



Technical Tip: Single Phase Foldback Function

Product(s): iQpump1000 and iQpump Micro Drives

Doc. No. TN.iQp.05

Overview

Yaskawa iQpump1000 and iQpump Micro variable frequency drives (VFD) operate using three-phase incoming power and are also suitable for use on single-phase power with appropriate considerations. Single-phase power considerations include the proper selection of drive model, input reactors, wiring and branch circuit protection and parameter tuning.

Operating a VFD on single-phase input power subjects the units DC bus circuitry to higher stress when compared to operation on three phase power.

iQpump1000 and iQpump Micro drives include a *Single Phase Foldback* feature that protects the unit from excess DC bus circuitry stress that results from use with single-phase input power. The iQpump1000 and iQpump Micro lifespan is maximized as this feature also provides a level of protection from unpredictable power supply issues.

A product of this protective feature is a reduction in motor speed when the VFD senses higher stress on the DC bus.

This Technical Tip is useful in preventing a *Single Phase Foldback* alarm and the subsequent reduction in motor speed that results from the operation of this protective feature. This document also provides application precautions and tips for troubleshooting input power connections.

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DC Bus Ripple and Single Phase Input Power

The standard Pulse-Width-Modulated (PWM) VFD contains a 6-pulse diode rectifier because of its simplicity and low cost. The 6-pulse rectification results in 360 Hz DC bus ripple when used with a three-phase 60 Hz supply. **Refer to Figure 1.**

The DC bus ripple becomes 120 Hz when the VFD is connected to single-phase input power. Additionally, the units DC bus circuit is subject to higher stress when providing power comparable to the VFD on three-phase input power. Input currents increase beyond those encountered with three-phase input. **Refer to Figure 2.**

Using the iQpump1000 or iQpump Micro in a single-phase input power application requires derating of the nameplate power rating to avoid over stressing the rectifier and DC bus components.

Figure 1: Three-phase Rectification

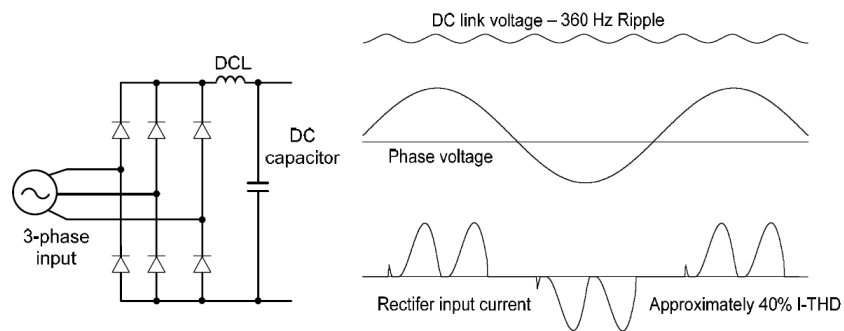
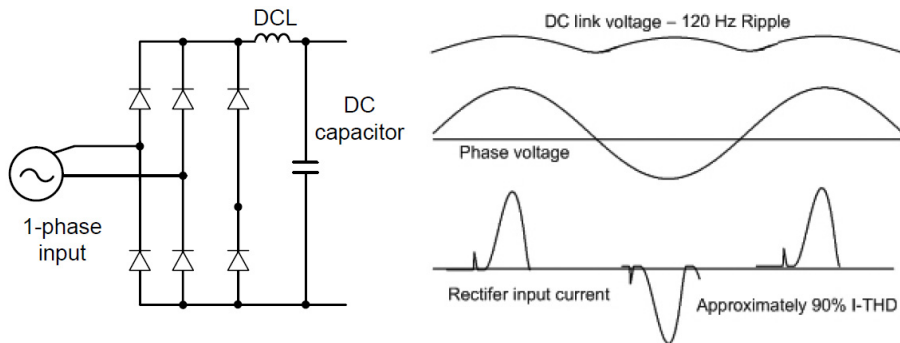


Figure 2: Single-phase Rectification



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The Single Phase Foldback Protective Feature

The *Single Phase Foldback* function maximizes VFD lifespan and provides a level of protection from unpredictable power supply issues.

An increase in DC bus ripple can be caused by;

- an absent phase of input power
- an out-of-tolerance transformer leg
- a VFD that is undersized for the application.

Single Phase Foldback detects and provides an alarm when the DC bus ripple voltage exceeds pre-programmed limits. The *Single Phase Foldback* protection will reduce motor speed until the DC bus ripple voltage is within programmed limits or the minimum pump motor speed is reached.

A decrease in motor speed reduces drive output power and also reduces the harmful DC bus ripple voltage.

Troubleshooting a Single Phase Foldback Alarm (Three-phase input power)

Follow these steps if the Single Phase Foldback alarm is displayed on the keypad. **Refer to Figure 3.**

- 1) Measure the voltage at the drive terminals (R/L1, S/L2, T/L3) to verify proper phase-to-phase voltage is present at the incoming power terminals on the drive.
- 2) Use a current clamp ammeter to test for a phase loss condition under load, and to verify balanced current flow.
- 3) Loose connections can cause a phase loss condition under load. **With main power off**, tighten all incoming power connections on the low current phase if the current is not balanced.

Application Precautions

The ideal three-phase power supply for a VFD is a grounded-Y configuration. Closed-delta configurations are also acceptable.

- High-leg or Wild-leg Delta

High-leg or Wild-leg Delta configurations are also compatible. For these main power configurations, do not connect the main power supply neutral point to the iQpump1000 or iQpump Micro input power terminals.

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Application Precautions (continued)

- Open-Delta

Open-delta input power configurations require;

- an AC input reactor connected between the main power transformer and the VFD
- use of a VFD that is one model larger than what is typical for a given motor.

For more information in the application of open delta transformers with VFDs, refer to Yaskawa article [PR.PS.01](#).

Troubleshooting a Single Phase Foldback Alarm (Single-phase input power)

Follow these steps if the *Single Phase Foldback* alarm appears on the keypad display:

- 1) Verify proper drive sizing using the iQpump1000 Quick Start Guide TOEPYAIP1W01, Appendix A.4. This manual is available on www.yaskawa.com.
- 2) Increase the value of parameter Q3-11 [Ripple Regulator Setpoint] until the *Single Phase Foldback* alarm message no longer occurs. The typical maximum value of parameter Q3-11 is 140%.
 - a) Parameter Q3-11 [Ripple Regulator Setpoint] is used to set a percentage of the maximum amount of ripple allowed before a *Single Phase Foldback* alarm occurs
- 3) The addition of an AC input reactor will also reduce DC bus ripple and prevent *Single Phase Foldback* detection. Refer to the iQpump1000 Quick Start Guide TOEPYAIP1W01, Appendix A.4, to select Yaskawa input reactors.

Figure 3: Single Phase Foldback Alarm Display

