

## When to Use a Line or Load Reactor

### Protecting the Drive or the Motor

Input and output reactors serve very different purposes. Simply put, an input reactor protects the drive and an output reactor protects the motor. However, there are a few more details to determine the correct application.

### Input (Line) Reactors

An input or line reactor helps protect a variable frequency drive (VFD) from input power line disturbances that could cause nuisance tripping or damage to the drive. An input (line) reactor also reduces the harmonics that the VFD generates back onto the line. Line reactors are sized based on the HP and voltage ratings of the drive in use. Lenze-AC Tech uses 3% or 5% reactors. Input (line) reactors should be used in these circumstances:

1. The input line power is prone to have disturbances such as surges, spikes, transients, etc.
2. The supply line power is very stiff (greater than 10 times the kVA rating of the connected VFD).
3. Where harmonic distortion is a concern. (IEEE-519 Harmonic Control in Electrical Power Systems)

Line reactors are connected in series between the input source and the VFD Controller. Refer to Figure 1 for proper wiring installation. The reactor should be mounted as close to the drive as possible.

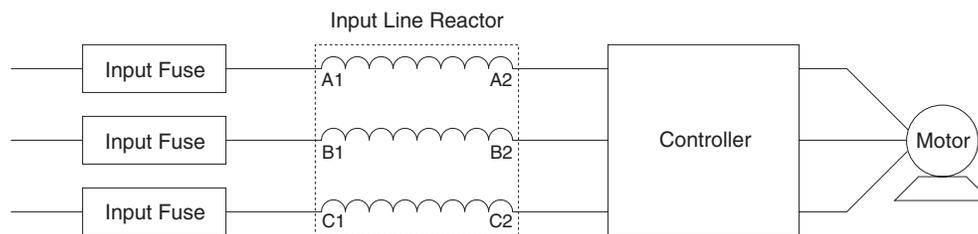


Figure 1: Input (Line) Reactor

### 3% Impedance Line Reactors

3% impedance line reactors should be used to reduce power line transient voltages caused by capacitor switching, line notching, DC Bus over-voltage tripping and inverter over-current and over-voltage conditions. They improve the true input power factor and reduce cross-talk between drives.

The input (line) reactor offers some protection to the drive in short-circuit conditions. If the supply transformer kVA rating is greater than ten times the drive kVA rating, then a line reactor is recommended to minimize damage to the drive in case the supply transformer ever shorts out. This line impedance is dependent on the short-circuit rating for the drive and on the supply power distribution transformer. Specifically, the line impedance must be greater than or equal to the ratio of the supply source transformer's rating to the drive's short circuit rating.

For example, let's say you have a 100kVA, 460V, 120A power transformer for your source and install a 3% line reactor in front of an MC series drive\*. This means for the simplest calculation, the available short-circuit current would be  $120A / .03 = 4000Amps$ . This is less than the MC series 5000A rating so the 3% line reactor would work fine. You can make this same calculation by determining the current of the supply transformer and the line reactor impedance.

\* The source transformer's impedance is not included because the difference in size makes it negligible.

## 5% Impedance Line Reactors

5% impedance line reactors have the same benefits as the 3% reactors plus they provide maximum harmonic mitigation without added capacitance. These harmonic signals produce distortion levels that may not be acceptable for certain high frequency or noise sensitive equipment. Use of them will help to comply with the IEEE 519 Standard and reduce motor operating temperature and motor noise.

## Multiple Input (Line) Reactors

In applications involving multiple drives in parallel, having more than one VFD connected to a common power line requires one line reactor per drive. Individual reactors will provide proper filtering and optimum surge protection for each VFD and reduce crosstalk between each unit. A single reactor connected to multiple VFDs does not provide adequate protection, filtering or reduce harmonic distortion when the system is partially loaded.

Each line reactor is connected in series between the input source and the VFD Controller. Refer to Figure 2 for proper wiring installation. Each set of input lines to the drive should be in its own separate steel conduit. The reactor should be mounted as close to the drive as possible.

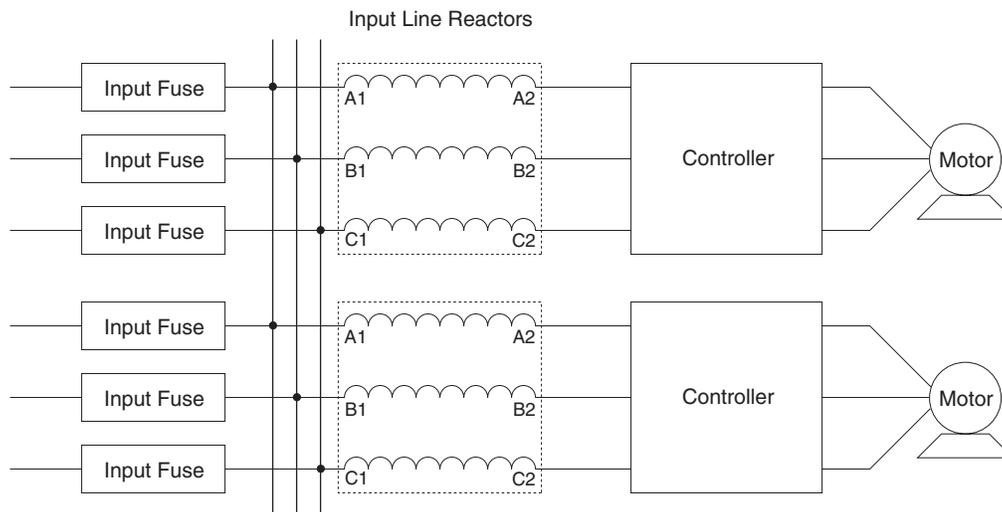


Figure 2: Multiple Input (Line) Reactors

## Output (Load) Reactors

An output (load) reactor, on the other hand, is used to protect the motor if the wiring distance between the VFD and motor is very long. The drive generates a high frequency PWM three-phase output and noise spikes are generated on the leading edge of these signals. These noise spikes get amplified due to the long cable lengths and the additional capacitance of the cable. The resulting voltage can exceed the motor's peak voltage rating where insulation breakdown occurs.

The general rule of thumb is that an output reactor should be used if the motor wiring is over 100 feet, but this value varies depending on the motor. If the motor meets the NEMA MG-1 Part 31 standard, it is possible to have as much as 300 ft of cabling without a reactor. If it does not meet the standard, the maximum cable length should be 100 ft. Also, if the distance is between 300 and 500 ft, a load reactor must be installed.

If the distance is between 500 and 1000 ft, you would use a special type of filter called a dV/dT filter, as they provide better protection at these extreme distances. This also varies depending on output cable specs, shielding, power conditions, and noise suppression as well as isolation techniques.

Load reactors are connected in series between the VFD Controller and the motor. Refer to Figure 3 for proper wiring installation. The reactor should be mounted as close to the drive as possible.

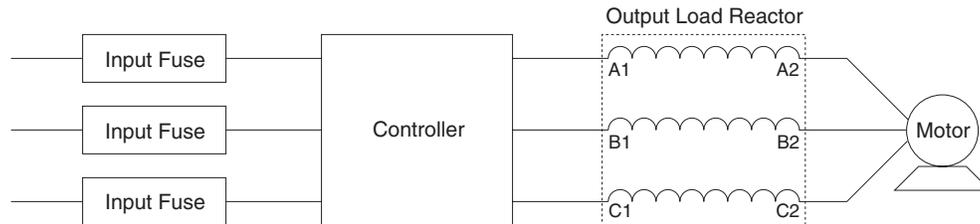


Figure 3: Output Load Reactor

### Multiple Motors

For an application involving more than one motor being controlled by a single drive, a single reactor can typically be used between the VFD and the motors. Note that each motor requires a separate thermal overload for proper protection. The reactor should be sized based on the total motor/load horsepower.

The load reactor is connected in series between the VFD Controller and the motors. Refer to Figure 4 for proper wiring installation. Each set of motor cables should be in a separate steel conduit to avoid noise and crosstalk that can cause nuisance tripping. The reactor should be mounted as close to the drive as possible.

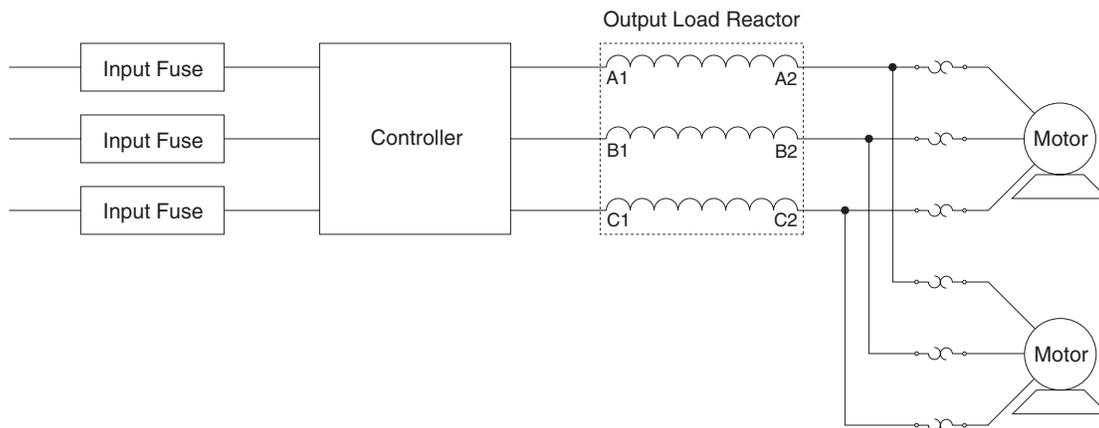


Figure 4: Output (Load) Reactor & Multiple Motors