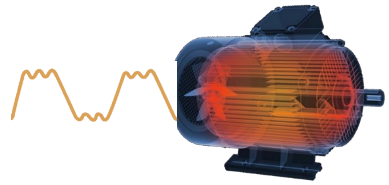
Clean Power **VFD**

Protect your motor, cable and bearing without external dV/dt or sinewave filter

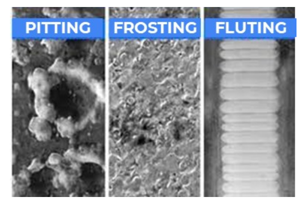
MOTOR OVERHEAT, INSULATION AND BEARING FAILURE

An AC motor is designed to work with sinusoidal signals. Conventional VFDs output Pulse Width Modulation (PWM) signals emulate the sinewave signals to the motor. These PWM signals cause the motor to overheat. It is also known that a motor's insulation lifespan drops by half for every 10°C or 50°F of overheating.



In addition, over long cable, the voltage spikes on the raising edge of the PWM signal can double and exceed the voltage rating of the motor's insulation, causing insulation failure These spikes also cause corona discharge on the motor's cable that damage its jacket and insulation.

And the imbalanced PWM signals cause voltage potential in the motor's structure known as Common Mode Voltage. The common mode voltage creates induced common mode current (i.e. bearing current) and generates sparks and arcing through the bearing lubricant. These sparks cause pitting, frosting and fluting and eventually bearing failure.



ELIMINATING PWM DRAWBACKS AT THE SOURCE

The advanced design of the ***Clean Power*** **VFD** uses SiC MOSFET technology to replace the 40 years old Insulated-Gate Bipolar Transistor (IGBT) design used in ordinary VFDs. SiC are leveraged to switch 50x faster than Si-based IGBTs, enabling the use of smaller passive components and integrated filters 100x to 200x smaller than external filters.

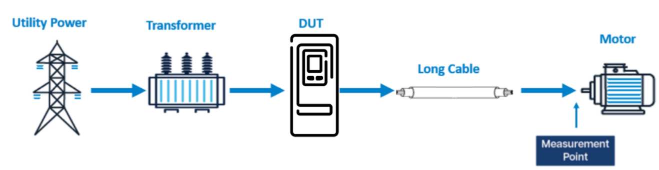
The ***Clean Power*** **VFD** outputs three sine-waves signals to the motor with very low harmonics, extremely low common mode voltage and low common mode current peak. Your equipment, motor, cable and motor bearings are thus protected and motors typically run 10 to 15% cooler, without costly external hardware such as dV/dt or sinewave filters.

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.

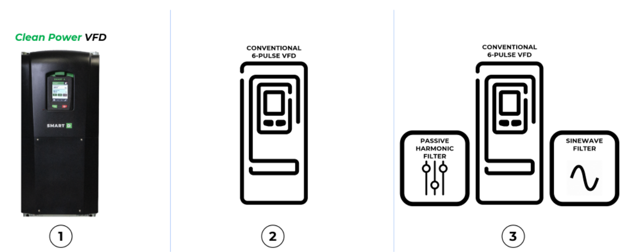
Moreover, an electrical generator (not shown) is used to provide the mechanical load of the motor. The load is controlled by modifying the generator field current.



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

Clean Power VFD Output Signals

Figure 1 shows the captured waveforms for the ***Clean Power*** **VFD** operating at 60Hz output frequency under full load condition. It clearly shows that the ***Clean Power*** **VFD** outputs sinusoidal signals to motor instead of PWM output signals.

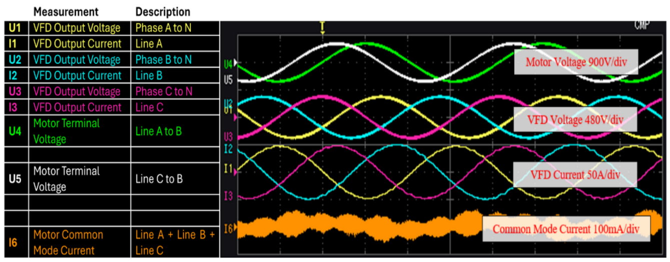

Figure 1: Clean Power VFD output signals

Common Mode Current Comparison

The Figures 2 and 3 show the motor common mode current for the tested systems. The ***Clean Power*** **VFD** has better performance in terms of common mode current where the peak value is kept below 0.07A.

The conventional VFD has the highest common mode current with peak value of about 1.3A. Adding the sine wave filter to the conventional VFD can reduce the peak common mode current by 50% as shown below. Mitigating the common mode current is critical to protect the motor from damaged bearing due to pitting, frosting and fluting with conventional VFDs.

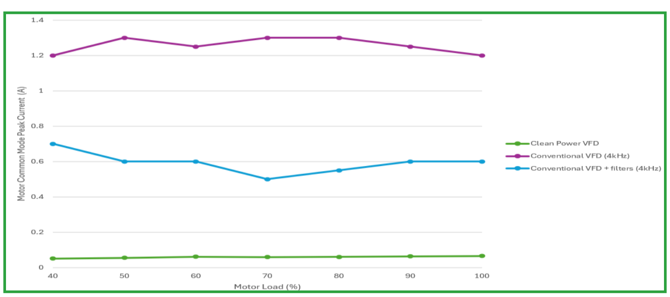

Figure 2: Common mode peak current comparison

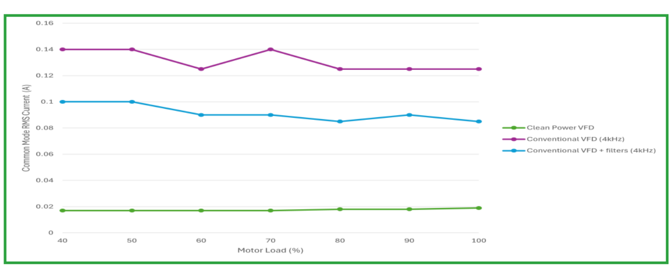

Figure 3: Common mode current (RMS) comparison

Motor Peak Voltage

Figure 4 shows motor peak voltage for all the tested systems. The peak voltage is relatively higher with conventional VFD due to the VFD output voltage and the mismatch between the long cable and motor impedance. Adding the sine wave filter to the conventional VFD reduces the peak voltage significantly. Similarly, the peak voltage is reduced with the ***Clean Power*** **VFD**. This allows the ***Clean Power*** **VFD** to be utilized for systems with long cable with reduced motor winding failures and premature motor insulation failure.

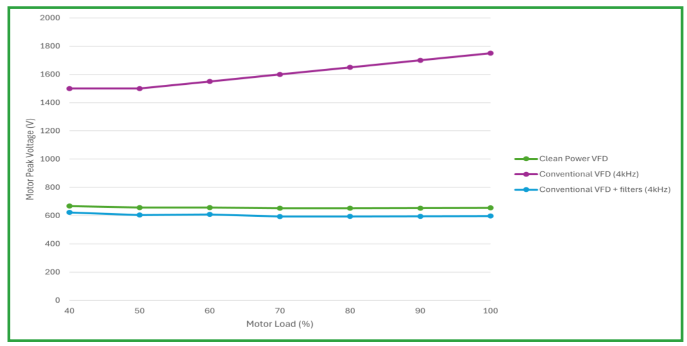

Figure 4: Motor peak voltage (V)

Conclusion

The test report presents motor side test results for the comparison of ***Clean Power*** **VFD** performance with a conventional VFD and the combination of a conventional VFD and a sinewave filter.

The peak voltage causes motor winding failures and premature motor insulation failure while the common mode current results in damaged bearing due to pitting, frosting and fluting. The superiority in the ***Clean Power*** **VFD** performance is due to the high switching frequency, high DC bus voltage, and utilizing medium frequency magnetic as integrated output filtering.

The ***Clean Power*** **VFD** with its sinusoidal signal output eliminates the need of external filters and mitigation solutions to protect the motor, cable and motor bearing. .

CLEAN SIGNAL

EMBEDDED FILTERS

OPTIMAL SYSTEM COST