**The Use of Input Chokes with Variable Speed Drives**

**Introduction**

Variable Frequency Drives (VFDs) are pivotal in modern industrial applications, offering precise control over motor speed and torque. Despite their advantages, VFDs generate high-frequency radio frequency interference, which must be filtered to adhere to legislation, and harmonic distortion, which compromises power quality and system performance. Input harmonics can cause significant Power quality (PQ) issues, and mains chokes, or line reactors, are instrumental in mitigating these issues. This article explores the role of input chokes in VFD applications, their benefits, and critical considerations for their implementation.

**Understanding Variable Frequency Drives**

VFDs control electric motor speed by varying the frequency and voltage of the power supplied. They consist of a rectifier, DC bus, and inverter. VFDs convert AC power to DC and back to a variable-frequency AC. This process, particularly in the rectifier and inverter stages, introduces significant harmonics and electrical noise.

**The Role of Input Chokes**

Input chokes are passive inductive components connected between the power supply and the VFD. They provide an impedance to incoming AC power, thus reducing harmonic distortion and limiting inrush current.

1. **Harmonic Mitigation**: VFDs produce harmonics due to their non-linear nature. These harmonics can cause overheating and interference with other equipment. Input chokes increase line impedance, reducing harmonic currents and improving power quality.
2. **Inrush Current Reduction**: VFDs can draw large inrush currents upon startup, causing voltage dips and stressing components. Input chokes limit the rate of current change (di/dt), reducing the magnitude of inrush currents and protecting system components.
3. **Transient Protection**: Voltage spikes can damage VFDs and motors. Input chokes absorb and dampen these transients, providing additional protection.

**Benefits of Using Input Chokes**

The inclusion of input chokes in VFD systems offers several benefits:

1. **Improved Power Quality**: By mitigating harmonics and transients, input chokes help maintain a cleaner power supply, enhancing system stability and efficiency.
2. **Extended Equipment Life**: Reduced thermal and electrical stress on VFDs and associated equipment prolongs operational life.
3. **Enhanced Motor Performance**: Smoother current and voltage profiles produce more efficient and reliable motor operation with less noise and vibration.
4. **Regulatory Compliance**: Input chokes help ensure compliance with industrial standards such as IEEE 519, avoiding penalties and operational issues.
5. **Reduce RMS Current and Energy Consumption** Input chokes are crucial in reducing the root mean square (RMS) current in systems utilizing Variable Frequency Drives (VFDs).

**Design Considerations**

Selecting and implementing input chokes requires careful consideration:

1. **Inductance Value**: Choose inductance based on VFD power rating and desired harmonic mitigation, typically rated to give a line voltage drop of between 2% and 4%. The difference in these ratings can significantly affect the reduction of harmonics and RMS input current to the drive. For example, **Figure 1** shows the harmonics of a 22kW VSD without choke and with 2% and 4% chokes for comparison. Total Harmonic Current Distortion (THDI) reduction at full-rated load reductions is approximately 19% and 36%, respectively.
2. **Voltage and Current Ratings**: Ensure the choke can handle maximum voltage and current. Undersized chokes may overheat, while oversized chokes can be costly. Chokes can be chosen for the reduced RMS current, allowing further cost reductions.
3. **Thermal Management**: Provide adequate ventilation or cooling to prevent overheating during operation. Water-cooled units can be utilised in areas with controlled ambient temperatures or space issues.
4. **Installation Location**: Install chokes close to the VFD to minimise impedance and maximise effectiveness. High ingress units, >IP54 allow units to be combined with modern standalone drives and mounted in control rooms without enclosures.

**Energy Consumption**

When placed between the power supply and the VFD, chokes provide impedance that limits the harmonic currents generated by the drive's non-linear load, reducing the overall RMS current. RMS current is the practical value of the varying current over time; the system consumes less power to deliver the same performance, leading to lower energy consumption and operational costs. See **Figure 2**, which shows the input current reduction for 2% and 4% chokes. For 2%, the reduction is 8.7%, and for 4%, the current is reduced by 17.2%

**Conclusion**

Input chokes are vital in VFD applications, offering significant benefits such as harmonic mitigation, inrush current reduction, and transient protection. By enhancing power quality, extending equipment life, and improving motor performance, input chokes contribute to industrial electrical systems' overall efficiency and reliability. Careful selection and implementation are essential to maximise these benefits and ensure compliance with industry standards, and in certain circumstances, they can mean input current reductions of up to 17%.

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**For further information or Press Enquiries contact:** Steve Hughes or Michelle Gillam

REO (UK) Ltd, Units 2-4 Callow Hill Road, Craven Arms Business Park,

Craven Arms, Shropshire, SY7 8NT  
**Telephone:** +44 (0)1588 673411

**Fax:** +44 (0)1588 672718

**www:** http://www.reo.co.uk

**e-mail:** marketing@reo.co.uk

**Twitter:** <https://twitter.com/REO_UK>

**Facebook:** <http://www.facebook.com/pages/REO-UK-Ltd/263330563768795>

**About REO:** REO manufactures a wide range of electronic power controllers, resistive and inductive wound components for use with modern Variable Frequency Drives, especially for challenging environments and applications. The company is becoming increasingly involved in renewable energy technology, where power quality is important. REO has manufacturing operations in Germany, the US, China and India.