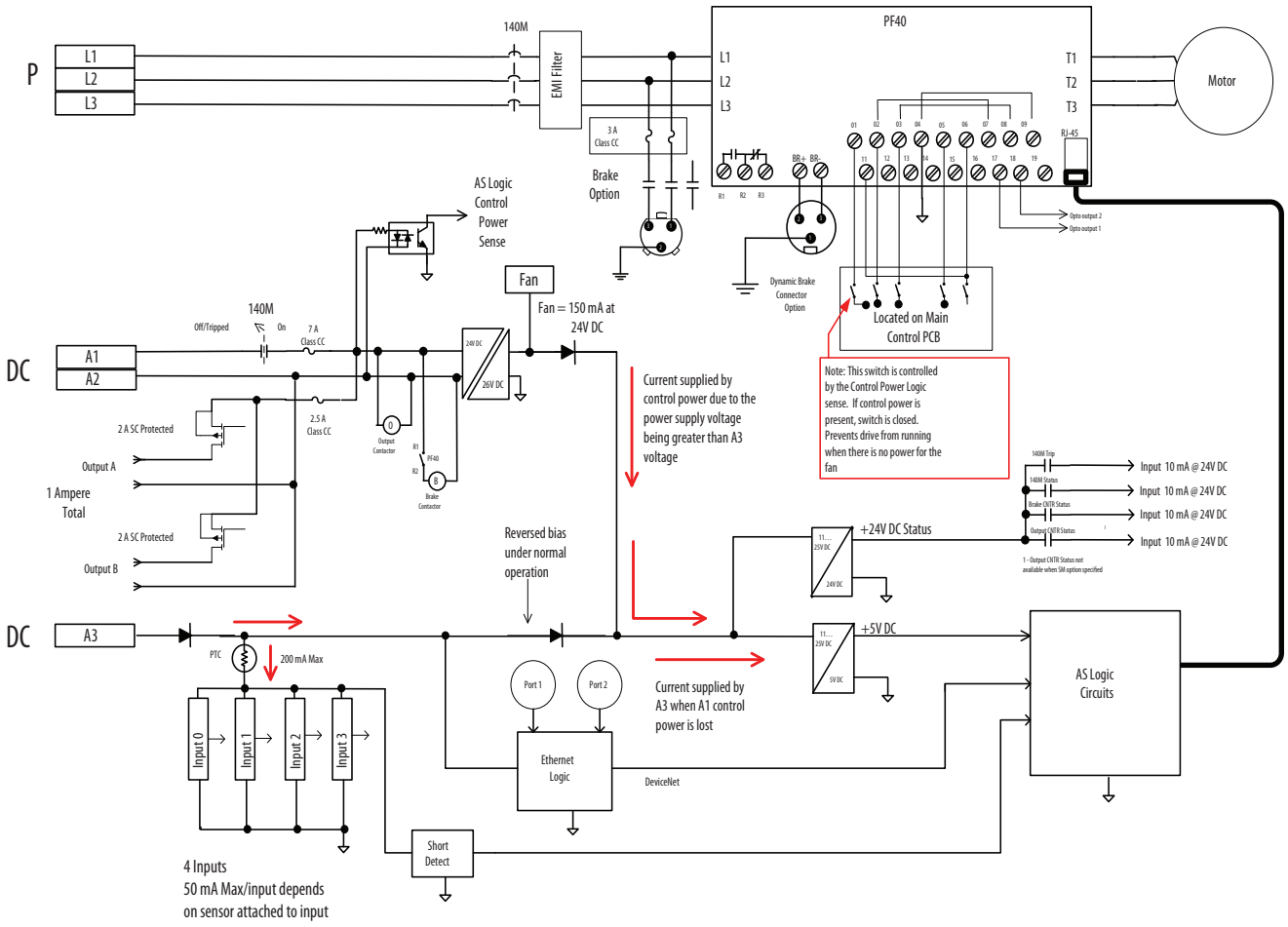


Figure 26 - ArmorStart ST Hard-wired Safety Version Internal Wiring Diagram - Bulletin 284E

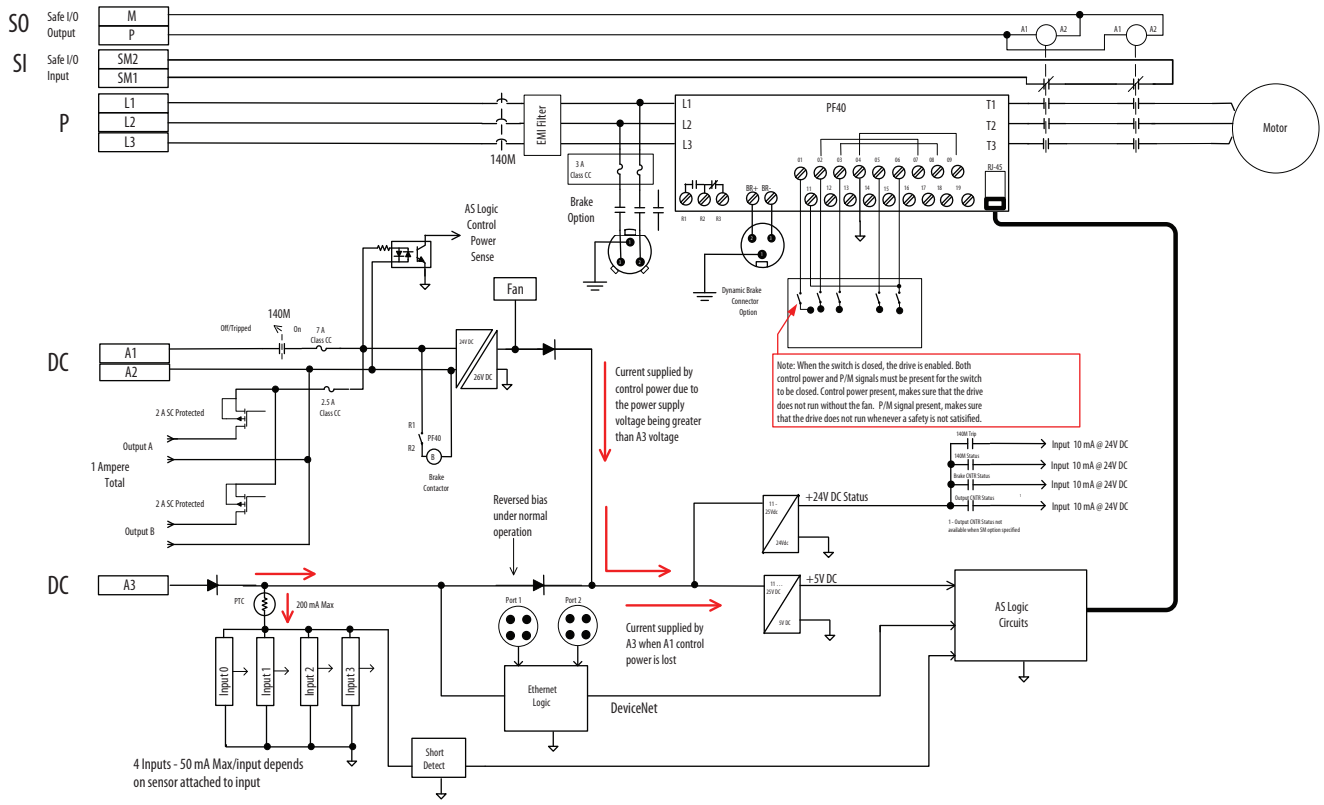
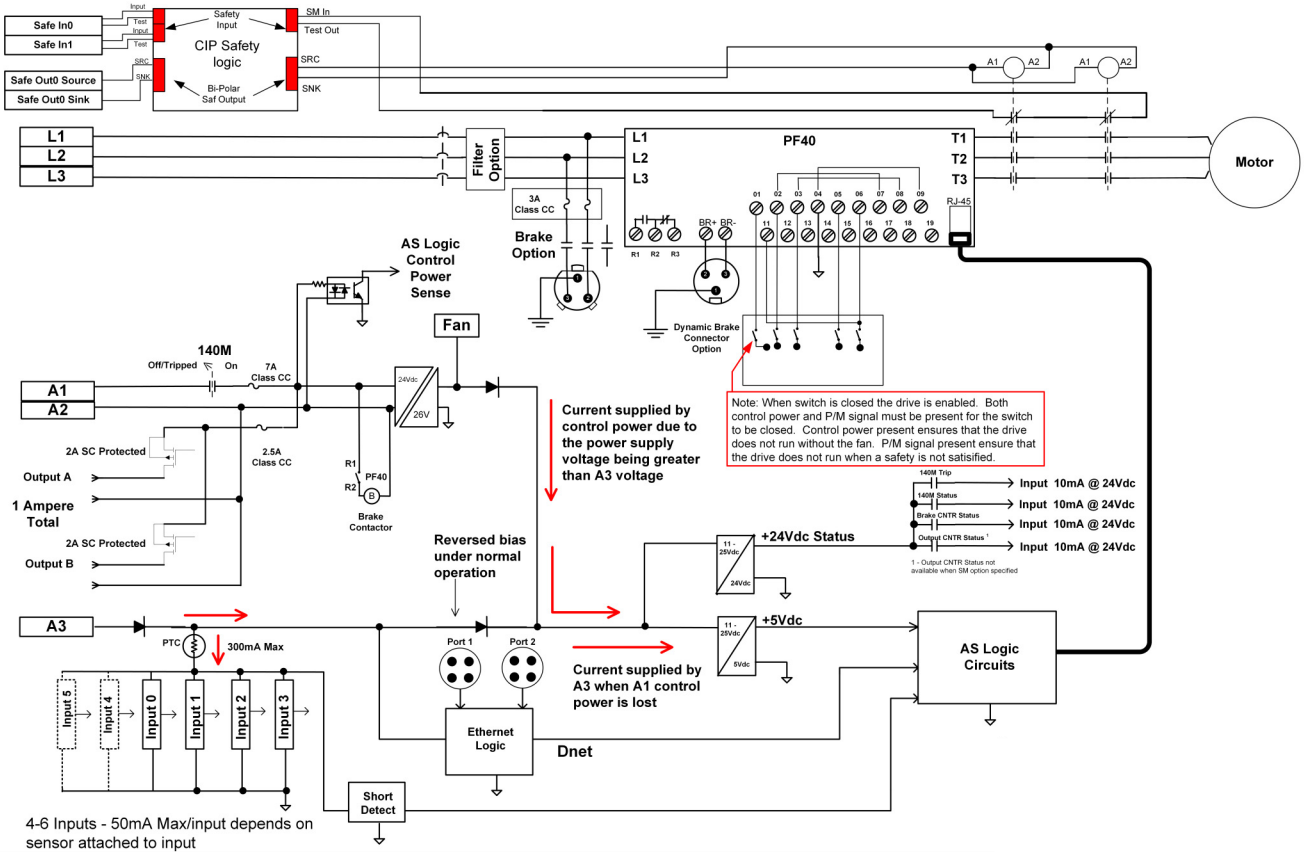


Figure 27 - ArmorStart ST Integrated Safety Version Internal Wiring Diagram - Bulletin 284ES/284GS



Approximate Dimensions

Figure 28 - ArmorStart Standard Version with RRG Gland - Bulletin 284E

Dimensions are shown in millimeters (inches). Dimensions are not intended to be used for manufacturing purposes.

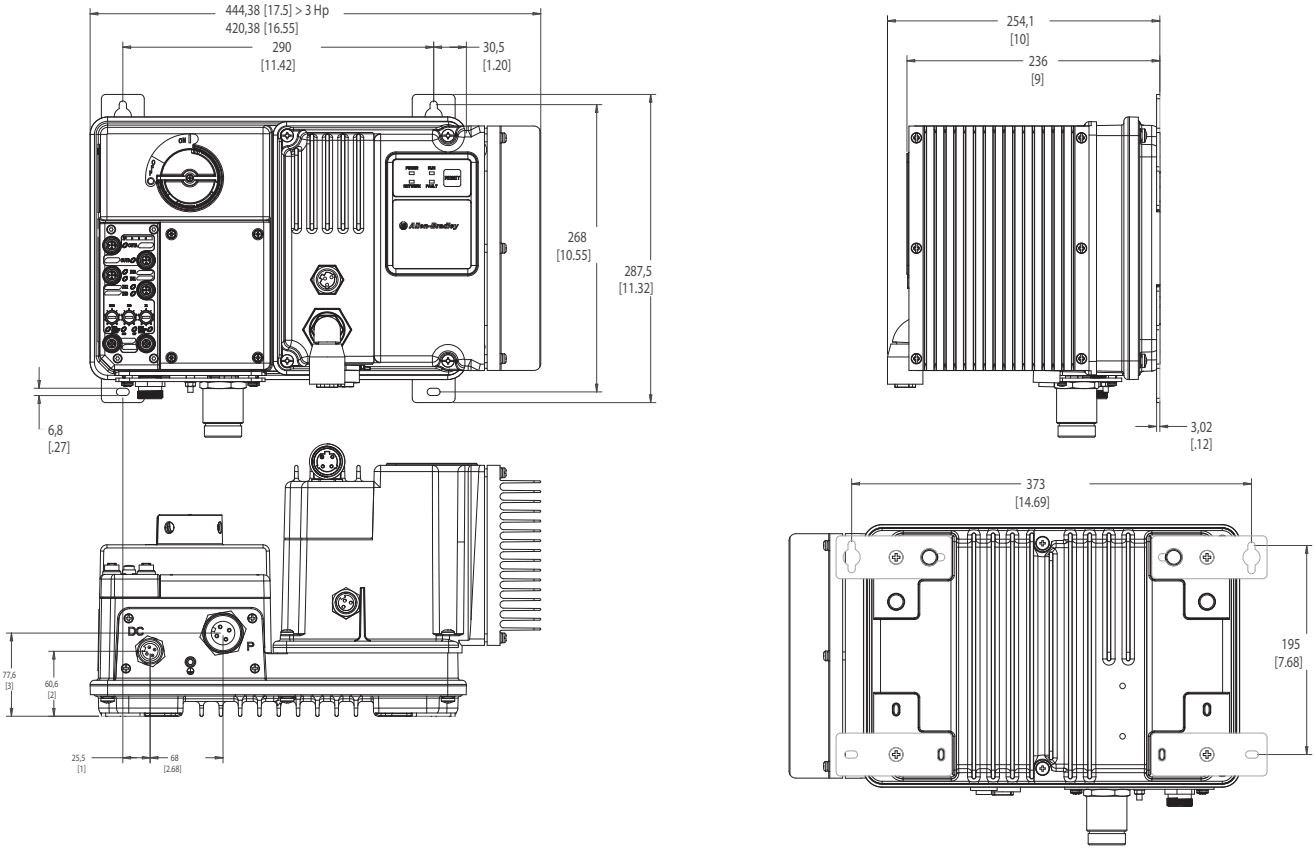
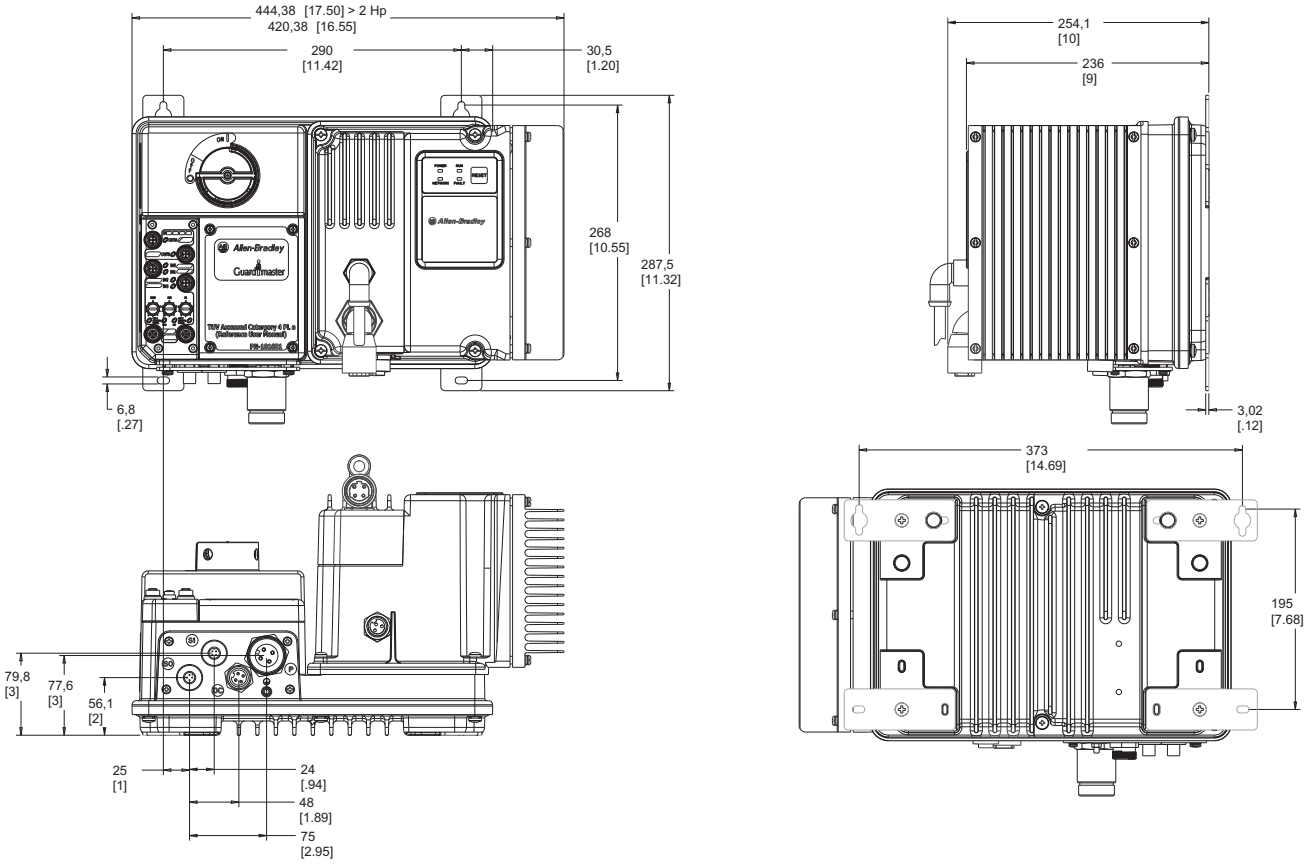


Figure 29 - ArmorStart Safety Version with RRG Gland - Bulletin 284E/284ES/284GS

Dimensions are shown in millimeters (inches). Dimensions are not intended to be used for manufacturing purposes.



Technical Specifications - Bulletin 284E/284ES/284GS VFDs

For VFDs with integrated safety, also see Safety Data for ArmorStart ST Motor Controllers with Integrated Safety.

Electrical Ratings

Attribute	UL/NEMA		IEC
Power Circuit			
Rated Operation Voltage	380/220…480/277V AC		380/220…480/277V AC
Rate Insulation Voltage	600V		600V
Rated Impulse Voltage	6 kV		6 kV
Dielectric Withstand	2200V AC		2500V AC
Operating Frequency	50/60 Hz		50/60 Hz
Utilization Category	—		AC-3(3)
Protection Against Shock	—		IP2X
Rated Operating Current Max.	**SVC - Performance**		
	Cat. No.	**3-phase Hp Rating**	**Output Current [A]**
	284E/284ES/284GS-FVD2P3Z-RRG*	1	2.3
	284E/284ES/284GS-FVD4P0Z-RRG*	2	4
	284E/284ES/284GS-FVD6P0Z-RRG*	3	6
	284E/284ES/284GS-FVD7P6Z-RRG*	3	7.6
Control Circuit			
Rated Operation Voltage	24V DC (+10%, –15%), SELV or PELV, (A2 must be grounded at voltage source)		
Rate Insulation Voltage	30V		30V
Rated Impulse Voltage	—		1.5 kV
Dielectric Withstand	1500V AC		2000V AC
Overvoltage Category	—		III
Operating Frequency	DC		DC
Short Circuit Protection			**480Y/277V**
Short Circuit Protection Device (SCPD) Performance Type 1	-10 or -25	Sym. amps rms	65 kA
		Max. Fuse(1)	30 A
	-10 or -25	Sym. amps rms	30 kA
		Max. Circuit Breaker(2)	60 A

(1) Class J, CC, and T fuses only.
(2) Only when used with Cat. No. 140G-H6C3-C60.
(3) IEC 60947-4-1 refers to utilization category AC-3 and is defined as occasional inching (jogging) or plugging for a limited time period. An example of this is machine setup. During this time the number of operations (e.g. one close and then open cycle of the contact) of inching or plugging should not exceed 5 operations per minute or more than 10 operations per 10 minutes. If the application exceeds this, then refer to AC-4 utilization category or the products mixed AC-3/AC-4 utilization category.

Mechanical Ratings

Attribute	UL/NEMA	IEC
Approximate Shipping Weight	13.6 kg (30 lb)	
Resistance to Shock		
Operational	15 G	
Non-Operational	30 G	
Resistance to Vibration		
Operational	1 G, 0.15 mm (0.006 in.) Displacement	
Non-Operational	2.5 G, 0.38 mm (0.015 in.) Displacement	
Power and Ground Terminals		
Wire Size	Primary/Secondary Terminal: #16…#10 AWG	Primary/Secondary Terminal: 1.0…4.0 mm^2
Tightening Torque	Primary Terminal: 10.8 lb·in Secondary Terminal: 4.5 lb·in	Primary Terminal: 1.2 N·m Secondary Terminal: 0.5 N·m
Wire Strip Length	0.35 in. (9 mm)	
Control Terminals		
Wire Size	#18…#10 AWG	1.0…4.0 mm^2
Tightening Torque	6.2 lb·in	0.7 N·m
Wire Strip Length	0.35 in. (9 mm)	
Disconnect Lock Out	Recommend 8 mm (5/16 in.) lock shackle or hasp. The hasp must not exceed 8 mm (5/16 in.) when closed.	

Control and I/O Power Requirements

Attributes	Units	A1/A2(2)	A3/A2(3)	A1/A2(2)	A3/A2(3)	A3/A2(4)
		Without Hand Off Auto		With Hand Off Auto		
Control Voltage	Volts	24V DC				
Module Inrush(1)	Amps	0.92	0.30	1.09	0.125	0.295
Module Steady	Amps	0.06	0.30	0.23	0.125	0.295
Total Control Power (Pick Up)	Watts	22.08	7.20	26.16	3.00	7.08
Total Control Power (Running)	Watts	1.44	7.20	5.52	3.00	7.08
Total Control Power (with Dynamic Brake or Output Contactor option)	Watts	—	—	12	3	8.4
Total Control Power (with Dynamic Brake and Output Contactor option)	Watts	—	—	15	3	8.4

(1) Instantaneous capacitive inrush exists for less than 10 ms, which can exceed 20 A. The power supply must have sufficient capacity to support this amount of instant power demand when multiple units are turned ON simultaneously. If supplies are weaker, we recommend applying unswitched power (A3-A2) first and after a 2…4 second delay, apply switched power.
(2) Add power requirements for outputs (1 A max.) to A1/A2.
(3) Add power requirements for inputs (200 mA max.) to A3/A2.
(4) If A1 power is disconnected.

Other Ratings

Attribute	UL/NEMA	IEC
Input Ratings – Sourced from Control Circuit (A3/A2)		
Rated Operation Voltage	24V DC	
Input On-State Voltage Range	10…26V DC	
Input On-State Current	3.0 mA @ 10V DC	
	7.2 mA @ 24V DC	
Input Off-State Voltage Range	0…5V DC	
Input Off-State Current	<1.5 mA	
Maximum Input Frequency Response	200 Hz (DeviceLogix response is greater than 200 Hz. Network response depends on control system network performance.)	
Input Filter – Software Selectable		
Off to On	Settable from 0…64 ms in 1 ms increments	
On to Off	Settable from 0…64 ms in 1 ms increments	
Input Compatibility	—	IEC 61131-2
Number of Inputs	4	
Sensor Source		
Voltage Status Only	11…26.4V DC from unswitched power (A3-A2)	
Current Available	50 mA max. per input, 200 mA for any single point	
Output Ratings – Sourced from Control Circuit (A1/A2) (Do not use as a power supply source to other devices)		
Rated Operation Voltage	26.4V DC	
Rate Insulation Voltage	250V	
Dielectric Withstand	1500V AC (UL)	2000V AC (IEC)
Type of Control Circuit	Solid-state sourcing output	
Type of Current	24V DC	
Conventional Thermal Current I_{th}	0.5 A each, 1 A, max combined	
Peak Output Current	Current limited 2…8 amps (5 amps, nom) @ 24V DC	
Type of Contacts	Normally open (N.O.)	
Number of Contacts	2	
Load Types	Resistive or light inductive	
Surge Suppression	Integrated diode, clamps @ 35V DC	
Thermo-Protection	Integrated short circuit and over current protection	
Maximum Cycle Rate	30 operations/minute capacitive and inductive loads	
Maximum Blocking Voltage	35V DC	
Maximum On-State Voltage @ Maximum Output	1.5V DC	
Maximum Off-State Leakage Current	10 µA	
Ethernet Port		
DHCP Timeout	30 s	
Communication Rate	10/100 Mbps with auto negotiate half-duplex and full-duplex	
Data Rate	• Transported over both TCP and UDP • Min. of 500 I/O packets/second (pps) • Supports up to 150 concurrent TCP sockets	

Other Ratings

Attribute	UL/NEMA	IEC
Network Connections	Supports scheduled (Class 1) and unscheduled (Class 3 and UCMM) connections	
	6 - Class 3 connections are supported simultaneously	
	Supports up to two Class 1 CIP connections [Exclusive owner (data) or listen-only]. One connection per PLC. Listen-only connection requires a data connection to be established.	
	Class 1 Connection API: 2…3200 ms Class 3 Connection API: 100…10 000 ms	
	20 ms Request Packet Interval (RPI) default	
	Three concurrent Encapsulation sessions	
	TCP port supports 5 concurrent incoming connections	
Ratings for Hardwired Safety Version Only		
SI - SM1 and SM2 (24V DC)		
Contact Rating	DC-12 L/R, 1 ms resistive, 6 A	
Contact Type	IEC 60947-5-1 Annex L - mechanically	
SO - P/M	3 W/0.125 A per contactor (Two safety contactors)	
Component Response Time		
1732ES-IB12XOBV2 or 1732ES-IB8XOBV4	See Guard I/O EtherNet/IP Safety Modules user manual, publication 1791ES-UM001	
Bulletin 284E	8…12 ms	
Average Frequency of a Dangerous Failure (PFH) and MTTF for Uncontrolled Stop(1)		
MTTF	100 years	
Average frequency of a dangerous failure (PFH)	6.0E-9 (1/h)	

(1) ArmorStart Safety controller used in combination with ArmorStart safety-related parts.

Drive Ratings – VFD Output Current vs. Input Current

Line Voltage [V]	Frequency [Hz]	3-Phase kW Rating	3-Phase Hp Rating	Output Current [A]	Input Current [A]
				Sensorless Vector Control	Sensorless Vector Control
380	50	0.4	—	1.4	2.15
		0.75	—	2.3	3.80
		1.5	—	4.0	6.40
		2.2	—	6.0	9.00
		3.0	—	7.6	12.40
460	60	—	0.5	1.4	1.85
		—	1	2.3	3.45
		—	2	4.0	5.57
		—	3	6.0	8.20
		—	5	7.6	12.5

Drive Characteristics

Attribute	Value
Output Frequency	0…400 Hz (Programmable)
Efficiency	97.5% (Typical)
Sensorless Vector Control	
Maximum (kW) Hp Rating/Input Voltage	5 Hp (3.3 kW)/480V AC
Preset Speeds	8
Skip Frequency	✓
StepLogic® Functionality	✓
Timer/Counter Functions	✓

Environmental Specifications

Attribute	UL/NEMA	IEC
Environmental		
Operating Temperature Range	–20…+40 °C (–4…+104 °F)(2)	
Storage and Transportation Temperature Range	–25…+85 °C (–13…+185 °F)	
Altitude(1)	1000 m (3281 ft)	
Humidity	5…95% (noncondensing)	
Pollution Degree	3	
Enclosure Ratings	UL Type 4/12/13 NEMA 4/12/13	IP67
EMC Emission Levels		
Conducted Radio Frequency Emissions	10V rms Communications Cables 10V rms (PE) 150 kHz…80 MHz	
Radiated Emissions	Class A, Group 1, equivalent to C2 emissions	
EMC Immunity Levels		
Electrostatic Discharge	4 kV contact and 8 kV Air	
Radio Frequency Electromagnetic Field	10V/m, 80 KHz…1 GHz 3V/m, 1.4 GHz…2 GHz 1V/m, 2.0 GHz …2.7 GHz	
Fast Transient	2 kV (Power) 2 kV (PE) 1 kV (Communications and Control)	
Surge Transient	1 kV (12) L-L, 2 kV (2) L-N (Earth)	
Internal Fan for Bulletin 284 only	Fan L10 Operation data: 80K hr at 40 °C (104 °F)	

(1) Altitude derating between1000…2000 m (3281…6562 ft) see Altitude Rating.
(2) Operating temperature derating available above 40 °C (104 °F), see Temperature Derating.

Temperature Derating

Derated operation in temperature range >+40 °C...+50 °C (+104 °F...+122 °F).

Adjusted maximum FLA for ambient °C (125% overload)

		Locations that do not require MTW wet rating		Locations that do require MTW wet rating	
	Max. FLA	+41 °C…+45 °C	+46 °C…+50 °C	+41 °C…+45 °C	+46 °C…+50 °C
Bulletin 284* - VFDs	7.6	6.6 (all amps derate - 13.2%)	6.0 (all amps derate -21.1%)	5.7 (all amps derate - 25.0%)	4.6 (all amps derate - 39.5%)

Certifications

Attribute	UL/NEMA	IEC
Standards Compliance	UL 508C CSA C22.2, No. 14 EN61800-5-1 EN61800-3 CE Marked per Low Voltage 2014/35/EU EMC Directive 2014/30/EU ODVA for EtherNet/IP	
Certifications	CE, KC, ODVA, RCM, TÜV, UL	

Sensorless Vector Control (SVC)

Protective Specifications – Sensorless Vector Control

Attribute	Value
Motor Overload Protection	I^2t overload protection – 150% for 60 seconds, 200% for 3 seconds (provides Class 10 protection)
Overcurrent	200% hardware limit, 300% instantaneous fault
Over Voltage	380…460V AC Input – Trip occurs @ 810V DC bus voltage (equivalent to 575V AC incoming line)
Under Voltage	380…480V AC Input – Trip occurs @ 390V DC bus voltage (equivalent to 275V AC incoming line)
Faultless Power Ride Through	100 milliseconds

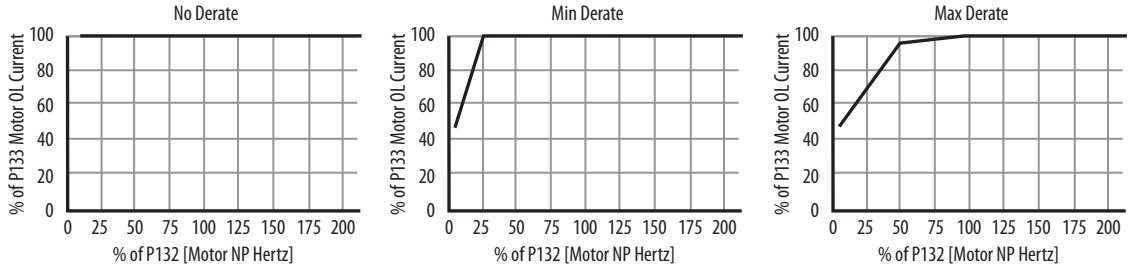
Control Specifications – Sensorless Vector Control

Attribute	Value
Carrier Frequency	2…16 kHz. Drive rating is based on 4 kHz.
Frequency Accuracy – Digital Input	Within ±0.05% of set output frequency.
Speed Regulation – Open Loop with Slip Compensation	±1% of base speed across a 60:1 speed range
Stop Modes	Multiple programmable stop modes including – Ramp, Coast, DC-Brake, Ramp-to-Hold, and S-curve.
Accel/Decel	Two independently programmable accel and decel times. Each time can be programmed from 0…600 s in 0.1 s increments.
Electronic Motor Overload Protection	Class 10 protection with speed sensitive response

Motor Overload Trip Curves

Motor overload current parameter provides class 10, 15, and 20 overload protection. Ambient insensitivity is inherent in the electronic design of the overload.

Figure 30 - Overload Trip Curves



Altitude Rating

- **0.5 Hp:** No Derating up to 2000 m (6562 ft)
- **1 Hp:** No Derating up to 2000 m (6562ft)
- **2 Hp:**Derate 1% per 100 m (328 ft) above 1000 m (3281 ft)
- **3 Hp:** No Derating up to 2000 m (6562 ft)
- **5 Hp:**Derate 1% per 100 m (328 ft) above 1000 m

Example: Application requires 2000 m for a 5 Hp ArmorStart controller

- 2000 m - 1000 m= 1000 m
- 1000/100 = 10
- 10 * 1%= 10%. Derate output amps by 10%
- (1 - 0.1) * 7.6 A = 6.8 A

It is possible to extend the operational range of the units if the ambient temperature is lower than 40 °C (104 °F), or if line reactors are used.

Replacement Parts

These tables list the replacement parts available for the controller.

Bulletin 284E Standard Version Controller

VFD Control Replacement Module

Input Voltage	kW	Hp	Cat. No.	
			Without HOA	With HOA
380…480V 50/60 Hz 3-Phase	0.75	1.0	284E-FVD2P3Z-N-RG-SBG-DB1-EMI	284E-FVD2P3Z-N-RG-3-SBG-DB1-EMI
	1.5	2.0	284E-FVD4P0Z-N -RG-SBG-DB1-EMI	284E-FVD4P0Z-N -RG-3-SBG-DB1-EMI
	2.2	3.0	284E-FVD6P0Z-N-RG-SBG-DB1-EMI	284E-FVD6P0Z-N-RG-3-SBG-DB1-EMI
	3.0	5.0	284E-FVD7P6Z-N-RG-SBG-DB1-EMI	284E-FVD7P6Z-N-RG-3-SBG-DB1-EMI

VFD Base Replacement Module

Input Voltage	kW	Hp	Cat. No.
380…480V 50/60 Hz 3-Phase	0.75	1.0	280E-FN-10-RG
	1.5	2.0	280E-FN-10-RG
	2.2	3.0	280E-FN-25-RG
	3.0	5.0	280E-FN-25-RG

Bulletin 284E/284ES/284GS Safety Version Controller

VFD Safety Control Replacement Module

Input Voltage	kW	Hp	Cat. No.	
			Hardwired and Integrated Safety without HOA	Hardwired and Integrated Safety with HOA
380…480V 50/60 Hz 3-Phase	0.75	1.0	284E-FVD2P3S-N-RG-SBG-DB1-EMI	284E-FVD2P3S-N-RG-3-SBG-DB1-EMI
	1.5	2.0	284E-FVD4P0S-N -RG-SBG-DB1-EMI	284E-FVD4P0S-N -RG-3-SBG-DB1-EMI
	2.2	3.0	284E-FVD6P0S-N-RG-SBG-DB1-EMI	284E-FVD6P0S-N-RG-3-SBG-DB1-EMI
	3.0	5.0	284E-FVD7P6S-N-RG-SBG-DB1-EMI	284E-FVD7P6S-N-RG-3-SBG-DB1-EMI

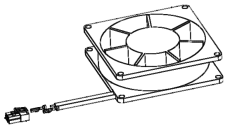
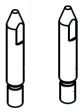
VFD Safety Base Replacement Module

Input Voltage	kW	Hp	Cat. No.				
			Hardwired Safety I/O - 4/2 Safety I/O - none	Integrated Safety I/O - 6/0 Safety I/O - 2/2	Integrated Safety I/O - 6/0 Safety I/O - none	Integrated Safety I/O - 4/2 Safety I/O - 2/2	Integrated Safety I/O - 4/2 Safety I/O - none
380…480V 50/60 Hz 3-Phase	0.75	1.0	280E-FNS-10-RG	280GS-FN-10-RG-22	280GS-FN-10-RG-00	280ES-FN-10-RG-22	280ES-FN-10-RG-00
	1.5	2.0	280E-FNS-10-RG	280GS-FN-10-RG-22	280GS-FN-10-RG-00	280ES-FN-10-RG-22	280ES-FN-10-RG-00
	2.2	3.0	280E-FNS-25-RG	280GS-FN-25-RG-22	280GS-FN-25-RG-00	280ES-FN-25-RG-22	280ES-FN-25-RG-00
	3.0	5.0	280E-FNS-25-RG	280GS-FN-25-RG-22	280GS-FN-25-RG-00	280ES-FN-25-RG-22	280ES-FN-25-RG-00

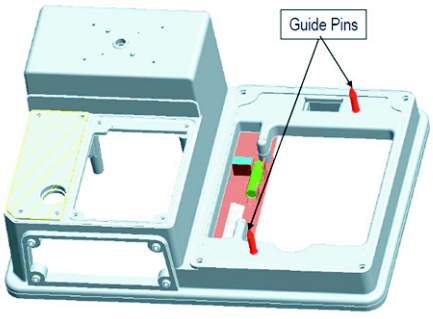
Replacement Fuses

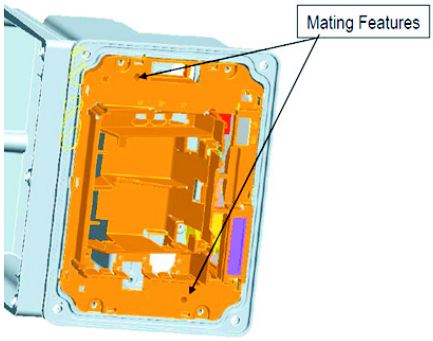
Fuse Type	Fuse Description	Cat. No.
Output Fuse	Fast-acting, high-interrupting capacity, tubular fuse Rating: 2.5 A, 250V Dimension [mm (in.)]: 20 (0.787) x 5 (0.197)	Littlefuse PN 021602.5
Control Fuse	UL Listed Class CC, CSA HRC-1 Rating: 7 A, 600V Dimensions [in.]: 1.5 x 0.405	Cooper Bussman PN KTK-R-7 or Littlefuse PN KLKR007.T
Source Brake Fuse (For use with Bulletin 284E with Brake option CB/SB)	UL Listed Class CC, CSA HRC-1 Rating: 3 A, 600V Dimensions [in.]: 1.5 x 0.405	Cooper Bussman PN KTK-R-3 or Littlefuse PN KLKR003.T

Replacement Fan

Description		Cat. No.
	Replacement Fan for 284 Control Module	284-FAN
	Replacement Guide Pins (two pins per package)(1)	284-PIN

(1) These pins are replacement parts for factory-installed alignment pins. They cannot be retrofitted in the field. The base module and control module require mating features as indicated in the following diagrams.





Safety Data for ArmorStart ST Motor Controllers with Integrated Safety

Safety Input (24V DC) Specifications

Attribute	Value
Input Type	Current sinking
IEC 61131-2 (input type)	Type 3
Voltage, on-state	11…30V DC
Voltage, off-state	-3…5V DC
Current, on-state, minimum	2 mA
Current, off-state, minimum	1.5 mA
Input Reaction Time, maximum	<10 ms + set values of ON/OFF delays

Safety Output (24V DC) Specifications

Attribute	Value
Output Type	Bipolar or current sourcing
Output Current	1 A bipolar / 500 mA sourcing
Field Capacitance, maximum	950 nF
Test Pulse Width	500 µs
Test Pulse Period	300 ms
Residual Voltage, maximum	0.3 V
Leakage Current, maximum	0.1 mA
Output Reaction Time, maximum	<10 ms + set values of ON/OFF delays
Short Circuit Protection	Yes

Test Output (24V DC) Specifications

Attribute	Value
Output Type	Current sourcing
Output Current	0.5 A
Test Pulse Width	500 µs
Test Pulse Period	300 ms
Field Capacitance, maximum	100 nF
Residual Voltage, maximum	0.3 V
Leakage Current, maximum	0.1 mA
Output Reaction Time, maximum	<10 ms + set values of ON/OFF delays
Short Circuit Protection	Yes

These PFH calculations are based on the equations from Part 6 of EN 61508 and show worst-case values. To achieve SIL 3/ Category 4, PLe, the maximum diagnostic test interval is one test per day.

Safety Data for Safe Torque Off Function

Attribute	Bulletin 281ES/GS Starter	Bulletin 284ES/GS VFD
PFH (1/hour)	3.62E-09	3.56E-09
SIL	3	3
PL	e	e
Category	4	4
Safe Failure Fraction (SFF)	99.1%	99.0%
$MTTF_D$ years	83.1	94.2
DC_{avg}%	98.2% (High)	98.0% (High)
HFT	1	1
Mission time	20 years(1)	20 years(2)

(1) The Bulletin 281ES/GS starter requires no maintenance if the average number of contactor operations is below an average of 49,970 cycles per year. An operation includes start-stop and Safe Torque Off (STO). An average rate higher than this will require replacement of the control module before the end of mission time. See SISTEMA library listed in the Additional Resources, for further information and calculation of maintenance.

(2) The Bulletin 284ES/GS VFD requires no maintenance if the number of STO operations is below an average of 34,900 cycles per year. An average rate higher than this annual average will require replacement of the control module before the end of mission time. See SISTEMA library listed in the Additional Resources, for further information and calculation of maintenance.

Safety Data for Safety I/O

Attribute	Single Channel Safety I/O(1)	Dual Channel Safety I/O
PFH (1/hour)	3.97E-09	3.44E-09
SIL	2	3
PL	d	e
Category	2	4
Safe Failure Fraction (SFF)	98.6%	94.5%
$MTTF_D$ years	177.8	100
DCavg%	97.2% (High)	97.2 (High)
HFT	0	1
Mission time	20 years	20 years

(1) Single channel safety I/O is only certified for use in functional safety applications with process safety times greater than or equal to 300 ms; or applications with demand rates less than or equal to 1 demand per 90 seconds.
If single channel safety I/O is used, pulse testing (external pulse testing for safety inputs, pulse testing for safety outputs) MUST be enabled on the single channel I/O points.

Safety Reaction Time

Attribute	Time
Safe Torque Off Safety Reaction Time[1] The safety reaction time for the Safe Torque Off function is the length of time from when the ArmorStart ST STO command receives the CIP Safety™ packet with an STO request and the time when motion-producing power is removed from the motor.	60 ms, maximum
Safety Input Reaction Time[2]	10 ms, maximum
Safety Output Reaction Time[2]	10 ms, maximum

(1) An input signal condition that is present for less than the reaction time may not result in the safety function being performed. Repeated requests of the safety function for less than the reaction time can result in a spurious detection of a fault.
(2) The times listed exclude the connection reaction time.

Safety reaction time is influenced by a number of factors, including the configuration of the safety I/O on your device and the configuration of your safety controller. These factors include:

- Safety Input On-Off and Off-On delay settings, if applicable
- Safety Input Connection Reaction Time Limit settings
- Safety controller Safety Task Period and Watchdog settings
- Produced and consumed safety Connection Reaction Time Limit settings
- Safety Output Connection Reaction Time Limit settings

For details on reaction time calculation of your safety system, see Reaction Times in the GuardLogix® Controller Systems Safety Reference Manual for your safety programmable controller. These manuals are listed in the Additional Resources.

Spurious Trip Rate (STR) and Mean Time to Failure Spurious (MTTF Spurious)

Attribute	Value
STR (per hour) [1]	1.19E-05
MTTF Spurious (years)	9.62

(1) Values are calculated according to the ISA TR-84 method.

Additional Resources

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

Resource	Description
ArmorStart ST Motor Controller User Manual, publication 280ES-UM001	Provides information on how to install, configure, program, and use ArmorStart ST controllers.
ArmorStart Motor Controller with Integrated Safety User Manual, publication 280ES-UM002	Provides information on how to install, configure, program, and use ArmorStart ST controllers with integrated safety.
ArmorStart ST Distributed Motor Controller (Includes safety version) Product Information, publication 280ES-PC001	Provides basic information on how to install, configure, and program, the ArmorStart controllers.
Applying More Than One ArmorStart Motor Controller in a Single Branch Circuit on Industrial Machinery, publication 280-AT003	This document explains how to use this Listing to apply the ArmorStart product family of motor controllers in multiple-motor branch circuits.
ArmorStart Distributed Motor Controller and ArmorConnect® Power Media Selection Guide, publication 280PWR-SG001	Provides information on product specifications, ratings, certifications, system interface, wiring diagrams, and dimensions, to aid in product selection.
ArmorStart Distributed Motor Controllers Selection Guide, publication 280-SG002	Provides information on product specifications, ratings, certifications, system interface, wiring diagrams, and dimensions, to aid in product selection
Guard I/O EtherNet/IP Safety Modules User Manual, publication 1791ES-UM001	Provides installation, specification, and other information for the Guard I/O EtherNet/IP safety modules.
GuardLogix Safety Application Instruction Set Reference Manual, publication 1756-RM095	Provides information on the GuardLogix Safety application instruction set.
GuardLogix 5570 and Compact GuardLogix 5370 Controller Systems Safety Reference Manual, publication 1756-RM099	Provides information on safety application requirements for GuardLogix 5570 and Compact GuardLogix 5370 controllers in Studio 5000 Logix Designer® applications.
GuardLogix 5580 and Compact GuardLogix 5380 Controller Systems Safety Reference, publication 1756-RM012	Provides information on safety application requirements for GuardLogix 5580 and Compact GuardLogix 5380 controllers in Studio 5000 Logix Designer applications.
Safety Automation Builder and SISTEMA Library	Download Safety Automation Builder® software to help simplify machine safety design and validation, and reduce time and costs. The SISTEMA tool, also available for download from the Safety Automation Builder page, automates calculation of the attained Performance Level from the safety-related parts of a machine's control system to (EN) ISO 13849-1.
Wiring and Grounding Guidelines for Pulse-width Modulated (PWM) AC Drives, publication DRIVES-IN001	Provides information to install, protect, wire, and ground pulse-width modulated (PWM) AC drives.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, rok.auto/certifications	Provides declarations of conformity, certificates, and other certification details.

You can view or download publications at http://www.rockwellautomation.com/global/literature-library/overview.page. To order paper copies of technical documentation, contact your local Allen-Bradley distributor or Rockwell Automation sales representative.

Rockwell Automation Support

Use the following resources to access support information.

Technical Support Center	Knowledgebase Articles, How-to Videos, FAQs, Chat, User Forums, and Product Notification Updates.	www.rockwellautomation.com/knowledgebase
Local Technical Support Phone Numbers	Locate the phone number for your country.	www.rockwellautomation.com/global/support/get-support-now.page
Direct Dial Codes	Find the Direct Dial Code for your product. Use the code to route your call directly to a technical support engineer.	www.rockwellautomation.com/global/support/direct-dial.page
Literature Library	Installation Instructions, Manuals, Brochures, and Technical Data.	www.rockwellautomation.com/literature
Product Compatibility and Download Center (PCDC)	Get help determining how products interact, check features and capabilities, and find associated firmware.	www.rockwellautomation.com/global/support/pcdc.page

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Rockwell Automation maintains current product environmental information on its website at http://www.rockwellautomation.com/rockwellautomation/about-us/sustainability-ethics/product-environmental-compliance.page.

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