

# Safety Switches with Variable Frequency Drives

## Introduction

The National Electrical Code® (NEC®) requires that a disconnecting means shall be located in sight from the motor location and the driven machinery location (Article 430.102(B)). The NEC® defines “in sight” as visible and not more than 50 feet (15.24 m) distant (Article 100 – definitions).

In many cases, motor starters will be located in another space than the motor and to meet code requirements, a safety switch is used to add a way to disconnect and lockout a motor. When an across the line starter is used, this won't cause an issue, but it can cause issues with a Variable Frequency Drive. When a motor is running with a VFD and is turned off at the safety switch, the VFD does not have a way of sensing that the motor load has dropped off completely in V/Hz control. The drive is designed to supply as much voltage as the motor is demanding and it would not be uncommon for the motor to not require any power once the load is moving due to inertia. Because of this, the VFD will continue to function and run as it normally would even though the load has been disconnected. When the safety switch is closed again, the VFD will function like an across the line starter and an enormous amount of inrush current will be generated and pulled through the drive.

Across the line starters are designed to handle these large current spikes for a short amount of time, but a VFD is meant to be used to ramp up and down the speed of a motor. Until recently, this inrush current could cause the IGBTs to fail and require complete replacement which can be very costly due to down time and the process being very labor intensive. A way to prevent these issues is to provide feedback from the safety switch back into the VFD that the switch has been opened and the VFD should stop running.

As a standard, safety switches are simple devices that cut off power to the motor, however, they have additional options including an auxiliary contact that will change states when the switch is changed. There are multiple ways to tie this back into the VFD to prevent it from running, but the two most common ways are to use it as a lockout contact that is wired into the RUN input of the drive or a Normally Closed contact is wired into the EXTERNAL FAULT input on the drive. Each method will be discussed in more detail below.

## Interlocking with RUN signal

Eaton provides terminal blocks to interlock an external signal to the RUN input as a standard on all Enclosed VFD Assemblies. From the factory, these terminal blocks come jumpered as in most cases this interlock signal is not required. This makes interlocking your safety switch as easy as running two wires from the safety switch into the VFD enclosure that are rated for 120Vac.

In the case that an open component VFD is being used or the drive was installed into an enclosure by a local panel builder, it will take some rewiring to interlock the VFD with the Safety Switch. Figure 1 below shows a simplified wiring scheme. By wiring a Normally Open Contact from the Safety Switch in series with the VFD's RUN Input, the drive will only be allowed to RUN when the switch is closed.



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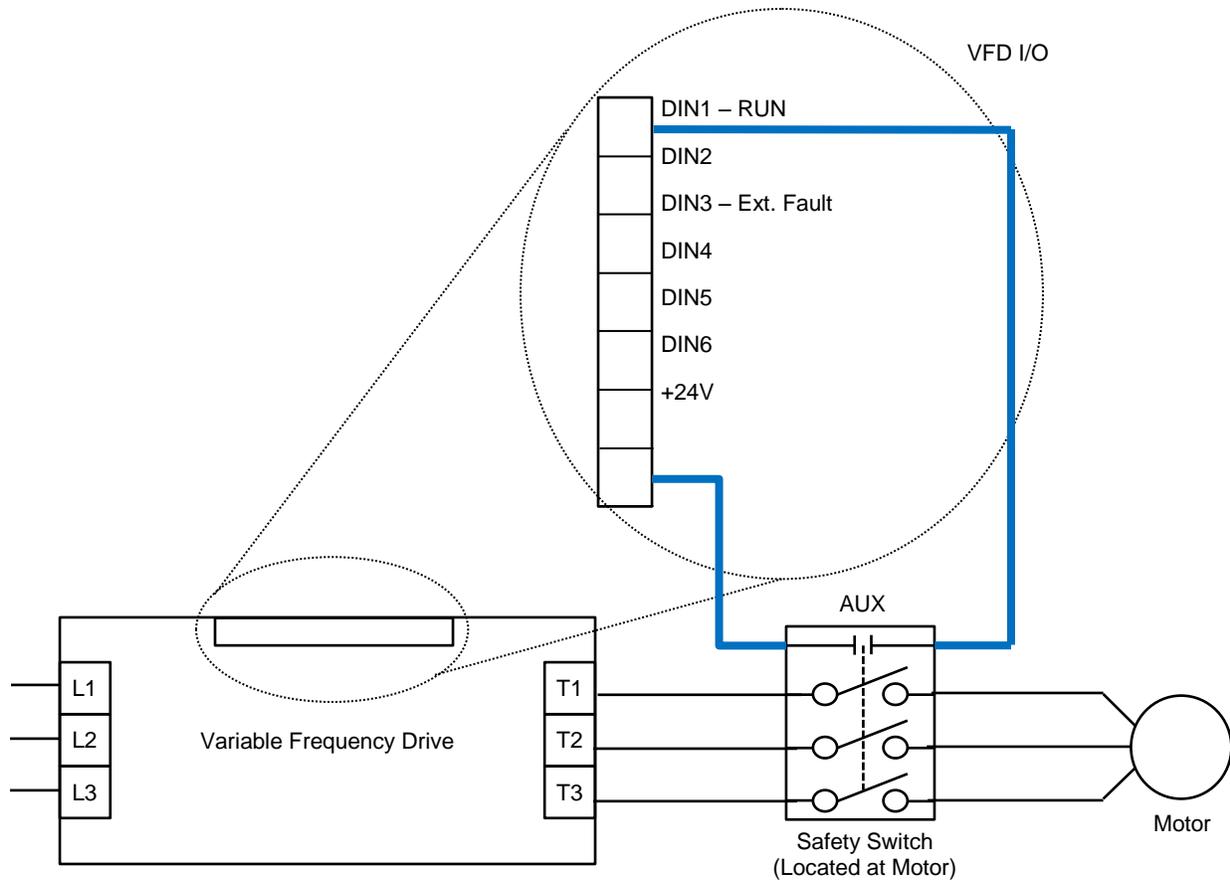
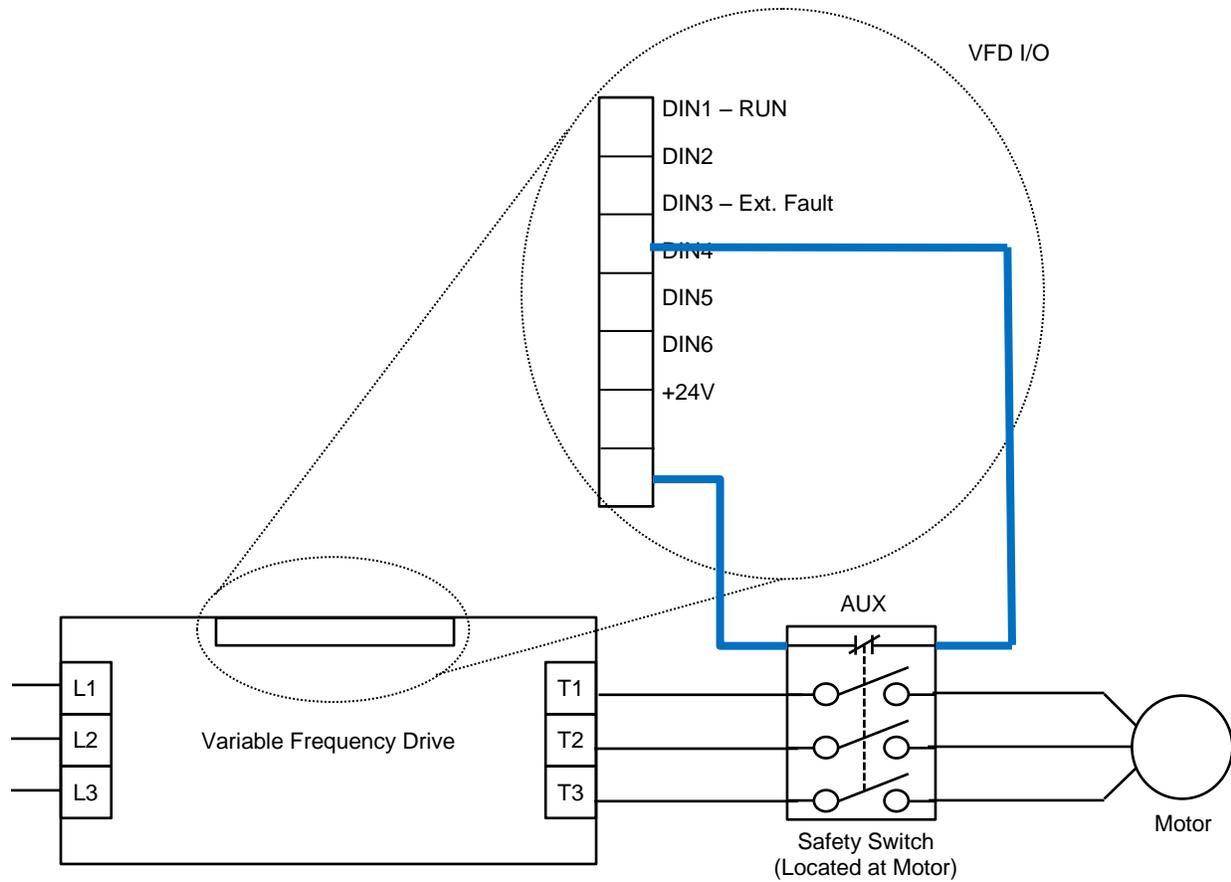


Figure 1 – Interlocking with the VFD RUN input

One of the main advantages of going this route is that the VFD will start to run again as soon as the Safety Switch is put back into the closed position. In the case where you don't have a local control station near the motor, this will save some time from having to go back to the main VFD to reset it to allow the unit to start back up. Some people would prefer that the motor needs to be manually restarted again in which case interlocking the Safety Switch with the VFD EXTERNAL FAULT input is a better solution.

### Interlocking with EXTERNAL FAULT signal

Wiring into the EXTERNAL FAULT input on the drive is a less common way of interlocking the Safety Switch with the VFD, but it will provide similar results. Figure 2 below shows a simplified wiring scheme on how to do this. By wiring a Normally Closed Contact from the Safety Switch in series with the VFD's EXTERNAL FAULT Input, the drive will register a Fault anytime the Switch is opened, causing the VFD to shut down.



**Figure 2 – Interlocking with the VFD EXTERNAL FAULT Input**

External Faults are typically looking for low signals to prevent issues with wires coming loose and faults not registering. In this case, as soon as the motor's power is cut at the safety switch, the drive will register an External Fault which cannot be cleared until the Safety Switch is closed again. The Drive can then be reset locally at the keypad or through a remote reset button with is wired into a RESET input on the VFD. The reset can also be done over the communication bus as well.

## Additional Help

In the US or Canada: please contact the Technical Resource Center at 1-877-ETN-CARE or 1-877-326-2273 option 2, option 6.

All other supporting documentation is located on the Eaton web site at [www.eaton.com/Drives](http://www.eaton.com/Drives)

