

## F7 Drive Safe-Off Option Technical Manual





# Contents:

1.0 Overview .....	2
2.0 Basic Concept .....	3
3.0 Changes From Standard Product .....	4
4.0 Limitations .....	5
5.0 Related Parameters and Functions .....	5
6.0 Function Description .....	5
7.0 Implementation .....	6
8.0 Connections .....	8
9.0 Precautions .....	9
10.0 References .....	10
11.0 Yaskawa Support .....	11

This document provides instructions for the proper installation and use of the Yaskawa drive with “Safe-Off” option. This document is a **supplement** to the F7 technical manuals, and describes the effects on the drive functions and parameters when the “Safe-Off” option is installed. Read and understand this document as well as the standard drive technical manuals before attempting to install, adjust, operate, inspect or maintain the drive. **Observe all cautions and warnings in this document and the standard drive technical manuals.** The Safe-Off option adds functionality to a standard AC drive to enhance or enable its use in specific applications. The Safe-Off option requires a special control board (**ETC 619320 - S7160**) and terminal board (**ETC 619330**) which replace the standard drive control board and terminal board.

The Safe-Off control board and terminal board are installed in the drive before delivery. The drive nameplate will display the conventional model number followed by “-118” indicating that the Safe-Off option is installed.

When seeking support for a drive with the Safe-Off option, it is imperative to provide the unique part number shown on the drive nameplate including the “-118” indicating Safe-Off.

**⚠ WARNING**

The Safe-Off function does not cut the power supply to the drive nor does it provide electrical isolation to the motor. The drive must be disconnected from the power mains before any installation or maintenance work is done. Always use “lock-out, tag-out” or similar approved safety protocol when servicing equipment.

**⚠ CAUTION**

Remove the jumper (link) connecting Safe-Off terminals BB, BB1 and SN to use the Safe-Off option. Follow the wiring diagrams illustrated in this document for implementing Safe-Off. If Safe-Off is **not** to be used, leave the jumper in place.



First, there is nothing inherently *unsafe* about an F7 without the Safe-Off option. However, the F7's operation is fully programmable. It is commanded by programmable inputs. Multiple sources (keypad, terminals, serial communications, option cards, etc.) can issue a *Run* command. When turning off the motor is essential to safety-related functions in the system, the F7's flexibility necessitates a reliable mechanism to ensure that the motor will stop and cannot be started regardless of how the drive is programmed, configured or controlled otherwise.

The Safe-Off option, when used with other safety components, provides protection according to **EN954-1 Category 3** for safe stop and protection against restart. An F7 drive equipped with the Safe-Off option is just one component in a safety control system. To assure that the Safe-Off function appropriately fulfills the safety requirements of the application, a thorough risk assessment shall be done according to ISO12100 for the whole safety system at the final installation. All components in the system must be appropriately selected and applied to achieve the desired safeguarding.

The Safe-Off function performs a safe stop according to the **EN60204-1 Stop Category 0** referred to as "uncontrolled stop by power removal" or "coast to stop." Safe-Off is certified to meet the requirements of the **EN954-1, Safety Category 3**. The Safe-Off function is implemented totally in hardware on the F7 control board.

Safe-Off disables the motor, not the drive controller. Power to the control board and display is maintained so all parameters, monitors and fault data may be read and observed. Also, all communications (Modbus, Profibus, DeviceNet, EtherNet/IP, etc.) stay active.

The Safe-Off function uses two independent hardware channels to redundantly block the driver signals to the output devices (IGBTs) so the motor is disabled and operation prevented. Redundancy ensures that a single fault in any of the parts involved in Safe-Off does not lead to a loss of the safety function.

Safe-Off is all electronic. No mechanical moving parts (relays) are involved in the Safe-Off circuitry. Safe-Off is suitable in applications classified as "medium risk" where coasting to a stop is the appropriate response to a fault condition.

Safe-Off merely prevents the motor from moving. The Safe-Off option does **not** serve as a motor disconnecting means (NEC Article 430 Part IX) and does **not** provide electrical safety. It is only suitable for preventing motor operation when people are working near parts of a machine affected by the drive system.

The Safe-Off option should **not** be used as the normal means to start and stop the drive.

## 2.0

## Basic Concept

The Safe-Off function option involves two added digital inputs, BB and BB1, as well as supply terminal SN on the terminal board. Removing the voltage from either terminal BB or BB1 disables the drive motor output. Both terminals BB and BB1 must be energized (connected to SN) for the drive to start or run the motor. BB and BB1 individually break the drive signals to the output devices (IGBTs) resulting in a reliable means of removing power from a motor and preventing it from restarting until both BB and BB1 are reenergized. As long as either BB or BB1 is open (deenergized), no command given the drive will start or run the motor no matter how the drive is programmed, configured or commanded.

The F7 with Safe-Off option is shipped from the factory with a jumper connecting BB and BB1 to SN. This jumper allows the F7 “out of the box” to operate as a conventional F7 drive without Safe-Off. The **jumper must be removed** to use the Safe-Off option.



The time from opening either Safe-Off input until the drive output is switched off is less than 10 milliseconds.

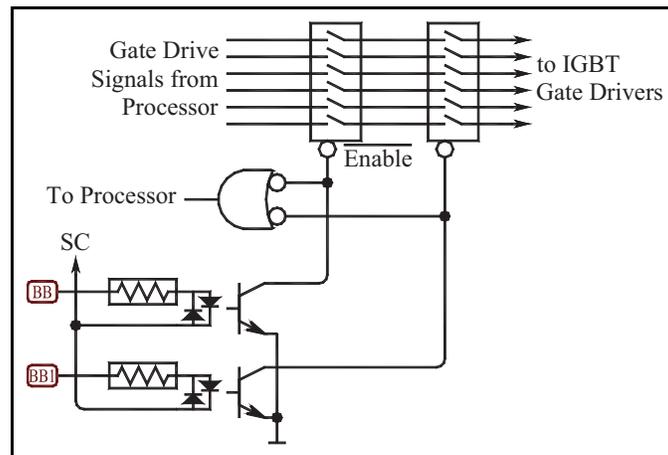
### 3.0

## Changes From Standard Product

The Safe-Off option requires a special F7 control board (**ETC 619320-S7160**) and terminal board (**ETC 619330**) which replace the standard drive control board and terminal board. The most salient difference is the **ETC 619330** terminal board's third row of control terminals containing the BB, BB1 and SN Safe-Off connections. The SN Safe-Off terminal is electrically connected to the standard SN terminal.

BB and BB1 have the same opto-coupler interface as the other digital inputs, S1 through S8, and operate from the same isolated 24V on-board control supply. Whereas S1 through S8 connect only to the F7's I/O processor, BB and BB1 also connect to hardware buffers that can block the gate drive signals to the IGBTs and prevent the motor from running.

The drive software interprets BB and BB1 exactly as a conventional "External Baseblock" command. Otherwise, all standard F7 parameters and monitors retain their original functionality. In fact, multifunction digital inputs (S3 through S8) can still be programmed as conventional "External Baseblock N.O." and "External Baseblock N.C." to maintain compatibility with previous utilizations.



**Safe-Off Circuitry Blocks the IGBT Gate Signals Through Two Separate Hardware Channels**

<b>4.0</b>	<b>Limitations</b>
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An F7 with the Safe-Off option has all the functionality of the conventional F7.

<b>5.0</b>	<b>Related Parameters and Functions</b>
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The Safe-Off option does not add or modify any parameters, monitors, multifunction input codes, multifunction output codes, faults or alarms.

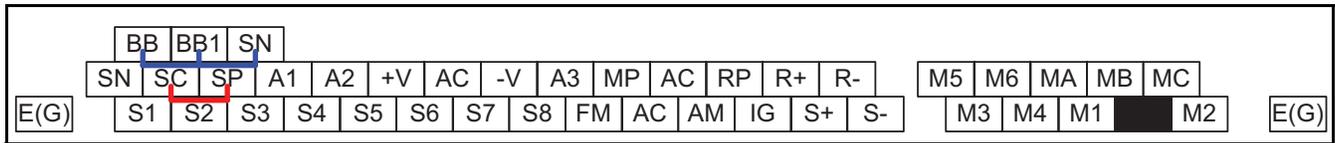
<b>6.0</b>	<b>Function Description</b>
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The blocking function of Safe-Off terminals BB and BB1 is fully implemented in hardware. Nevertheless, the drive software still monitors BB and BB1 inputs and treats them as a conventional **External Baseblock** command like Multifunction Inputs programmed with codes “8” or “9.” When the drive receives a Baseblock command (either software or hardware implemented), it turns off the output devices (IGBTs) and no output voltage is applied to the motor. The motor coasts. The drive can be forced into a baseblock state by either closing a digital input configured for “Ext Baseblk N.O.” (H1-0x= 8) or opening a digital input configured for “Ext Baseblk N.C.” (H1-0x= 9) or by opening either Safe-Off input BB or BB1.

The time from opening either Safe-Off input until the drive output is switched off is less than 10 milliseconds.

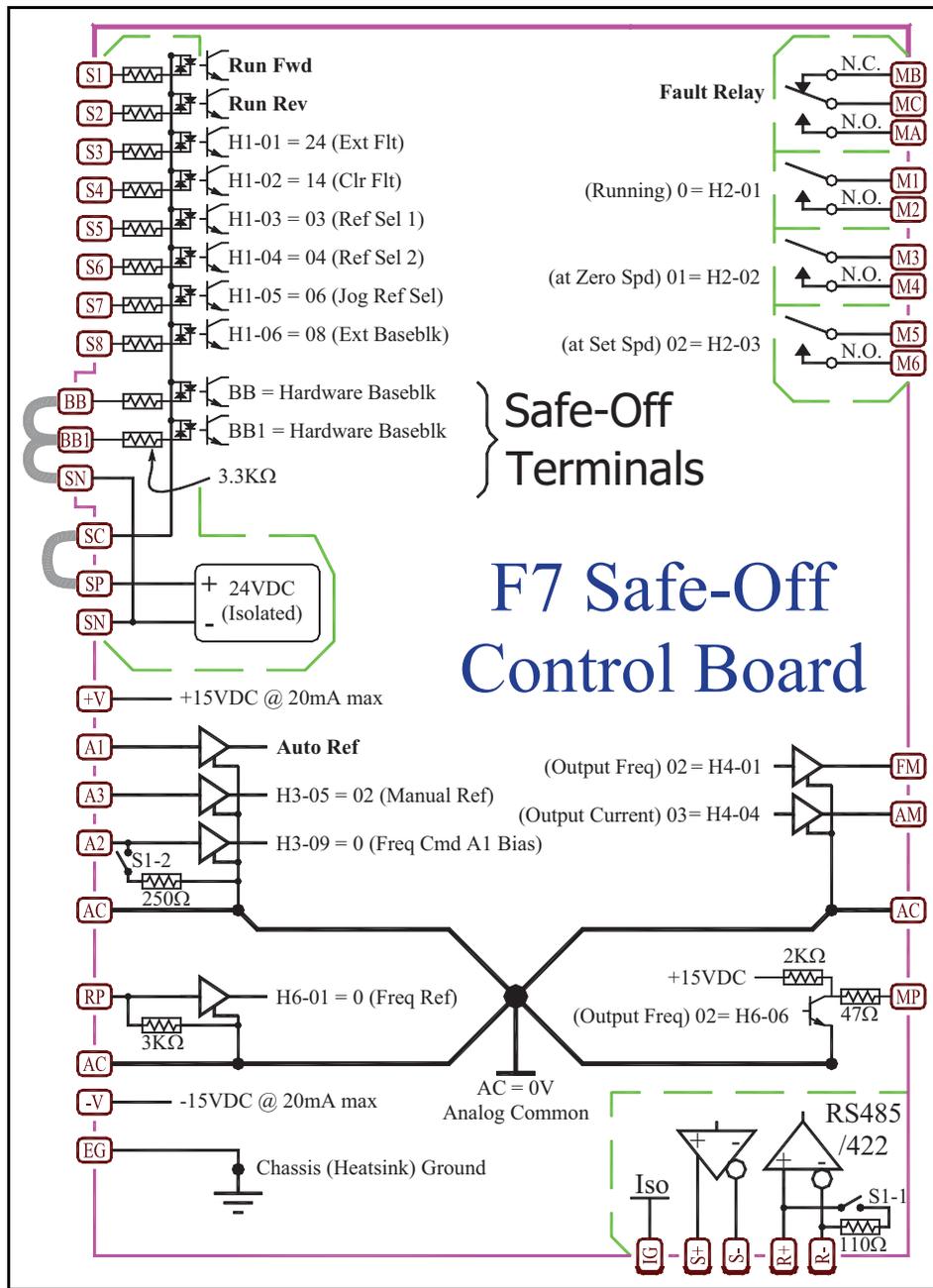
When the Baseblock command is removed, the drive immediately performs the **Speed Search** function to catch the coasting (or stopped) motor and ramp it back to the commanded speed. Parameter b3-01 determines which method of speed search (either Current Detection or Speed Estimation) is used. See the **F7 Drive Programming Manual** TM.F7.02 for complete descriptions of Baseblock and Speed Search functions.

<b>7.0</b>	<b>Implementation</b>
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**Physical Arrangement of Control Terminals for F7 with Safe-Off Option (including Factory-Installed Jumpers)**

For a complete description of the terminals other than BB, BB1 and SN, see the **F7 User Manual** TM.F7.01. When shipped from Yaskawa, the drives have removable jumpers connecting SC and SP and connecting BB, BB1 and SN. This jumper arrangement is compatible with physical contacts or NPN-type output drivers. In this configuration the inputs are “current-sourcing” and can be driven by outputs that are “current-sinking.”



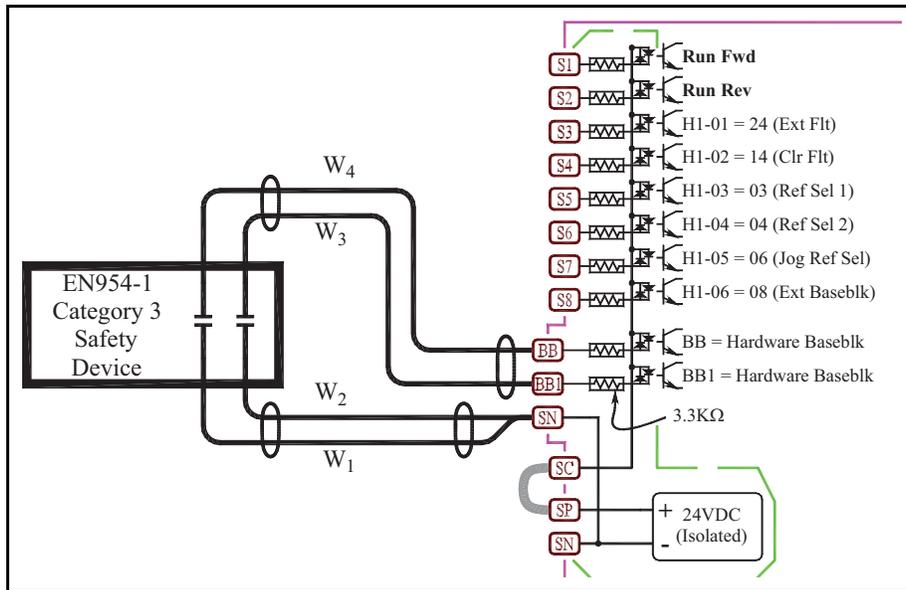
F7 Safe-Off Control Board

# 8.0

# Connections

If the Safe-Off function is used, the factory-installed wire link (jumper) between terminals SN, BB and BB1 must be **removed entirely**. Connect the drive to an EN954-1, Safety Category 3 interrupting device so that a Safe-Off request breaks the connection between the terminal SN and both terminals BB and BB1. The normal connection is shown below. Wires  $W_1$  and  $W_2$  should be run separately from  $W_3$  and  $W_4$ . A short circuit from  $W_1$  or  $W_2$  to  $W_3$  and  $W_4$  would bridge the contacts of the safety device and nullify its operation.

To maintain the integrity of the safety system, no other control input should be connected to Safe-Off terminals BB or BB1.



**Normal Connection to EN954-1 Category 3 Safety Device**

### Safe Disable Terminals

No.	Signal Name	Signal Level
BB	Hardware Baseblock	24VDC, 8mA
BB1	Hardware Baseblock1	photocoupler
SN	Sequence input neutral	-
SC	Sequence input common	-

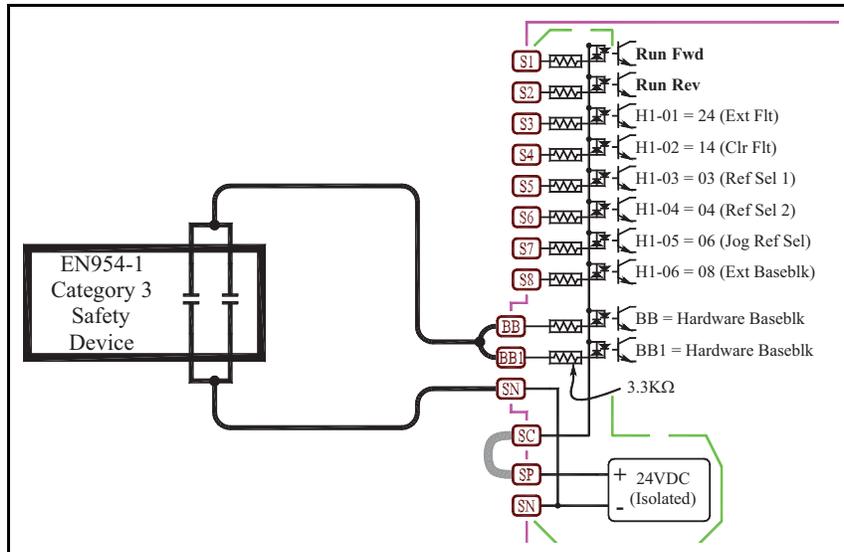
Terminals	Terminal Screws	Tightening Torque (N•m)	Possible Wire Sizes mm <sup>2</sup> (AWG)	Recommended Wire Size mm <sup>2</sup> (AWG)	Wire Length
BB, BB1, SC, SN	Phoenix type	0.5 to 0.6	Solid wire: 0.14 to 2.5 Stranded wire: 0.14 to 1.5 (26 to 14)	0.75 (18)	50 m or less

## 9.0

## Precautions

If two separate signal lines from the safety device to inputs BB and BB1 are used as shown on the previous page, the drive does not need to be installed in an IP54 enclosure. If only one signal line from the safety device to the drive is used, and BB and BB1 are linked at the drive, then the drive must be installed in an enclosure with a protection degree of at least IP54 in order to maintain EN954-1, Safety Category 3 compliance.

If the safety device and the drive are installed in separate cabinets, the Safe-Off wires must be installed in a short-circuit proof manner.



**Only Permissible in IP54 Enclosure**

The Safe-Off function does not cut the power supply to the drive and does not provide electrical isolation to the motor. The drive must be disconnected from the power mains before any installation or maintenance work is done. Always use “lock-out, tag-out” or similar approved safety protocol when servicing equipment.

### Risk Assessment Required

To assure that the Safe-Off function appropriately fulfills the safety requirements of the application, a thorough risk assessment shall be done according to ISO12100 for the whole safety system at the final installation.

### Safety Function Inspection

Check the safety function during periodic maintenance by hitting the STOP switch or tripping the appropriate safety interlock. Verify both that the applicable motor stops and that the digital operator shows the “BB” indication on the display. If the motor does not stop or the “BB” indication does not appear, **discontinue using the drive at once**. Replace the F7 or its control board and do not resume operation until it is verified both that the applicable motor stops and that the digital operator shows the “BB” indication on the display.

*F7 User Manual TM.F7.01*

*F7 Drive Programming Manual TM.F7.02*

ZERTIFIKAT ♦ CERTIFICATE ♦ 認証証書 ♦ СЕРТИФИКАТ ♦ CERTIFICADO ♦ CERTIFICAT



## CERTIFICATE

No. Z10 07 08 22733 014

**Holder of Certificate:** Yaskawa Electric Corporation  
Inverter Plant

2-13-1 Nishimiyaichi  
Yukuhashi, Fukuoka  
824 JAPAN

**Factory(ies):** 63989, 42802, 51347

**Certification Mark:**



**Product:** Static power converter  
AC Inverter

**Model(s):** CIMR-F7\*\*\*\*\*-Spec \*\*\*\*\*  
AC Inverter  
with risk category 3 stop circuit  
For nomenclature see attachment

**Parameters:**

Rated voltage:	200 to 240V3ac and 380 to 480V3ac
Rated current:	200V3ac: 457A 400V3ac: 743A
Rated frequency:	50 / 60 Hz
Protection class:	I
Over voltage category:	III
Remark:	When installing/inserting the equipment all requirements of the mentioned test standards must be fulfilled.

**Tested according to:** EN 954-1:1996 cat. 3  
EN 50178:1997  
EN 61800-3:2004

The listed product was tested on a voluntary basis and complies with the relating standards or directives. The certification mark shown above can be affixed on the product. The certification mark must not be altered in any way. See also notes overleaf.

**Test report no.:** 717501106

**Date,** 2007-08-21



TÜV SÜD Product Service GmbH - Zertifizierstelle - Ridlerstrasse 65 - 80339 München - Germany

**Drives Technical Support in USA and Canada**

Technical Support for Inverters and Drives is available by phone as follows:

Normal: Monday through Friday during the hours of 8 a.m. to 5:00 p.m. C.S.T.

Emergency: After normal hours, 7 days a week including weekends and holidays

To contact Drives Technical Support, please call 1-800-YASKAWA (927-5292).

From the menu, dial 2 for Inverter and Drive Products, then 5 for Technical Support.

Drives Technical Support can also be reached by e-mail at [DriveSupport@yaskawa.com](mailto:DriveSupport@yaskawa.com).

Support information, such as technical manuals, FAQs, instruction sheets and software downloads are available at our website, [www.yaskawa.com](http://www.yaskawa.com).

When calling for technical support, please have the following materials available:

- The appropriate Technical Manual in hand because the support associate may refer to this
- Complete nameplate information from the drive and the motor.
- (Confirm that Drive Nameplate Output amps is equal to or greater than Motor Nameplate amps)
- A list with your parameter settings
- A sketch of the electrical power train, from AC line to motor, including filters and disconnects

**Field Service, Start Up Assistance, Factory Repair, Replacement Parts, and Other Support**

Contact Drives Technical Support for help with any of these needs.

**Technical Training**

Training is conducted at Yaskawa training centers, at customer sites, and via the internet.

For information, visit [www.yaskawa.com](http://www.yaskawa.com) or call 1-800-YASKAWA (927-5292).

From the phone menu, dial 2 for Inverter and Drive Products, then 4 for Product Training.

**Support in Other Countries**

Yaskawa is a multi-national company with offices and service representation around the world.

To obtain support, always contact the local distributor first for guidance and assistance.

Contact the closest Yaskawa office listed for further assistance.

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# F7 Drive Safe-Off Option

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## **YASKAWA ELECTRIC EUROPE GmbH**

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