Clean Power **VFD**

Boosting Efficiency with Superior Power Factor and Smarter Energy Use

POOR POWER FACTOR CAN STRAIN THE ELECTRICAL GRID AND INCREASE ENERGY COSTS

Conventional VFDs are non-linear loads and create harmonics in the electrical system, which lead directly to poor power factor affecting negatively the electrical system.

Strain on the electrical grid:

Increased current demand: Poor power factor means more current is needed to deliver the same amount of useful power. This increased current flow can strain the electrical grid and distribution system.
Voltage drops and regulation issues: Higher currents can cause significant voltage drops across conductors, leading to voltage regulation problems. This affects the stability and reliability of the electrical supply.

Higher energy costs:

Increased Operational Costs: Lower power factor can lead to increased operational costs due to the need for larger capacity transformers, generators, and other infrastructure to handle the higher currents.
Utility Penalties: Many utility companies charge extra for low power factor because it requires them to generate and manage more power to deliver the same amount of real power to customers. These penalties compensate for the additional costs associated with managing low power factor loads.

Equipment overheating and damage:

Overloading: Persistent low power factor can cause electrical equipment to operate at higher currents than designed, leading to overheating and potential damage.
Reduced Lifespan: Overheating can shorten the lifespan of equipment, resulting in more frequent maintenance and replacement, which adds to operational costs.

ACTIVE POWER FACTOR CORRECTION AND REDUCED REACTIVE POWER

The ***Clean Power*** **VFD** uses an Active Front End (AFE) to reduce harmonics distortion compared to traditional rectifiers. This AFE actively corrects power factor in real-time and prevents the creation of additional reactive power, which can harm power factor.

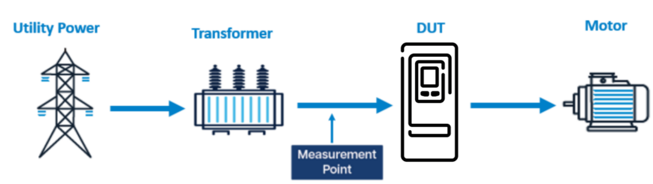
By outputting three sine-wave signals with minimal harmonics, the ***Clean Power*** **VFD** ensures that the current waveform aligns closely with the voltage waveform. This alignment reduces the phase difference between voltage and current, thus decreasing reactive power and achieving a power factor closer to unity. This indicates more efficient use of electrical power.

EXTERNAL LAB TEST SETUP

An autotransformer with impedance of less than 2% is used to supply the systems under test with voltage of 480V.

In addition, 500ft of VFD cable is used to connect a 25HP motor to the systems.

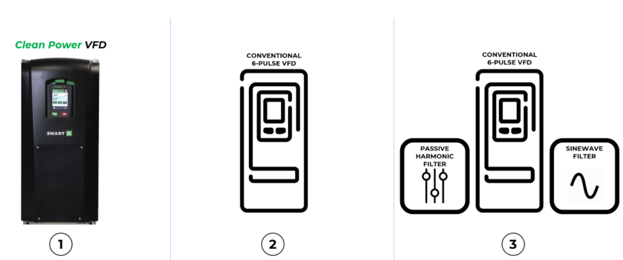
Moreover, an electrical generator (not shown) is used to provide the mechanical load of the motor. The load is controlled by modifying the generator field current.



Drive Systems Under Test (DUT)

The same tests were performed on three (3) drive systems:

1. Clean Power VFD
2. Conventional 6-pulse VFD without filters
3. Conventional 6-pulse VFD with a passive harmonic filter and a sinewave filter



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Performance Comparison Results

Input Line Voltage and Current Waveforms

Figure 1 shows the captured voltage and current waveforms for the ***Clean Power*** **VFD** operating at 60Hz under full load condition. It clearly shows that the ***Clean Power*** **VFD** supply voltage and current are aligned, minimizing the phase difference, thus reducing the reactive power and resulting in a power factor near unity. (from 0.992 to 0.996)

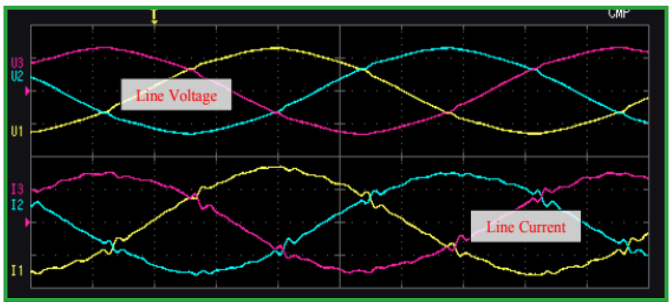

Figure 1: Clean Power VFD: Input voltage and current waveforms

Figure 2 shows the power factor on the line side for the conventional VFD. It illustrates how harmonics distort the Current, causing misalignment between the voltage and current waveform creating lower power factor (0.94 to 0.95).

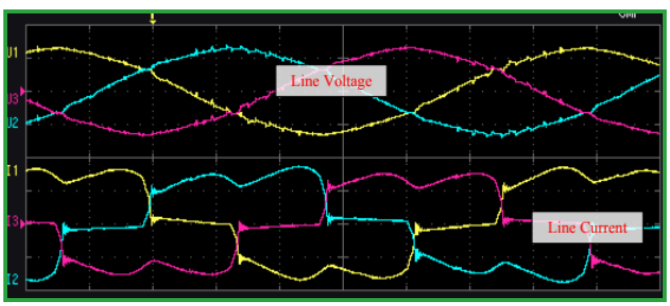

Figure 2: Conventional VFD: Input voltage and current waveforms

Figure 3 shows the power factor on the line side for the conventional VFD with passive harmonic filter. It shows that the harmonic filter helps to re-align the voltage and current, which helps to improve the power factor.

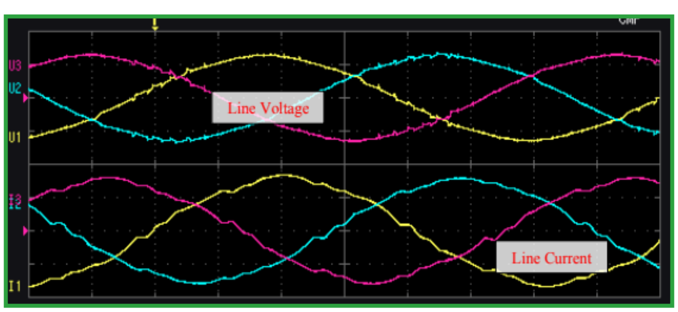

Figure 3: Conventional VFD with filters: Input voltage and current waveforms

Power Factor Comparison

Figure 4 shows the power factor on the line side for the tested systems. As expected when the load increases, the conventional VFD's power factor becomes greater with close to 0.95 at full load.

Adding the passive harmonic filter to the conventional VFD, the power factor is improved, closer to unit. The decrease of power factor could be caused by the reactor power of the capacitors of the passive harmonic filter.

The ***Clean Power*** **VFD** has better performance in terms of power factor near unity, from 0.992 at to 0.996 .

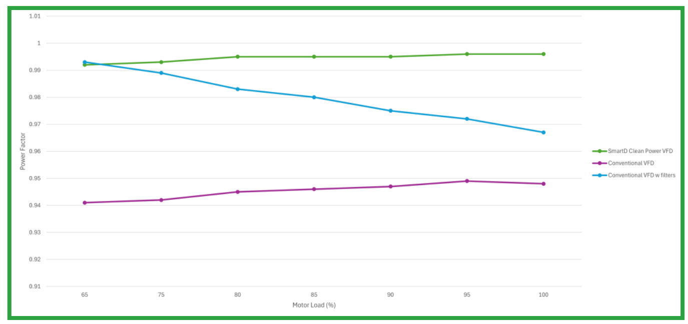

Figure 4: Power factor on the line side from 65% to 100% load

Conclusion

The test report compares the performance of the ***Clean Power*** **VFD** with a conventional VFD and a combination of a conventional VFD and filters, focusing on input voltage and current waveforms and power factor results.

The ***Clean Power*** **VFD** demonstrates superior power factor performance due to its high switching frequency, active front end, and integrated filters. These features enable it to generate clean input and output signals, reducing harmonic distortion.

By minimizing the impact of harmonics on voltage and current waveforms, the ***Clean Power*** **VFD** achieves a power factor close to unity. This results in optimal power efficiency and reduced energy costs.

CLEAN SIGNAL | **EMBEDDED FILTERS** | **OPTIMAL SYSTEM COST**