

Introduction

Traditional VFD systems often require external braking resistors or other accessories to achieve effective and stable braking. However, the **Clean Power VFD** eliminates the need for these additional components, providing a seamless, efficient, and stable braking process. This technical note outlines the testing methodologies and results demonstrating the superior braking performance of the Clean Power VFD.

Braking Resistors

Braking resistors are typically used in VFD systems to dissipate excess energy generated during deceleration. This energy, if not managed properly, can lead to instability and inefficiency in the braking process.

No need for external resistors

The **Clean Power VFD** utilizes advanced control algorithms and an innovative design to manage this energy effectively, ensuring smooth and controlled braking without the need for external resistors.

The **Clean Power VFD** maintains consistent braking performance across different load conditions.

The **Clean Power VFD** 's design ensures that power quality remains high during braking, with minimal harmonic distortion and stable voltage and current waveforms, which contribute to the overall efficiency and reliability of the motor control system.

Test setup and Methodology

The performance of the **Clean Power VFD** was evaluated through a series of rigorous tests comparing it with conventional VFD systems. The tests focused on dynamic and steady-state responses during braking scenarios

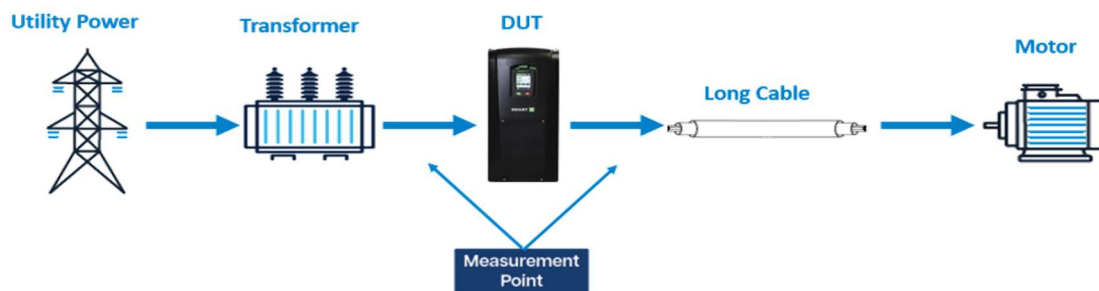


Figure 1: Clean Power VFD Test Schematic for Braking Performance Evaluation

External lab setup

An autotransformer of impedance of less than 2% is used to supply the **Clean Power VFD** with voltage of 480V.

In addition, A 25HP motor is used to load the **Clean Power VFD**. Moreover, an electrical generator (not shown) is used to provide the mechanical load of the motor. The load was controlled by controlling the generator field current.

Support Equipment: ABB Baldor-Reliance AC Motor, Georator Corporation AC Generator, Hammond Power Solutions Autotransformer, Hioki Power Meter, Nexans VFD Cable

Results

The following sections present the dynamic and steady-state performance of the **Clean Power VFD** during braking.

Dynamic Response

The dynamic response was tested by rapidly decelerating the motor from full speed to a complete stop.

Figures 2 and 3 illustrate the output frequency and motor load during the braking process.

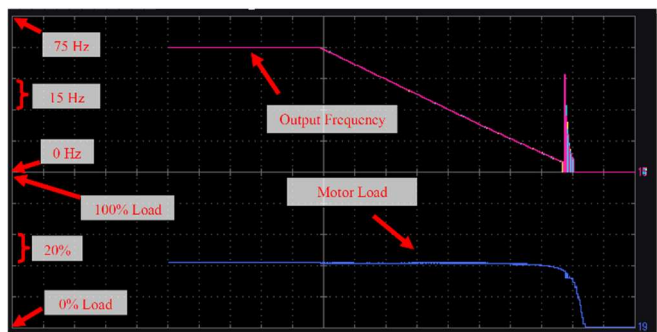


Figure 2: Output Frequency and Motor Load During Deceleration (50 seconds ramp down)



Figure 3: Output Frequency and Motor Load During Deceleration (25 seconds ramp down)

The results show a smooth and linear decrease in frequency and controlled braking torque without fluctuations, indicating a stable and efficient braking process.

Steady-State Response

The steady-state response was evaluated by monitoring the actual frequency against the reference frequency during various braking scenarios.

The following table summarizes the steady-state error measurements, demonstrating minimal deviation from the reference values.

Reference Frequency (Hz)	Actual Frequency (Hz)	Steady-State Error (%)
30	29.9961	-0.013
35	34.9974	-0.007
40	39.9953	-0.012
45	44.9955	-0.010
50	49.9960	-0.008
55	54.9922	-0.014
60	59.9934	-0.011

Energy Management During Braking

Figure 4 presents the power input and output waveforms during the braking process, showing how the **Clean Power VFD** efficiently manages the braking energy without requiring an external braking resistor.

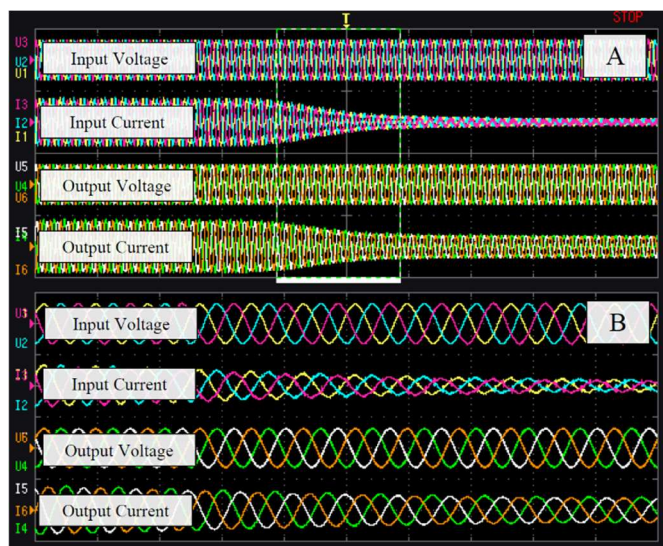


Figure 4: Power Input and Output Waveforms During Braking with close-up view on the deceleration

Regeneration Feature of the VFD

One of the key features of the **Clean Power VFD** is its advanced regeneration capability. Unlike traditional braking systems that dissipate the excess energy as heat using braking resistors, the **Clean Power VFD** is designed to regenerate the energy back to the power supply. This not only enhances energy efficiency but also reduces heat dissipation, leading to a more sustainable and cost-effective operation.

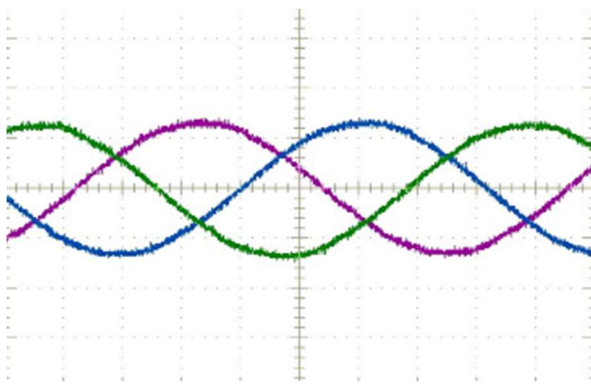


Figure 5: Power Input Waveforms During Regeneration

Maintaining Signal Quality in Regeneration Mode

A significant advantage of **Clean Power VFD**'s regeneration feature is the maintenance of high signal quality in both voltage and current. This ensures that the power being regenerated is clean and stable, minimizing any potential disruptions or noise in the system.

Exceptional Total Harmonic Distortion (THD) Performance

In addition to maintaining signal quality, **Clean Power VFD** exhibits exceptional Total Harmonic Distortion in current (THDi) performance during regeneration. This means that the harmonic content of the regenerated current remains low, reducing the risk of harmonic-related issues in the power network. The low THDi during regeneration contributes to the overall efficiency and reliability of the VFD, making it an ideal choice for applications where power quality is critical.

Motor Torque (%)	Motor Speed (%)	VFD input THDi (%)
50 % regen	100 %	3.988
75 % regen	100 %	2.46
100 % regen	100 %	1.805

Conclusion

The test results demonstrate that the **Clean Power VFD** eliminates the need for external braking resistors by utilizing advanced control algorithms and integrated energy management.

It ensures consistent performance across loads, simplifies system design, reduces heat generation, and improves power quality, resulting in a more efficient, stable, and reliable motor control system.

Furthermore, the **Clean Power VFD**'s advanced regeneration feature significantly enhances its efficiency and sustainability. By regenerating excess energy back to the power supply, it minimizes energy wastage and reduces the thermal footprint.

The maintenance of high signal quality in both voltage and current during regeneration ensures clean and stable power delivery, avoiding disruptions and maintaining optimal performance.

Additionally, the exceptional Total Harmonic Distortion in current (THDi) performance during regeneration highlights the **Clean Power VFD**'s superior design, ensuring minimal harmonic interference and contributing to the overall reliability and effectiveness of the system.