



Allen-Bradley



DriveGuard[®]

**Safe-Off Option for
PowerFlex[®] 70 AC Drives**

User Manual

www.abpowerflex.com

**Rockwell
Automation**

Important User Information

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

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

Reproduction of the contents of this manual, in whole or in part, without written permission of Rockwell Automation, Inc. is prohibited.

Throughout this manual we use notes to make you aware of safety considerations.



ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss.

Attentions help you:

- identify a hazard
- avoid the hazard
- recognize the consequences

Important: Identifies information that is especially important for successful application and understanding of the product.



Shock Hazard labels may be located on or inside the drive to alert people that dangerous voltage may be present.

DriveExplorer, DriveTools32, and SCANport are trademarks of Rockwell Automation.

PLC is a registered trademark of Rockwell Automation.

ControlNet is a trademark of ControlNet International, Ltd.

DeviceNet is a trademark of the Open DeviceNet Vendor Association.

Table of Contents

Section	Page
General Description	2
What Is the PowerFlex Safe-Off Option?	2
Safety of Machinery Standards	3
EMC Instructions	3
Approved Equipment	3
Installation and Wiring	4
Option Board Installation	4
Wiring	6
Description of Operation	8
Supplemental Information	11
Certification	11

Summary of Changes

The information below summarizes the changes to the PowerFlex Safe-Off Option User Manual since the February 2004 release.

Description of New or Updated Information	See Page(s)
Normal relay states corrected in Minotaur MSR9T internal schematic (Figure 4).	9

General Description

The PowerFlex Safe-Off board, when used with suitable safety components, provides protection according to EN 954-1:1997; Category 3 for safe-off and protection against restart. The PowerFlex Safe-Off option is just one safety control system. All components in the system must be chosen and applied correctly, to achieve the desired level of operator safeguarding.

What Is the PowerFlex Safe-Off Option?

The PowerFlex Safe-Off Option Board:

- Is designed to safely remove power from the gate firing circuits of the Drive's output power devices (IGBT's). This prevents them from switching in the pattern necessary to generate AC power to the motor.
- Can be used in combination with other safety devices to meet the Stop and protection against restart requirements of EN 954-1.

Important: The option is suitable for performing mechanical work on the drive system or affected area of a machine only. It does not provide electrical safety.



ATTENTION: To avoid an electric shock hazard, verify that the voltage on the bus capacitors has discharged before performing any work on the drive. Measure the DC bus voltage at the +DC and -DC terminals or test points (refer to your drive's *User Manual* for locations). The voltage must be zero.



ATTENTION: In safe-off mode, hazardous voltages may still be present at the motor. To avoid an electric shock hazard, disconnect power to the motor and verify that the voltage is zero before performing any work on the motor.

Safety of Machinery Standards

The PowerFlex Safe-Off Board meets the following council directives:

- EN 60204-1 Safety of machinery – Electrical equipment of machines – Part 1: General Requirements
- EN 954-1:1997; Category 3 - Safety-related parts of control systems

EMC Instructions

CE Conformity

Conformity with the Low Voltage (LV) Directive and Electromagnetic Compatibility (EMC) Directive has been demonstrated using harmonized European Norm (EN) standards published in the Official Journal of the European Communities. PowerFlex Drives comply with the EN standards listed below when installed according to the User and Reference Manuals.

CE Declarations of Conformity are available online at:

<http://www.ab.com/certification/ce/docs>.

Low Voltage Directive (73/23/EEC)

- EN50178 Electronic equipment for use in power installations

EMC Directive (89/336/EEC)

- EN61800-3 Adjustable speed electrical power drive systems Part 3: EMC product standard including specific test methods.

Approved Equipment

The following devices have been approved for use with the PowerFlex Safe-Off Option:

- PowerFlex 70 Enhanced Control AC Drive: 240V, 400V, and 480V versions only.

Installation and Wiring

Installation must be in accordance with the following steps and must be carried out by suitably competent personnel. This device is intended to be part of the safety related control system of a machine. Before installation, a risk assessment should be performed to determine whether the specifications of this device are suitable for all foreseeable operational and environmental characteristics of the machine to which it is to be fitted.

At regular intervals during the life of the machine check the safety function for proper operation. How frequently the safety function is checked is dependent on the safety analysis of the machine section controlled by the drive.

Allen-Bradley cannot accept responsibility for a failure of this device if the procedures given in this publication are not implemented or if it is used outside the recommended specifications in this publication.

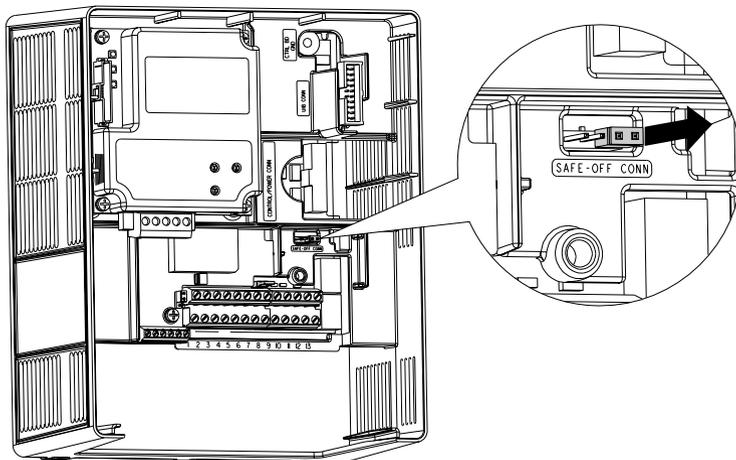


ATTENTION: The following information is merely a guide for proper installation. Rockwell Automation, Inc. cannot assume responsibility for the compliance or the noncompliance to any code, national, local or otherwise for the proper installation of this equipment. A hazard of personal injury and/or equipment damage exists if codes are ignored during installation.

Option Board Installation

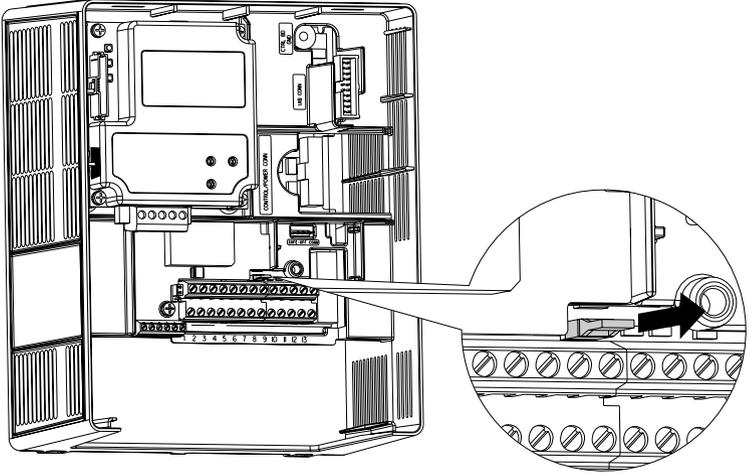
1. Remove the Safe-Off Connection jumper.

Figure 1 Safe-Off Connection Jumper Location (Typical)



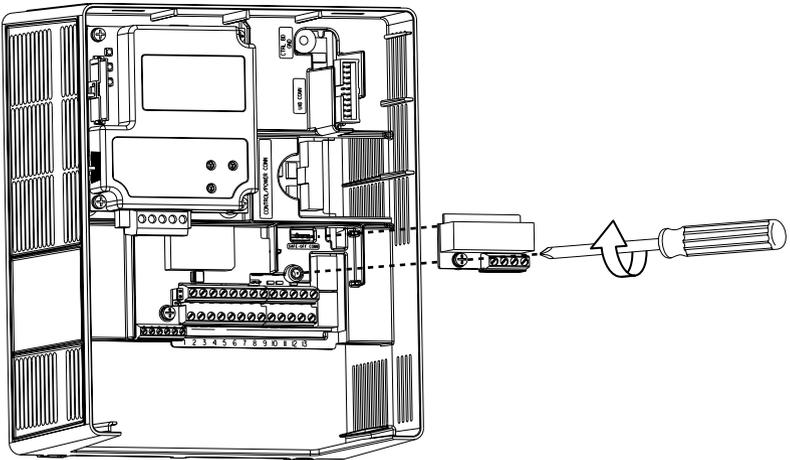
2. Remove the Hardware Enable jumper.

Figure 2 Hardware Enable Jumper Location (Typical)



Important: The hardware enable jumper must be removed when using the Safe-Off option. Failure to remove the jumper will cause the drive to fault when a start command is issued.

3. Plug the Safe-Off Board into the four pin connector.



4. Tighten screw.

Wiring

Important points to remember about wiring:

- Always use copper wire.
- Wire with an insulation rating of 600V or greater is recommended.
- Control wires should be separated from power wires by at least 0.3 meters (1 foot).

Safe-Off Board Terminal Block Specifications

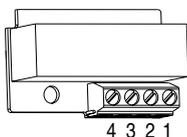
Wire Size Range ⁽¹⁾		Torque	
Maximum	Minimum	Maximum	Recommended
1.5 mm ² (16 AWG)	0.14 mm ² (26 AWG)	0.25 N-m (2.2 lb.-in.)	0.22 N-m (1.9 lb.-in.)

⁽¹⁾ Maximum / minimum that the terminal block will accept - these are not recommendations.

Wire Types

	Wire Type(s)	Description	Minimum Insulation Rating
Unshielded	Per US NEC or applicable national or local code	—	300V, 60 degrees C (140 degrees F)
Shielded	Multi-conductor shielded cable such as Belden 8770 (or equiv.)	0.750 mm ² (18 AWG), 3 conductor, shielded.	

PowerFlex Safe-Off Board Terminal Description



No.	Signal	Description
1	Monitor - N.C.	Normally closed contacts for monitoring relay status.
2	Common - N.C.	Maximum Resistive Load: 250V AC / 30V DC / 50 VA / 60 Watts Maximum Inductive Load: 250V AC / 30V DC / 25 VA / 30 Watts
3	+24V DC	Connections for user supplied power to energize coil.
4	24V Common	33.3 mA typical, 55 mA maximum.

Verify Operation

At regular intervals during the life of the machine check the safety function for proper operation. Both safety channels shall be verified using the table below. How frequently the safety function is checked is dependent on the safety analysis of the machine section controlled by the drive.

Safety Function Status	Drive In Safe State	Drive In Safe State	Drive In ⁽¹⁾ Safe State	Drive Able To Run
Safety Channel Operation				
Safe-Off Option Terminals 3 & 4	No Power Applied	Power Applied	No Power Applied	Power Applied
PowerFlex 70 Enable Input	No Power Applied	No Power Applied	Power Applied	Power Applied
Description For Verification				
Safe-Off Option Monitor Contact Terminals 1 & 2	Closed	Open	Closed	Open
PowerFlex 70 Drive Inhibits Param. 214, Bit 2	Value = 1	Value = 1	Value = 0	Value = 0

⁽¹⁾ A Start/Run command will cause an F111 “Enable Hardware” fault.

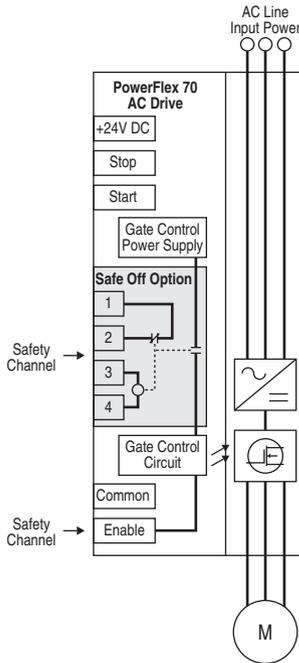
Description of Operation

The PowerFlex 70 Safe-Off option (see [Figure 3](#)) disables the drive's output IGBT's by disconnecting the gate control power supply. When used in combination with a second safety channel (the Enable input), the system satisfies the requirements of EN 954-1, Category 3 for safe-off and protection against restart.

Under normal drive operation, the Safe-Off relay is energized, the enable input is energized, and gate control power is available to the gate control circuit. If either of these inputs is de-energized, the gate control circuit is disabled. To meet EN 954-1, Category 3 operation, both safety channels must be de-energized. Refer to the following examples for details.

Important: By itself, the Safe-Off option initiates a coast-to-stop action. If coasting to a stop is not desired, additional protective measures should be taken.

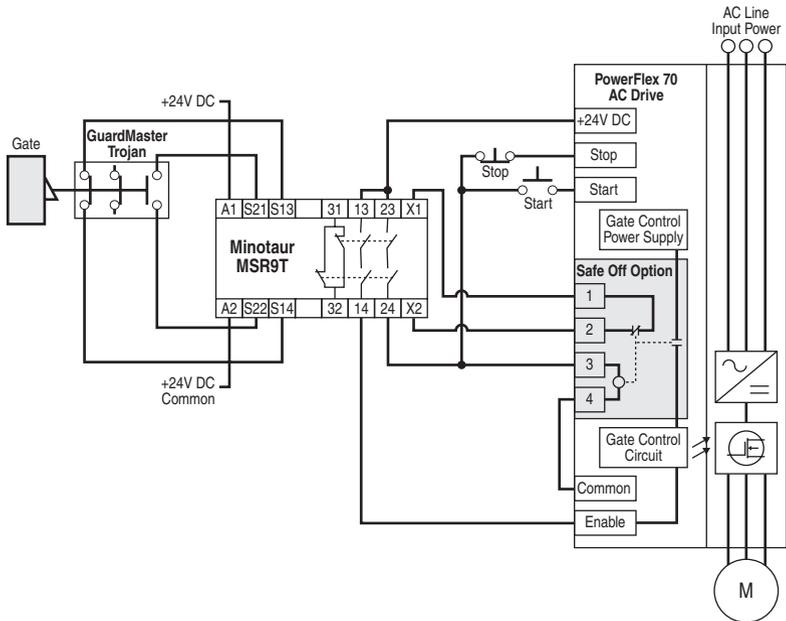
Figure 3 Safe-Off Drive Circuitry



Example 1

Safe-Off Connection with Coast-to-Stop Action, Dual Channel

Figure 4 Stop Category 0 – Coast



Circuit Status

Circuit shown with guard door closed and system ready for normal drive operation.

Operating Principle

This is a dual channel system with monitoring of the safe-off circuit and drive. Opening the guard door will switch the input circuits (S13-S14 & S21-S22) to the Minotaur monitoring safety relay unit. The output circuits (13-14 & 23-24) will cause the Safe-Off option and drive Enable circuit to go immediately to a safe state (off) and the motor will coast to stop. To restart the drive, the Minotaur safety relay must first be reset followed by a valid start command to the drive.

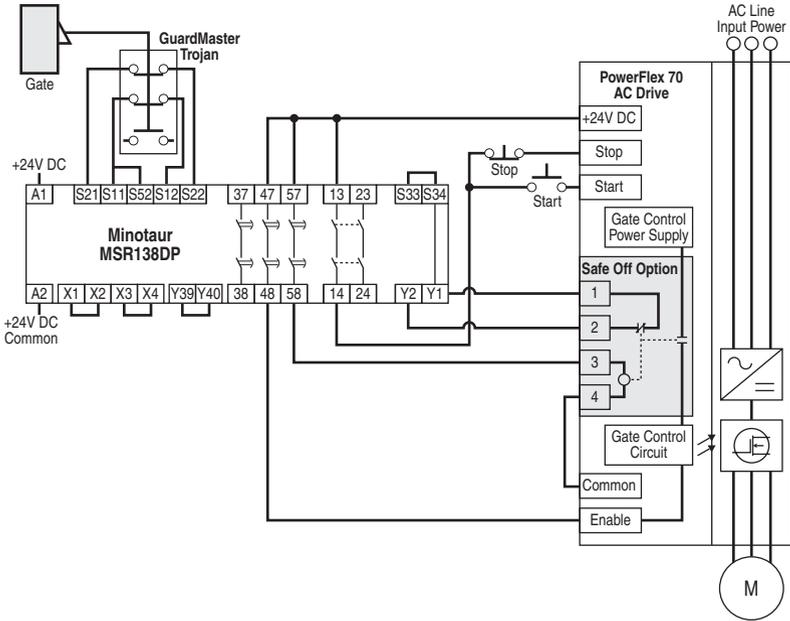
Fault Detection

A single fault detected on the Minotaur safety input circuits will result in the lock-out of the system to a safe state (off) at the next operation and will not cause loss of the safety function.

If the Safe-Off option sticks ON, the motor will stop on command due to the enable input. The system cannot be reset and thereby reveals the fault condition to the operator.

Example 2 Safe-Off Connection with Controlled Stop Action, Dual Channel

Figure 5 Stop Category 1 – Controlled



Circuit Status

Circuit shown with guard door closed and system ready for normal operation.

Operating Principle

This is a dual channel system with monitoring of the safe-off circuit and drive. Opening the guard door will switch the input circuits (S11-S12 & S21-S22) to the Minotaur monitoring safety relay unit. The immediate output circuits (13-14) will issue a Stop command to the drive and cause a controlled deceleration. After the programmed delay, the timed output circuits (47-48 & 57-58) will cause the Safe-Off option and the drive Enable circuit to go to a safe state (off). If the motor has not stopped rotating, it will coast to stop. To restart the drive, the Minotaur safety relay must first be reset followed by a valid start command to the drive.

Fault Detection

A single fault detected on the Minotaur safety input circuits will result in the lock-out of the system to a safe state (off) at the next operation and will not cause loss of the safety function.

If the Safe-Off option sticks ON, the motor will stop on command due to the enable input. The system cannot be reset and thereby reveals the fault condition to the operator.

Supplemental Information

Certification



TÜV Rheinland Group

TÜV Anlagentechnik GmbH
Automation, Software und Informationstechnologie

ZERTIFIKAT CERTIFICATE

Nr./No. 968/EZ 166.00/04

Prüfgegenstand/ Product tested	Adjustable Frequency AC Drive	Zertifikatsinhaber/ License holder	Rockwell Automation 6400 West Enterprise Drive USA-Mecler, WI 53052 United States of America
		Hersteller/ Manufacturer	Rockwell Automation, Inc. 02, W. 1st Street, USA-Sumner, Iowa 52074 United States of America
Typbezeichnung/ Type designation	Allen Bradley PowerFlex 70 AC Drive Frame Size 240V, 400V, 480V Frame A/B/C/D	Verwendungszweck/ Intended application	Safety relevant applications; Safety Function "Safe stop-dwell" according to EN 954-3 category 3
Prüfgrundlagen/ Codes and standards forming the basis of testing	EN 954-3:1996 DIN EN ISO 13849-2:2003 EN 60204-1:1997 DIN EN 5078:04:58 EN 61800-3:1996 & A1:2000		
Prüfungsergebnis/ Test results	The safety function "Safe stop-dwell" fulfills the requirements for category 3 according to EN 954-3.		
Besondere Bedingungen/ Specific requirements	The possibility of the small movement of the motor resulting from simultaneous IGBT failures must be taken into account during the hazard analysis of the system. Fault exclusion for the external wiring has to be made according to DIN EN ISO 13849-2. The user manual "Safe Off Option for PowerFlex 70 AC Drive" (Publication PFLX-LM00 A-EN-F-February 2004) and "PowerFlex 70 Adjustable AC Drive" (Publication 20A-LM00 F-EN-F-July 2002) have to be considered.		



Der Prüfbericht-Nr. 968/EZ 166.00/04 vom 2004-02-25 ist Bestandteil dieses Zertifikates.
Der Inhaber eines der Prüfgegenstände gültiger Genehmigungs-Ausweise ist berechtigt, die mit dem Prüfgegenstand übereinstimmenden Baugruppe mit dem abgetasteten Prüfzeichen zu versehen.

The test report no. 968/EZ 166.00/04 dated 2004-02-25 is an integral part of this certificate.
The holder of a valid license certificate for the product tested is authorized to affix the test mark shown opposite to products which are identical with the product tested.

TÜV Anlagentechnik GmbH
Geschäftsbereich ASI
Automation, Software und Informationstechnologie
Am Gauwerk Stein, 51125 Köln
Postfach 91 00 51, 51121 Köln

2004C2-25

Datum/Date

Firmenstempel/Company seal

Unterschrift/Signature

Notes:



www.rockwellautomation.com

Power, Control and Information Solutions Headquarters

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

Publication PFLEX-UM001B-EN-P – January 2006

Supersedes February 2004

Copyright © 2006 Rockwell Automation, Inc. All rights reserved. Printed in USA.