

AHD™ Technology

Active Harmonic Damping



*High-
performance
harmonic
mitigation*



AHD™ TECHNOLOGY

High-performance harmonic mitigation for variable-speed drives

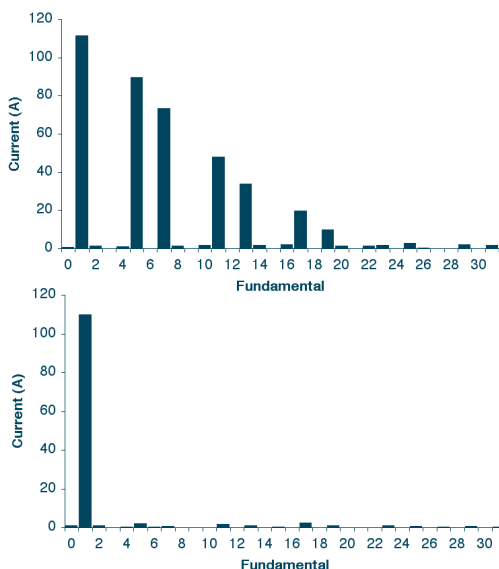
Proprietary AHD™ technology integral to

Unico's 1200 series drives provides a

cost-effective solution for improving

power quality that

- Increases equipment longevity
- Improves system reliability
- Reduces energy consumption
- Helps systems meet IEEE-519 guidelines



Comparison showing the harmonic spectrums of an unmitigated conventional 6-pulse drive (top) and an 18-pulse drive with AHD™ control (bottom)

Overview

AHD™ Active Harmonic Damping technology from Unico is a unique solution for improving power quality in variable-speed drive systems. Incorporated into Unico's 1200 series drives, AHD™ technology automatically dampens harmonic distortion to improve energy utilization, extend equipment life, and improve system reliability and productivity. When used in concert with other harmonic solutions, AHD™ drives provide an economical path to satisfying the IEEE-519 and similar standards.

Harmonics

The frequency conversion process used in an electronic drive generates a problematic form of electrical pollution referred to as harmonics. Harmonic currents are those that deviate from a pure sine wave and are generally expressed as a percentage of the fundamental current or as a distortion power factor. Excessive harmonics are a concern not only because they degrade energy efficiency, but because they cause voltage

distortion that can affect other equipment on the line and lead to overheating, overloading, mechanical resonance, unreliable and unpredictable operation, and premature failure.

IEEE-519 Standard

The Institute of Electrical and Electronic Engineers (IEEE) has created a standard to minimize problems associated with nonlinear equipment like drive systems that generate harmonic currents. The IEEE-519 recommendations specify the maximum acceptable levels of harmonic components and total harmonic distortion (THD) as a function of the stiffness of the power source, which is given by the short-circuit ratio (R_{SC}). The guideline expresses limits for current harmonics and distortion as percentages of load current, which is defined as the average current of the maximum demand, measured over 15-minute intervals, for the preceding 12 months. The THD of current calculated using that definition is referred to as total demand distortion (TDD).

IEEE-519 Maximum Current Distortion Limits (% of I_L)

R_{SC} (I_{SC}/I_L)	Individual Harmonic Order (Odd Harmonics)					TDD
	$h < 11$	$11 \leq h < 17$	$17 \leq h < 23$	$23 \leq h < 35$	$35 \leq h$	
< 20	4.0	2.0	1.5	0.6	0.3	5.0
$20 < 50$	7.0	3.5	2.5	1.0	0.5	8.0
$50 < 100$	10.0	4.5	4.0	1.5	0.7	12.0
$100 < 1,000$	12.0	5.5	5.0	2.0	1.0	15.0
$> 1,000$	15.0	7.0	6.0	2.5	1.4	20.0

Acceptable levels of harmonics as a function of stiffness of the power source (R_{SC}), where I_{SC} is the maximum short-circuit current at the point of common coupling (PCC) and I_L is the maximum demand-load current (fundamental frequency component) at the PCC. From IEEE-519-1992, "Recommended Practices for Harmonic Control in Electrical Power Systems."

Typical Harmonic Mitigation Results

Method	THD
Conventional drive	More than 100%
AHD™ control with 3% line reactor	Less than 30%
AHD™ control with passive harmonic filter	Less than 8%
AHD™ control with 12-pulse drive and isolation transformer	Less than 12%
AHD™ control with 18-pulse drive and isolation transformer	Less than 8%
AHD™ control with 24-pulse drive and isolation transformer	Less than 5%
AHD™ control with 12-pulse drive and autotransformer	Less than 12%
AHD™ control with 18-pulse drive and autotransformer	Less than 8%
AHD™ control with 24-pulse drive and autotransformer	Less than 5%

AHD™ Technology

Unico's 1200 series variable-speed drives utilize metal-film capacitors rather than conventional electrolytic capacitors. Patent-pending AHD™ technology takes advantage of the relatively low bus capacitance of this topology to precisely control the bus voltage and minimize harmonic currents. Input harmonic currents appear as fluctuations in the bus voltage that are multiples of six times the power-line frequency. The AHD™ control automatically detects and damps those fluctuations to minimize harmonic distortion.

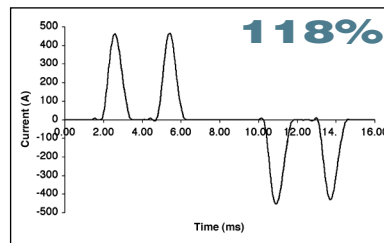
Configurations

The AHD™ drive is an essential part of a portfolio of harmonic solutions that also includes link chokes, line reactors, multiphase techniques, harmonic filters, and hybrid combinations. Harmonic mitigation solutions generally increase in cost with the degree of harmonic reduction. The need for more aggressive treatment of harmonics generally increases along with the

size of the drive system. AHD™ control not only enhances the performance of whatever method is chosen, but it allows the selected configuration to outperform conventional techniques while lowering cost and system complexity.

Six-Pulse Drive

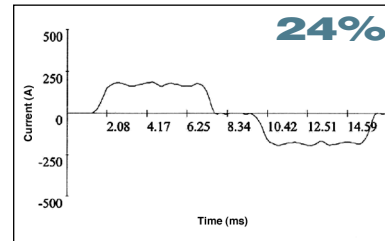
Variable-speed drives typically provide for a three-phase input that causes what is referred to as six-pulse harmonic behavior. Without filtration, a conventional six-pulse drive can have harmonic current distortion of more than 100%. Using a large DC link choke, this can be brought down to about 30%.



Conventional 100 hp 6-pulse drive without a DC link choke

Six-Pulse Drive with Line Reactor

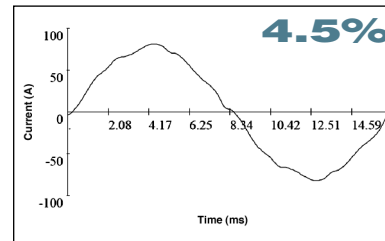
With AHD™ technology, a Unico drive can achieve harmonic distortion of about 24% using a small line reactor in place of the link choke. While this compares favorably to traditional drive topologies, further mitigation strategies must be employed to meet the maximum allowable harmonic current of 20% in the IEEE-519 specification.



150 hp 6-pulse Unico drive with AHD™ control and 3% line reactor

Six-Pulse Drive with Passive Harmonic Filter

Unico six-pulse drives with AHD™ control can be combined with a passive harmonic input filter to achieve performance similar to an 18-pulse system. Harmonic currents are reduced to less than 5% in compliance with IEEE-519 for short-circuit currents of less than 20. Harmonic filters do contain capacitors that must be factored into decisions on their use on power lines with resonance problems.



60 hp 6-pulse Unico drive with AHD™ control and passive harmonic input filter

Multiphase Drives

Unico drives 50 hp and above provide for either a three-phase (6-pulse) or six-phase (12-pulse) connection. Drives of 100 hp and above have options for three-, six-, and nine-phase (6-, 12-, and 18-pulse) connections, while drives of 300 hp or more can be configured for operation up to 24-pulse. These drives with AHD™ control can be used with a 12-, 18-, or 24-pulse isolation transformer to reduce harmonic currents to less than 12%, 8%, and 5%, respectively. These are within the IEEE-519 specification for systems with short-circuit ratios of less than 100, 50, and 20, respectively.

Twelve- and 18-Pulse Drives with Autotransformers

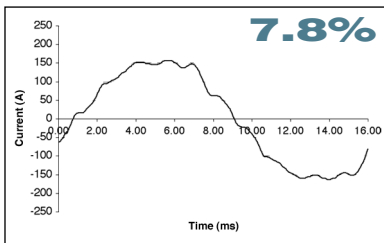


Unico 250 hp 12-pulse autotransformer (front) is extremely compact relative to a comparable isolation transformer

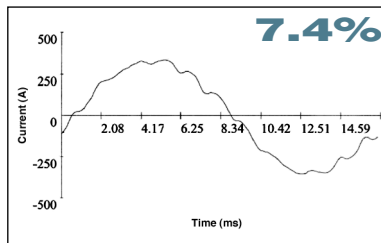
AHD™ technology can also be combined with 12- and 18-pulse autotransformers to provide a lower-cost alternative to isolation transformers. This unique combination reduces input harmonic currents to about 8% and 5%. Autotransformers offer the added benefit of being significantly smaller than comparable isolation transformers.

Tandem Drive Operation

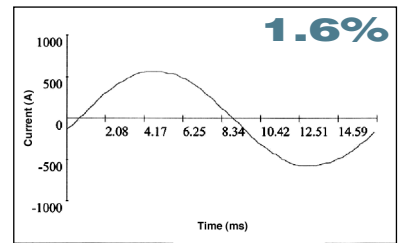
For installations that require the utmost in clean power, the Unico 12-pulse autotransformer offers a unique feature that allows two drives to be operated in tandem to achieve a nearly perfect sinusoidal waveform. Tandem drives with identical loads can achieve harmonic distortion current of less than 2%, which was actually about half the incoming voltage distortion in the test case. Even with a three-to-one imbalance in drive loading, tandem operation still meets the IEEE-519 standard with harmonic current distortion of about 5%.



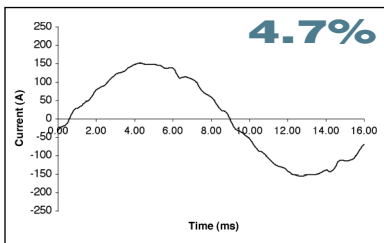
100 hp 12-pulse Unico drive with AHD™ control and dual-output isolation transformer



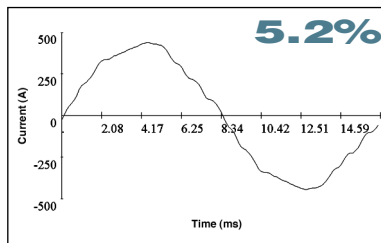
250 hp 12-pulse Unico drive with AHD™ control and autotransformer



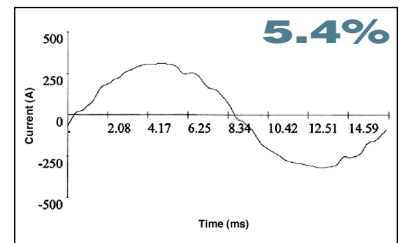
Tandem 250 hp Unico drive systems with AHD™ control (equal loads)



100 hp 18-pulse Unico drive with AHD™ control and triple-output isolation transformer



300 hp 18-pulse Unico drive with AHD™ control and autotransformer



Tandem 250 hp Unico drive systems with AHD™ control (unequal loads)

UNICO-Worldwide



United States patent pending.

All trade designations are provided without reference to the rights of their respective owners.

Specifications subject to change without notice.

Corporate Headquarters

UNICO, Inc.
3725 Nicholson Road
P. O. Box 0505
Franksville, Wisconsin
53126-0505
USA

voice: 262.886.5678
fax: 262.504.7396

www.unicous.com

United States

New Lenox, Illinois
815.485.5775

Wixom, Michigan
248.380.7610

Austinburg, Ohio
216.387.8486

Midland, Texas
432.218.7665

Sandy, Utah
801.942.2500

South America

El Tigre, Venezuela
58.283.241.4024

Maracaibo, Venezuela
58.261.792.4047

Europe
Milton Keynes,
England

44.1908.260000

Wilnsdorf, Germany
49.2739.303.0

Canada

Mississauga,
Ontario
905.602.4677

Mexico

Tampico
52.833.217.4543

Asia

Beijing, China
86.10.6218.6365

Osaka, Japan
81.66.945.0077