

# Improve Operating Efficiency and Reduce Installed Cost with Altivar™ 212 Adjustable Speed Drives

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## Introduction

The Altivar™ 212 adjustable speed drive operates more efficiently and provides additional installed cost savings as compared to typical AC drives on centrifugal pump and fan applications.

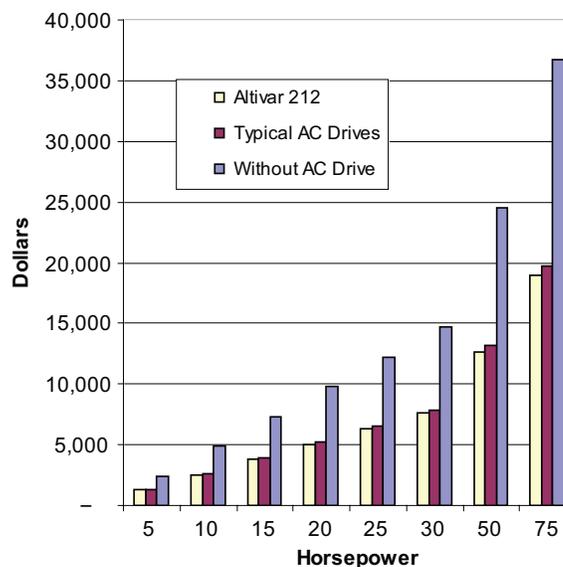
Applying AC drives on centrifugal pump and fan applications has been, and continues to be, an excellent way to obtain energy savings and reduce maintenance costs. By eliminating air flow dampers, inlet guide vanes, and throttling valves—and by using an AC drive to control air and fluid flow—users have reduced energy costs and maintenance costs.

Until now, AC drives from most manufacturers have provided similar rates of energy savings by reducing the power the motor needs to provide optimum flow. This bulletin describes the operating efficiency improvements and cost savings that users can obtain by applying an Altivar 212 drive on centrifugal pump and fan applications in place of typical AC drives, and the technology designed into the Altivar 212 drive that provides these additional savings.

## How Much Improvement in Operating Efficiency Does the Altivar 212 Drive Offer?

The Altivar 212 drive is able to provide a 3%–5% operating efficiency improvement over typical AC drives on centrifugal pump and fan applications. Based on typical duty cycle and energy costs, a 3%–5% improvement in efficiency can save \$120–\$195 per year per drive when compared to typical AC drives on a 15 hp motor. Figure 1 provides estimated energy costs of the Altivar 212 drive, a typical AC drive, and operation with traditional contactor control over a range of motor sizes.

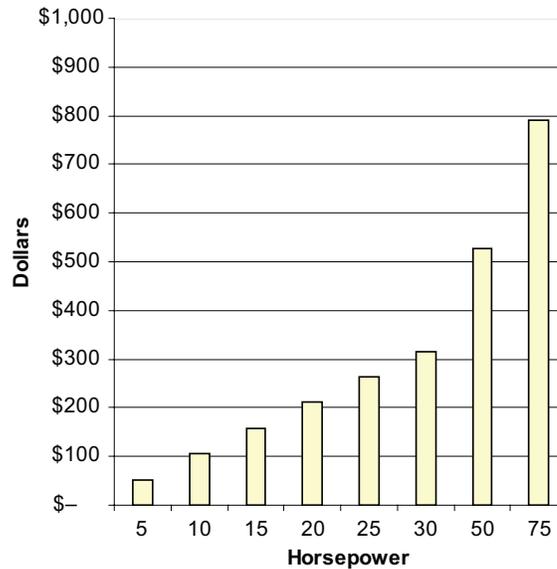
Figure 1: Estimated Annual Energy Costs <sup>1</sup>



<sup>1</sup> Savings are based \$0.09 / kWh; 7300 operating hours and a duty cycle of 100% speed for 1825 hours, 80% speed for 3650 hours, and 50% speed for 1825 hours.

Figure 2 shows the estimated reduction in energy costs of an Altivar 212 drive compared to typical AC drives. Multiply the savings by the number of motors and the annual savings offered by the Altivar 212 drive can be considerable.

**Figure 2: Estimated Annual Reduction in Energy Costs of an Altivar 212 Drive Compared to Typical AC Drives <sup>2</sup>**



## What is Different About Altivar 212 Drive Technology?

The key design principles that enable the Altivar 212 drive to provide the improvement in operating efficiency over typical AC drives used in pump and fan applications are:

- the unique, optimized power section, and
- the engineering of the motor control algorithm and a powerful motor control processor.

The power section design has been optimized by reducing the DC bus capacitance value to approximately 3%–5% of the capacitor value of an equivalent horsepower, typical AC drive. This modifies the input current waveform characteristics by significantly reducing current spikes observed during the capacitor charging cycle. Total input current draw is reduced, lowering input current harmonics and input line RMS current values. This is accomplished without AC line reactors, swinging chokes, or DC bus chokes used by typical AC drives.

<sup>2</sup> Savings are based \$0.09 / kWh; 7300 operating hours and a duty cycle of 100% speed for 1825 hours, 80% speed for 3650 hours, and 50% speed for 1825 hours.

Figure 3 shows a typical input voltage and current waveforms of a 100 hp 6-pulse AC drive. The double-humped waveform shows the peak current reaching 300 A as the capacitors charge.

**Figure 3: Typical AC Drive Input Waveform**

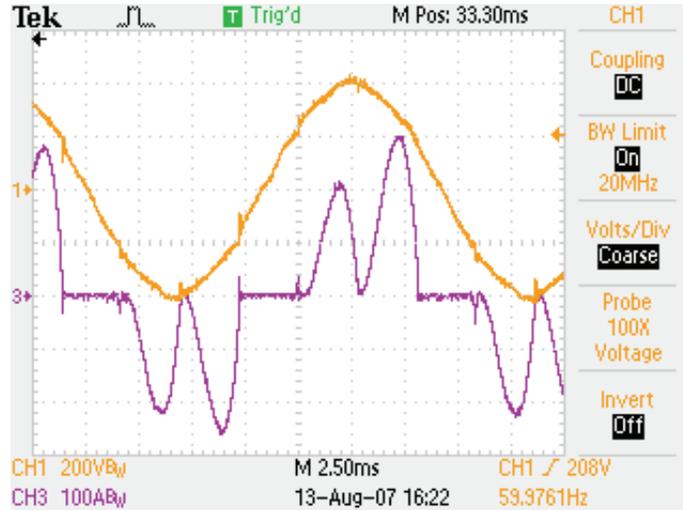
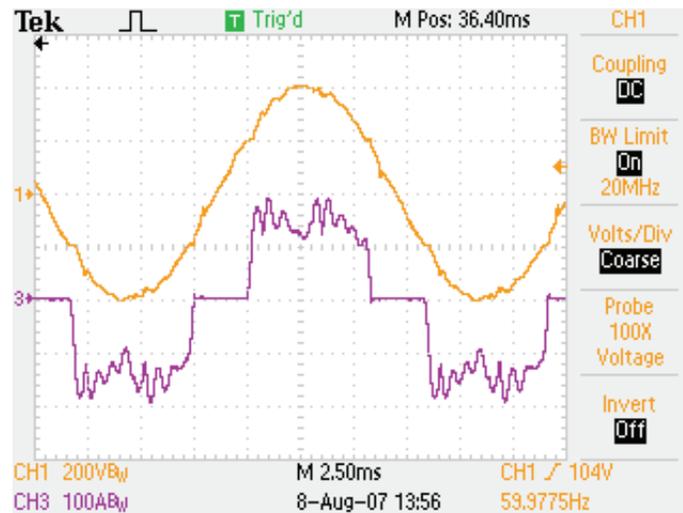


Figure 4 shows typical input voltage and current waveforms of a 100 hp Altivar 212 drive. Note the dramatic change in the shape of the input current waveform. The current peaks only reach up to 190 A. Because of the reduced capacitance, the input current is a square-shaped waveform, eliminating the large, double-humped waveform which generates large harmonic currents. This square-shaped current waveform produces lower harmonic currents and lowers RMS input current.

**Figure 4: Altivar 212 AC Drive Input Waveform**



By eliminating line reactors, swinging chokes, and DC bus chokes, the power section has less resistance, which reduces energy losses and provides a portion of the efficiency improvement offered by the Altivar 212 drive.

The second key design aspect of the Altivar 212 drive is the engineering of the motor control algorithm and the powerful motor control processor used to produce a smooth, sinusoidal waveform to the motor.

As there is less DC bus capacitance, there is more DC ripple on the DC bus. The motor control algorithm and processor are engineered to manage this ripple and produce a smooth, sinusoidal current waveform to the motor suitable for powering motors on centrifugal pump and fan applications.

## What are the Benefits of Altivar 212 Drive Technology?

Three benefits of this technology are detailed below.

1. Harmonic reduction is equivalent to results obtained with line reactors, swinging chokes, or DC bus chokes at a lower cost.

This technology provides harmonic mitigation without the use of line reactors, swinging chokes, or DC bus chokes. Harmonic mitigation of the Altivar 212 drive is equivalent to a typical AC drive with a line reactor, swinging choke, or DC bus choke design. Eliminating these reactors and chokes, and the space needed to mount them, can reduce the installed cost by 4%–6% in a typical installation. See Schneider Electric Product Data Bulletin 8800DB0702 for more information on the harmonic mitigation benefits of the Altivar 212 drive and for a comparison of harmonic mitigation techniques.

2. Reduction in input line current saves wiring cost and over current protection device costs.

A benefit of the technology designed into the Altivar 212 drive is the reduction of the input line current when compared to typical AC drives. Figures 5 and 6 show the reduction in RMS current for a 15 hp drive. Figure 5 shows a typical AC drive. It exhibits the double-humped waveform as the capacitors charge. Note that the RMS current value is 20.53 A. Figure 6 shows the Altivar 212 drive. The waveform peaks are much lower as the capacitors charge. Note that the RMS current value is 14.25 A, 30% less than the typical AC drive. The technology used in the Altivar 212 drive results in lower RMS input currents by reducing high peak current during the charging cycle.

Figure 5: RMS Input Current of a Typical 15 HP AC Drive

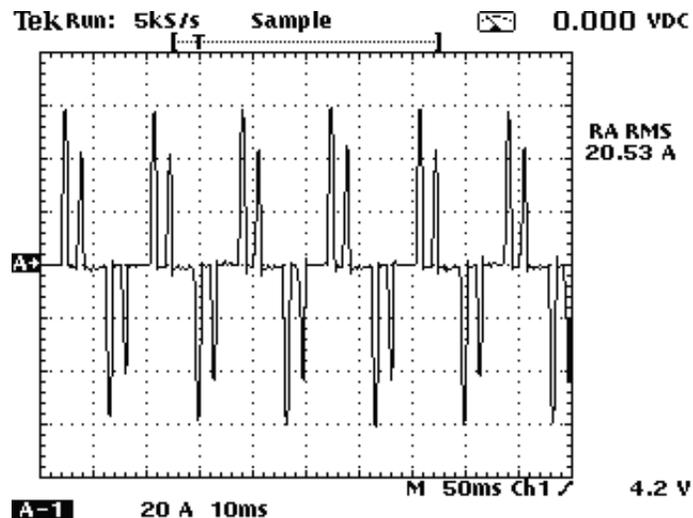


Figure 6: RMS Input Current of a 15 HP Altivar 212 Drive

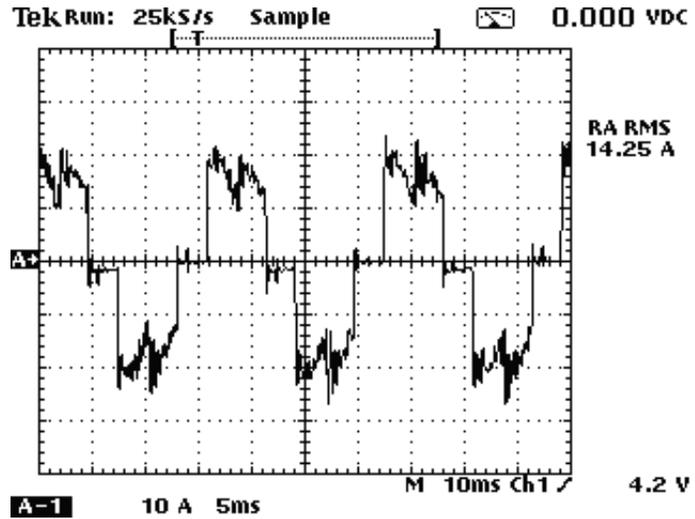
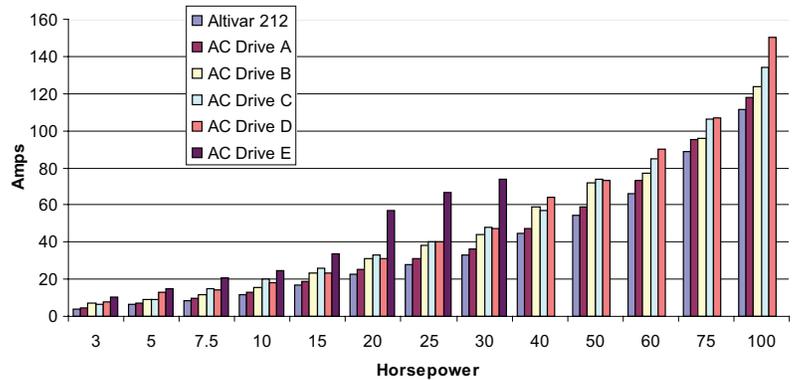


Figure 7 illustrates input currents from several typical AC drives at different horsepower sizes. As can be seen in the graph, the Altivar 212 drive has lower input line current values. This lower input line current allows wire size and over current protection devices to be sized accordingly smaller, often reducing the total installed cost by 2%–4% compared to typical AC drives.

Figure 7: Maximum Input Currents of the Altivar 212 AC Drive and Other Typical AC Drives



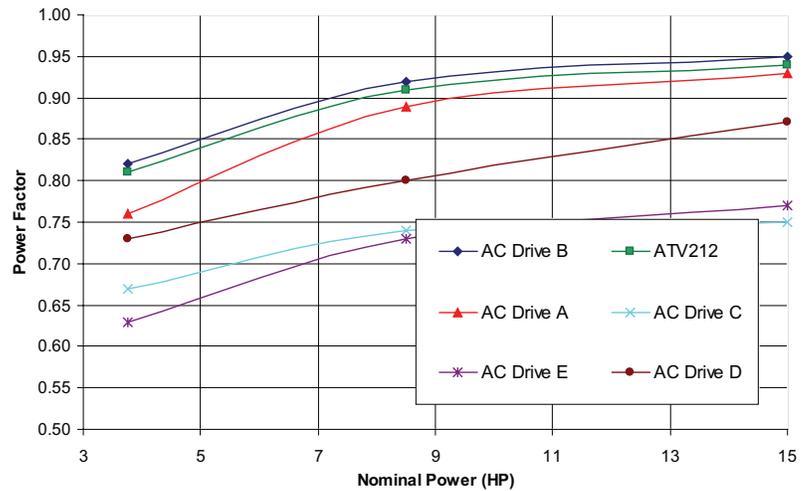
3. Better power factor than typical AC drives improves operating efficiency.

Another benefit of the technology designed into the Altivar 212 drive that contributes to its superior operating efficiency is the improvement in the power factor when compared to typical AC drives. The Altivar 212 drive, like most AC drives, converts incoming AC power to DC power using full wave rectifiers. The optimized design of the input section and reduced DC bus capacitance in the Altivar 212 drive converts AC power to DC power more efficiently through the speed range, because the current waveform is more in phase, or in step, with the voltage waveform when compared to a typical AC drive design. In electric power systems, a load with a low power factor draws more current than a load with a high power factor for the same amount of useful power transferred.

Higher currents increase the energy losses, and require larger wires and other over current protection equipment. As detailed earlier in this bulletin, the Altivar 212 drive has lower input currents.

Figure 8 illustrates the power factor of several typical 15 hp AC drives at different speed / load profiles. As shown in the graph, the Altivar 212 drive maintains a high power factor through the speed / load range encountered in centrifugal pump and fan applications. The high power factor means that the Altivar 212 drive is operating more efficiently, minimizing losses, improving electrical load power quality, and contributes to providing a 3%–5% operating efficiency improvement over typical AC drives on centrifugal pump and fan applications.

**Figure 8: Power Factor vs. Nominal Power**



### What are the Draw Backs of Altivar 212 Drive Technology?

With lower DC bus capacitance, the Altivar 212 drive has a reduced capacity to ride through AC power line dips or sags. The Altivar 212 drive has an auto-restart feature and a robust catch-on-the-fly algorithm designed to minimize the effect of voltage dips and sags. The catch-on-the-fly algorithm has also proven to do an exceptional job of catching a reverse spinning load, bringing the load to a standstill, and accelerating in the proper direction. This catch-on-the-fly algorithm is a useful feature for wind-milling fan loads. If voltage ride-through is a major concern in an installation, the Altivar 61 drive, with its industry leading, SEMI-F47 certified, voltage sag ride-through capability, may be the preferred solution.

### Why is Observed Output Current Sometimes Greater Than Input Current?

It is common to observe higher output current than the incoming current with many AC drives. While this observation is not unique to the Altivar 212 drive, this phenomena can be observed more often with the Altivar 212 drive because of the technology used in the design of the product. This phenomena can occur for two reasons:

1. The power factor at the input of a typical AC drive is much higher than the power factor of a typical AC induction motor. The capacitor bank of a typical AC drive has a power factor correction effect and exhibits a high power factor, usually in the 93%–96% range, at full load. Current flow in induction motors lags the voltage and exhibits lower factors, typically in the 85%–87% range. Motor power factor varies by motor design and construction. Having a lower power factor, the motor draws more current as the motor supplies power to the load. The higher power factor means

that the Altivar 212 drive is operating more efficiently, contributing to good power quality, and providing an operating efficiency improvement over typical AC drives on centrifugal pump and fan applications.

2. AC drives vary the output voltage throughout the speed range while the input voltage is constant. These different combinations of power at the input and output can exhibit higher output current than incoming current. While output current can exceed input current the same is not true for power. Total power input is greater than power output due to internal losses in an AC drive. These losses can come from powering displays, LEDs and cooling fans, and from losses in the power components. AC drives applied to variable torque loads provide tremendous energy savings over time due to reduction in speed and horsepower required to meet part load conditions. The design of the Altivar 212 drive minimizes these internal losses to operate more efficiently than typical AC drives.

## Altivar 212 Drive Benefits

The Altivar 212 drive operates more efficiently and provides additional installed cost savings compared to typical AC drives on centrifugal pump and fan applications. There are AC drive solutions that provide lower harmonic mitigation and provide longer voltage sag ride-through capability. However, these have higher installed costs and operate less efficiently. The Altivar 212 drive provides a robust solution that is uniquely positioned in a cost-benefit analysis. In summary, the Altivar 212 drive provides the following benefits.

- Harmonic mitigation equivalent to line reactors, swinging chokes, and DC bus chokes; reducing required panel space and installed cost by 4%–6% through eliminating components.
- Reduction of input line currents reduces wire size and over current protection device cost, reducing the total installed cost by 2%–4%.
- Operating efficiency improvement of 3%–5% over typical AC drives from an improved power factor and by minimizing losses in the drive and input cables.

## Data Source

The test data used in this document was obtained from an independent, third-party lab contracted by Schneider Electric.

## For Additional Information:

Additional information about Altivar 212 drives and options is available from:  
<http://products.schneider-electric.us/products-services/products/ac-drives-and-soft-starts/>

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