

IEC and NEMA rated contactors

Application in a VFD bypass

There are two primary classifications of contactors: IEC and NEMA rated. Each contactor type has advantages and disadvantages. NEMA rated contactors are generally used in heavy industrial applications, as they are considered more robust than IEC contactors. However, that robustness comes with added size and cost that is not necessary for many other applications. The selection of the contactor type should be done based on the application of the contactor. For example, does the contactor need to open and close once an hour, or 30 times an hour? This Technical Note 071 explores IEC and NEMA rated contactors for use in variable frequency drive (VFD) bypass configurations on pump and fan applications.

History of NEMA rated contactors in bypass

In the infancy of VFDs, well over 30 years ago, VFDs were not as reliable. While the VFD provided excellent energy savings and process control for pump and fan applications, the VFD was still prone to inconvenient failures. As a result, VFDs were often specified and equipped with bypasses. If a VFD package was to fail, then the unit would be placed into bypass. Bypass mode runs the motor at full speed until the drive can be replaced or repaired. A bypass consists of 2 or 3 contactors. Figure 1 shows a simplified one-line diagram of a 3-contactor bypass.

The 3-contactor bypass consists of:

- Output contactor – while in bypass mode this contactor opens and isolates the output side of the VFD. This contactor is closed while in VFD mode.
- Bypass contactor – while in bypass mode this contactor closes and applies direct across-the-line utility power to the motor. This contactor is open while in VFD mode.
- Input contactor – while in bypass mode this contactor opens and isolates the input side of the VFD. This contactor is closed while in VFD mode. ABB does not recommend an input contactor, however they can be provided upon custom request. The original intent of the input contactor was to allow service work to the VFD while the package was in bypass mode. However, based on the evolution of electrical safety, including modern arc flash guidelines, the industry has now acknowledged that the input contactor does not provide adequate isolation for service work.

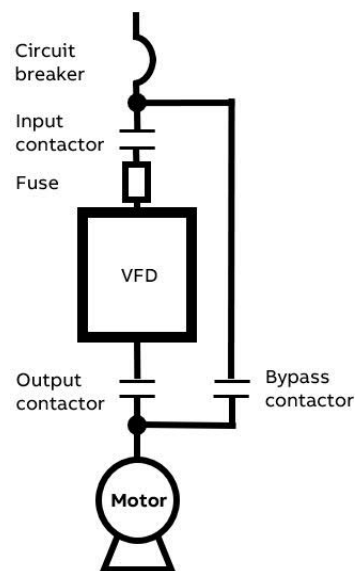


Figure 1: 3-contactor bypass

NEMA contactors were the contactor of choice in North America when VFDs were at their infancy. At that time, IEC contactors were not well known or readily available in the North American market. Therefore, this was a natural fit for NEMA contactors to be used for VFD bypass configurations. However, as we flash forward to modern times, most bypass configurations now use IEC contactors for pump and fan applications.

Transition to IEC contactors

NEMA rated contactors are more robust than IEC contactors. Essentially, the NEMA rated contactor is oversized compared to its rating. This oversizing results in a physically larger footprint and a higher cost. NEMA contactors still have their place for applications where the number of motor start/stops per hour is high, jogging, overload (peak) conditions, or reversing. IEC contactors, on the other hand, are designed based on standard application needs, and not the most severe duty applications as mentioned above. Pump and fan applications are a natural fit for using IEC contactors in bypass configurations, especially considering most bypasses do not have a high duty cycle.

IEC contactors became the standard for VFD bypasses for several reasons:

- Applications – the typical pump and fan application is not considered a severe duty application requiring a NEMA rated contactor. IEC contactors work fine for most pump and fan applications.
- Bypass – of the contactors used in a VFD bypass configuration, only the actual bypass contactor would ever be exposed to the inrush current of starting the motor across the line. The input (if applicable) and output contactor are continuously pulled in while in VFD mode, thus they don't experience across the line inrush current, nor will their contacts ever make or break significant current like a bypass contactor. Input and output contactors are not required to be NEMA rated, and the bypass contactor should only be NEMA rated when the application is severe and warrants the oversized solution.
- VFD quality – significant improvements have been made in VFD quality, especially over the past 20 years. A bypass is considered an insurance policy for critical applications. Even if a VFD were to fail, the bypass contactor may be exposed to tens or hundreds of cycles, but never the hundreds of thousands of cycles that contactors are designed to handle. Based on the low duty cycle of a VFD bypass contactor, even an IEC contactor can be considered oversized for the real-world pump and fan application need. Also, VFD lead-time and repairs are much shorter today, so while in the past a VFD may need to be in bypass for months before it was replaced, now that VFD may be in bypass for only days or weeks.
- Size and cost – due to the oversized nature and fewer NEMA sizes, the NEMA contactors are physically larger and more expensive than IEC contactors. The VFD package itself could potentially end up larger too, as the physically larger size of the multiple contactors can impact enclosure size in some cases.
- Lead-time – most VFD manufacturers have standardized on using IEC contactors for the reasons described above. Requiring NEMA rated contactors will result in a "custom" VFD package that is likely to have a longer lead-time.

NEMA rated contactors were the standard for early VFD bypass designs. Over time, IEC contactors became accepted in the North American market for applications such as municipal water pumps and HVAC pump and fans. Improved VFD quality resulted in low usage (cycles) of bypass contactors on applications that don't require NEMA rated contactors. This led to IEC contactors becoming the standard solution for bypass configurations. Only the most demanding, heavy industrial application should have a bypass requiring NEMA rated contactors. The application demand of a pump or fan, combined with the duty cycle of a bypass, rarely requires a NEMA rated contactor. Package cost (and in some cases size) will be reduced by using properly sized IEC contactors for the bypass. Simply said, bypass packages should use IEC contactors when applied to pump and fan applications.