Matrix drives a step forward for AC-to-AC conversion

The concept of Matrix drives—the process of direct AC-to-AC conversion—has been around for years, but advancements in technology have now brought that idea into practice. Christopher Jaszczolt from the Matrix drives product management team for Yaskawa America Inc. talks about how improvements in technology offer new opportunities to utilize this technology in practice.

Q: What are Matrix drives, and what makes them different?

JASZCZOLT: Drives are used to operate motors at various speed under various conditions to meet an application's needs. Drives elicit motor control by generating their own output voltage waveform. This is usually accomplished by converting AC input voltage to a DC supply. The DC supply is then pulsed to the motor to generate the desired AC output voltage. On the other hand, Matrix Drives do away with the AC-to-DC-to-AC conversion. Instead, a Matrix Drive directly convert AC input voltage to AC output voltage.

Direct AC-to-AC conversion technology has been in practical use for well over a decade. Some may know the technology by the name Cycloconverter. These devices use dual bridge SCRs (switches) to convert AC line voltage to lower frequency AC motor voltage. These have been used on many low speed applications such as mine winders, washing machines, and water pumps.

Yaskawa's Matrix drive took a large leap forward using IGBTs for its direct AC-to-AC conversion to provide better motor control, higher speeds (up to 400 Hz), and low input current harmonic performance in an inherently regenerative package. An IGBT's higher switching rates mean better hardware and processing power is needed to control the direct AC-to-AC conversion.

The Matrix drive as we know it today is Yaskawa's second generation Matrix drive. The current Matrix drive technology provides more application-related features and functions, as well as improved efficiency in a much more compact package. All this maintains the drive's inherent low input harmonic current performance and its automatic and instantaneous regenerative capabilities.

The Matrix Drive differentiates itself by directly converting AC input power to AC output power. Traditional drives convert AC input power to a DC voltage supply (DC bus). Then, the drives use the DC voltage to generate a pulse width modulated (PWM) output voltage waveform to simulate a sine wave and control the motor. The Matrix drive does away with the AC-to-DC voltage conversion - and the DC bus capacitors - and provides motor control voltage from 0 to 400 Hz directly from your 60 Hz supply line voltage.

Q: How are regenerative drive solutions a better technology than traditional drive technology?

JASZCZOLT: Traditional drive technology with its DC bus used to generate the output voltage waveform does not have the ability to handle regeneration. The diode bridge used for the AC-to-DC conversion is a one-way acting device, which means it only allows current to flow into the drive. During a regenerative condition, as the motor forces energy onto the DC bus, the diode bridge will block that energy from going back onto the line.

The DC bus voltage builds up quite quickly, causing the drive to fault to protect itself from an overly high voltage potential and stop production. Someone then may have to physically go on-site to reset the drive and, as a result, many installations lose tremendous amounts of money due to downtime. When required to avoid these faults, traditional drives typically employ a scheme to divert extra regenerative energy away from the DC and on to a dynamic braking resistor. The resistor burns this energy off as heat to allow the drive to continue operation without faulting.

The Matrix drive technology is an all-in-one compact configuration that simply needs three wires in and three wires out to control your motor. The Matrix drive's switches are bi-direction, which means they can provide power to the motor or take power from the motor and put it back onto the supply line. Directing that extra energy back onto the supply line allows that energy to be used by other loads on the same power supply, which means a lower utility bill due to the lower power draw. In many cases, the cost of the drive can be recovered through regenerative savings.

Q: What are the advantages of having a Matrix drive that is inherently regenerative? What should end users expect?

JASZCZOLT: The Matrix drive will inherently and automatically deal with regeneration, which leads to a faster and cleaner installation. There is no more worrying about overshooting the speed reference causing an overvoltage fault due to an aggressive acceleration time, or adjusting deceleration times and s-curves to avoid nuisance drive faults.

The Matrix drive's continuous 100% regenerative capability with a 150% overload for 60 seconds means that if you can start the motor, then you can stop the motor without additional tuning. All this without worrying about how regeneration will impact the drive or application. Simply stated, the Matrix drive offers the fastest, cleanest installation of a regenerative solution on the market with the inherent ability to eliminate downtime due to nuisance overvoltage trips. It saves you time and money.

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