Johnson Controls

DX Ducted Systems
Technical Services
Service Tips Letter

Letter: **ST-006-2019**

Date: April 17, 2019

To: All DX Ducted Systems Service, Sales, and Training Managers
All DX Ducted Systems Distribution Service, Sales, and Training Managers

Subject: **Additional Information - Variable Frequency Drive Power Concerns**

Product: Light Commercial

Summary: All Light Commercial products with a Variable Frequency Drive (VFD)

References: NFPA 70, National Electrical Code
Mitsubishi, FR-D700 Instruction Manual

Disclaimer: JCI warrants that the Service/Products will perform substantially in conformance with its Documentation. JCI shall not be liable for warranty nonconformance caused by misuse or negligence or willful misconduct.

Based on customer feedback on ST-004- 2019, we have added more data crucial for contractor understanding of the scope of this field issue. We are opting to issue a new letter with these additions.

Situation:
With the addition of a Variable Frequency Drive (VFD) to a wide range of products, it is necessary to determine the power supply of the system before installing the product. Some power supplies may require field installation of additional equipment to ensure proper operation of the VFD.

Reasons for additional equipment requirements include:

- VFDs convert AC volts to DC volts.
- VFDs reference ground with respect to each leg of voltage.
- Utility power distribution systems must have a ground connection on the secondary side of the transformer.
- Wye transformers have the ground connection at the center of the Wye, resulting in an equal voltage from any power leg to ground with respect to any other power leg.
- It isn't possible to have equal reference to ground in a Grounded Delta system.
- Delta systems are grounded using one of two methods;
  - At the corner of the delta (aka 'Grounded B Phase')
  - At the center of one of the windings (aka 'Wild Leg or High Leg').
- Delta systems can result in unbalanced voltages on the inputs to the VFD, causing unbalanced current flow in the conductors carrying power to the VFD, which can result in over-amping on those conductors when the motor is near its Full Load Amps.
- Delta systems will need to be identified and may require special attention as described below.

Technical Information:
The type of power supply can be identified by measuring the incoming voltage with a voltmeter. The following measurements will help in determining the type of power supply. All measurements referenced are approximate, your actual field measurements may vary slightly from the numbers provided in this letter. Three different power supply types are discussed below.

1. 3 Phase Wye Power Supply
This type of power supply is the most commonly found and can be detected by measuring incoming power readings as follows:

208V systems	**460 V Systems**
L1 to ground - ≈ 120 volts	L1 to ground - ≈ 277volts
L2 to ground - ≈ 120 volts	L2 to ground - ≈ 277volts
L3 to ground - ≈ 120 volts	L3 to ground - ≈ 277volts

The 3 Phase Wye power supply will not require further modification to allow the VFD to function properly. However, 208v systems will require Parameter 19 to be changed from 230 to 208.

2. Corner Grounded Delta Power Supply
This type of power supply can be detected by measuring incoming power supply readings as follows:

240 V systems	**480 V systems**
L1 to ground - ≈ 230 volts	L1 to ground - ≈ 460 volts
L2 to ground - ≈ 0 volts	L2 to ground - ≈ 0 volts
L3 to ground - ≈ 230 volts	L3 to ground - ≈ 460 volts

Note: The leg that reads 0 volts to ground is normally L2. With a Corner Grounded Delta, 2 legs will read voltages to ground that are the same or almost the same and one leg will read 0 volts to ground. This is the "B-Phase."

Installation of a special transformer is required to operate the VFD in conjunction with Corner Grounded Delta Power Supply. Contact a qualified commercial electrician. Refer to Application Conditions section below for details.

3. High Leg Power Supply
Also known as wild-leg or stinger-leg, a High Leg power supply is a less common power supply, but does occur in older power systems. Typical voltage readings for this type of power supply readings are:

208/230 V systems	**460 V systems**
L1 to ground - ≈ 120 volts	L1 to ground - ≈ 277volts
L2 to ground - ≈ 208 volts	L2 to ground - ≈ 415 volts
L3 to ground - ≈ 120 volts	L3 to ground - ≈ 277 volts

Note: Higher voltages are present on one leg with normal voltages on the other 2 legs. Always place the High-Leg on L2 of JCI Commercial equipment.

Application Conditions:
Some application conditions may require field installation of a larger VFD or a method of balancing input voltages to ensure correct operation. In conditions that require a different drive model to survive the voltage imbalance, the use of a special transformer, aka. "line reactors" can be used to get voltage back into balance so original VFD can be used and survive the voltage variations that could cause failure of the drive. Line reactors have their requirements as well, which means they have to be properly sized.

Installation of a special transformer "aka Line reactor" may be required to operate the VFD in conjunction with High-Leg power supplies. Contact a qualified commercial electrician to have the device sized correctly. The device must be securely grounded and the addition of a grounding ring on the motor is required. As the line reactor balances voltages, noise is generated resulting in induced voltage onto the motor armature. The induced voltage seeks a pathway to ground and finds it through the bearings of the motor. This creates a condition called "electrical discharge machining", resulting in a small arc of electricity (during motor operation) in the race of the bearing causing it to fail prematurely as the arc actually blows away part of the bearing race.

Summary:
Understanding the application and installation requirements at the front of the job is required for proper and successful installation of a Variable Frequency Drive (VFD) in a wide range of products.

Knowledge of the power supply system specified and being used before installing the product is required. Some power supplies may require you to add additional equipment to ensure proper operation of the VFD.

Notification of this requirement with customers, engineers, end users is imperative. If line reactors are not used and the option of a larger drive is the desired remedy, then internal wiring may need to be upsized and fused internally in the cabinet in alignment with National Electric Code (NEC) to achieve this as it will be installed after the fact. A licensed, qualified electrician must be used for this task.

Please let us know if you have any questions or need more information on this topic.

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