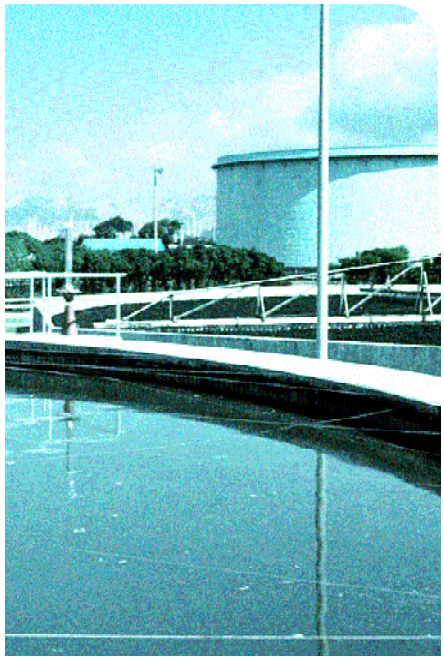
LISTEN.
THINK.
SOLVE.℠



LOW HARMONIC DRIVE PACKAGES ENGINEERED FOR YOU.

VARIABLE FREQUENCY DRIVE PACKAGES WITH HARMONIC MITIGATION.

HARMONICS

A GROWING CONCERN FOR CUSTOMERS

Harmonics are deviations from the ideal sinusoidal AC line voltage and current waveforms. These distortions are typically low in magnitude and can have an impact on the performance of your connected devices. With the advent of power electronics, non-linear loads and power switching devices such as Variable Frequency Drives (VFDs), there is concern for a potential increase in the level of harmonic distortion conducted back onto the utility power lines.

POTENTIALLY COMPROMISING

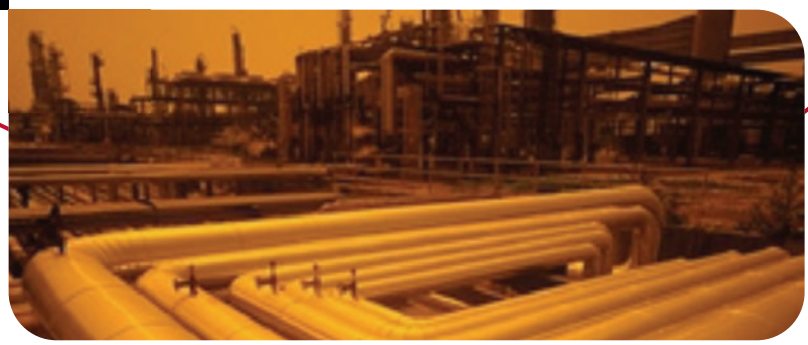
Harmonic distortion can impact your electrical systems in a number of ways: Conductor insulation overheating, higher temperature rise in transformers and motors resulting in shorter life, and instrumentation signal interference can occur from harmonic distortion. Depending on your facility and the system parameters, these issues may have a significant effect on various elements of your installation. Facility engineers need to determine if, how and where to mitigate harmonic distortion in the power distribution system to reduce the risk of any serious consequences.

STRAIGHTFORWARD SOLUTIONS

Fortunately, reducing harmonic distortion to acceptable limits is easily attainable. The Institute of Electrical and Electronics Engineers (IEEE) has created guidelines that set reasonable limits for harmonic current and voltage distortion for various systems and locations (IEEE 519-1992). Many software calculation programs are also available for you to help predict the level of harmonic content and determine the mitigation requirements for your installation.

ROCKWELL AUTOMATION® HAS THE ANSWER

By applying the appropriate technology, the effects of harmonics can be reduced, thereby minimizing the effects of potential damage to your assets. Rockwell Automation® offers a variety of low and medium voltage VFD options in small-foot print packages, engineered to minimize harmonic distortion at the source. Several proven harmonic mitigation techniques are available to meet your requirements for budget, space limitations and harmonic attenuation. Rockwell Automation has a proven track record and large installed base of low harmonic VFDs in various industrial and commercial applications. These technologies include 18-pulse and active front-end converters as well as both active and passive filters, employed to minimize harmonics and adhere to IEEE 519-1992 standards.

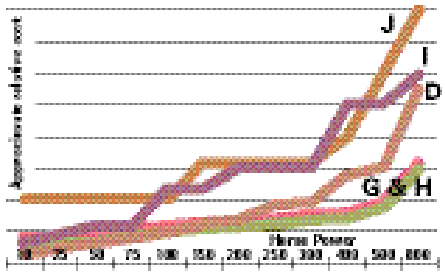


Harmonic Mitigation Techniques

LESS HARMONIC DISTORTION →

Performance Comparison

MORE EXPENSIVE →



Cost Comparison

FOOTPRINT SIZE →

Size Comparison

DRIVE HARMONIC MITIGATION TECHNIQUE		COMMENTS
6 Pulse AC Drive without a DC Link Choke	A	This is the simplest AC drive design. It does not provide any harmonic mitigation.
6 Pulse AC Drive with a DC Link Choke	B	The DC Link choke provides a significant reduction in low frequency harmonics produced by the drive.
Input Line Reactor	C	Adding this reactor reduces transient surges or spikes on the line but provides little added harmonic mitigation when used with a buffered drive. It is sometimes used on distribution systems composed of a small percentage of non-linear load as compared to total load.
Passive Filters and 6-pulse AC Drives	D	This is a cost-effective solution at 200 horsepower and below. It may cause a power system resonance condition in some installations. Use caution when applying this type of filter with generator power sources.
12 Pulse Converter with Auto Transformer	E	This is not guaranteed to meet IEEE 519-1992 without analysis. It has a slightly reduced component count and complexity compared to an 18-pulse drive. An auto transformer will have a lower cost and smaller physical size (easier to mount in the enclosure line-up) than an isolation transformer.
12 Pulse Converter with Isolation Transformer	F	This is also not guaranteed to meet IEEE 519-1992 without analysis. It also has a slightly reduced component count and complexity compared to an 18-pulse drive. An isolation transformer supplies slightly less Total Harmonic Distortion (THD) than an auto transformer.
18 Pulse Converter with Auto Transformer	G	This meets IEEE 519-1992 general requirements at the drive input terminals without analysis; when power phases are balanced within 1/2% (1% when required). An auto transformer will have a lower cost and smaller size (easier to mount in the enclosure line-up) than an isolation transformer. Comparable cost to 12-pulse. Ve ry cost-effective above 300 horsepower.
18 Pulse Converter with Isolation Transformer	H	This method will also meet IEEE 519-1992 general requirements at the drive input terminals without analysis; provided the input power phases are balanced within 2%. An isolation transformer supplies slightly less THD than an auto transformer.
Active Front End	I	This solution actively tracks and regulates input current to maintain sine wave current draw. This technique generates minimal voltage distortion allowing the input power converter to meet IEEE 519-1992 at the input terminals of the drive. This method is most cost-effective on large common bus systems with many drives, or on single high horsepower ratings requiring braking. For medium voltage drive applications, this is generally the most cost-effective solution.
Active Power Filter	J	This is an external solution that actively monitors harmonic distortion levels and injects cancellation harmonic current onto the line to meet IEEE 519-1992 at the power line where the active filter is connected. Cost-effective only on large common AC bus applications.

LOW VOLTAGE

AC DRIVE HARMONIC SOLUTIONS

CHOOSE FROM A RANGE OF TIME-TESTED AC DRIVE SOLUTIONS

Meeting your application needs and matching your installed base, the PowerFlex® family of AC drives and the 1336 PLUS™ II AC drive family is a proven solution that offers the flexibility and variety of passive filters to comply with even the most stringent harmonic requirements.

TECHNOLOGY WITH A TRACK RECORD

The PowerFlex family of AC drives represents the culmination of over 30 years of drive design and manufacturing experience. This compact, modular design offers advanced fan and pump control features designed to improve system performance and reduce energy consumption. A built-in software algorithm adjusts output voltage diminishing standing waves from damaging motor insulation allowing up to 600 feet of cable between the VFD and motor.

DECREASE YOUR FOOTPRINT

With the latest generation of IGBT power technology, some power rating sizes have been reduced, without sacrificing efficiency or performance. PowerFlex drives offer the same features as the 1336 PLUS II with many enhancements. A sleep/wake feature is built in to activate and deactivate the drive based on a reference signal threshold input.

SAVE TIME

To reduce start-up time, a built in SMART™ start menu allows you to program the basic drive operational settings without having to go through the entire menu of adjustments. This simplifies commissioning and reduces training.

1336 PLUS II SOLUTION

The 1336 PLUS II drive family is a time-tested solution that offers the flexibility of an 18-pulse solution as well as a variety of passive filters to resolve many tough harmonic requirements. Starting from 50 hp at 480 volt and 600 volt applications, the 1336 PLUS II family can meet your application needs and match your installed base.

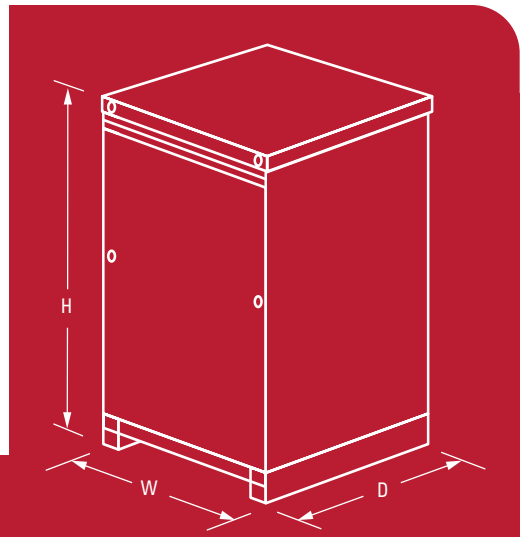
LOWER YOUR ENERGY COSTS WHILE BOOSTING PERFORMANCE

Low Voltage 18 pulse drives from Rockwell Automation utilize a Patented autotransformer designs that reduce size and heat loss while improving overall efficiency and system performance. These low harmonic drive solutions include all the features and benefits of our standard drive package, including: Flying start (for applications requiring starting into spinning motors), a built in PI function providing closed loop set point control without additional hardware, built in economizer feature automatically adjusting the output voltage to the motor during light load conditions, reducing power usage.

Common interface modules and control boards reduce inventory needs and training requirements. All programming can be accomplished through an intuitive human interface module with an easy to read illuminated LCD display. Custom engineered features can be added to customize the drive to your application including lightening arrestors, motor protection relays, solid state bypass, Resistance Temperature Detector (RTD) monitor, moisture monitoring relays, NEMA 4/4X and NEMA 12 configurations.

IMPROVE YOUR POWER QUALITY THROUGH BETTER MONITORING

The Powermonitor™ 3000 family is a cost-effective, compact, revenue accurate microprocessor meter for monitoring power quality and collecting energy usage data. This meter is capable of providing real-time continuous IEEE-519 compliance verification which can be communicated via RS-232, RS-485, DeviceNet™, Remote I/O, EtherNet/IP™ or ControlNet™.



ENCLOSURE DIMENSIONS

STAND ALONE ENGINEERED PACKAGED LOW VOLTAGE AC DRIVE DIMENSIONS

STANDARD[3] 18 PULSE DIMENSION CHART FOR NEMA 1, MCC (STYLE) ENCLOSURE PACKAGE WITH INTEGRATED AUTOTRANSFORMER

Rating	1336 family		PowerFlex 700 family						Heat Loss[2]
HP	Constant Torque		Variable Torque		Heavy Duty (150% for one minute)		Normal Duty (110% for one minute)		Approximate
	Frame	Dimensions (inches)	Frame	Dimensions (inches)	Frame	Dimensions (inches)	Frame	Dimensions (inches)	Watts
40	C [1]	91.5H X 30W X 30.21D	C [1]	91.5H X 30W X 30.21D	3 [1]	91.5H X 25W X 25D	3 [1]	91.5H X 25W X 25D	1201
50	C [1]	91.5H X 30W X 30.21D	C [1]	91.5H X 30W X 30.21D	4 [1]	91.5H X 30W X 25D	3 [1]	91.5H X 25W X 25D	1501
60	C [1]	91.5H X 30W X 30.21D	C [1]	91.5H X 30W X 30.21D	5 [1]	91.5H X 35W X 25D	4 [1]	91.5H X 30W X 25D	1802
60	D	91.5H X 55W X 30.21D							1802
75	D	91.5H X 55W X 30.21D	D	91.5H X 55W X 30.21D	5 [1]	91.5H X 35W X 25D	5 [1]	91.5H X 35W X 25D	2252
100	D	91.5H X 55W X 30.21D	D	91.5H X 55W X 30.21D	6 [1]	91.5H X 35W X 25D	5 [1]	91.5H X 35W X 25D	3003
125	D	91.5H X 55W X 30.21D	D	91.5H X 55W X 30.21D	6 [1]	91.5H X 35W X 25D	6 [1]	91.5H X 35W X 25D	3753
150	D	91.5H X 55W X 30.21D	D	91.5H X 55W X 30.21D	6 [1]	91.5H X 35W X 25D	6 [1]	91.5H X 35W X 25D	4504
150	E	91.5H X 70W X 30.21D			9	91.5H X 65W X 25D			4504
200	E	91.5H X 70W X 30.21D	E	91.5H X 70W X 30.21D	9	91.5H X 65W X 25D	6 [1]	91.5H X 35W X 25D	6005
200							9	91.5H X 65W X 25D	6005
250	E	91.5H X 70W X 30.21D	E	91.5H X 70W X 30.21D			9	91.5H X 65W X 25D	7507
250	F/J	91.5H X 65W X 35D			10	95.5H X 65W X 25D			7507
300	F/J	91.5H X 65W X 35D	F/J	91.5H X 65W X 35D	10	95.5H X 65W X 25D	10	95.5H X 65W X 25D	9008
350	F/J	91.5H X 65W X 35D	F/J	91.5H X 65W X 35D	10	95.5H X 65W X 25D	10	95.5H X 65W X 25D	10509
400	F/J	91.5H X 65W X 35D	F/J	91.5H X 65W X 35D	11	95.5H X 90W X 25D	10	95.5H X 65W X 25D	12011
450	F/J	91.5H X 65W X 35D	F/J	91.5H X 65W X 35D	11	95.5H X 90W X 25D	10	95.5H X 65W X 25D	13512
500	J	91.5H X 90W X 25D	J	91.5H X 90W X 25D	11	95.5H X 90W X 25D	11	95.5H X 90W X 25D	15013
600	J	91.5H X 90W X 25D	J	91.5H X 90W X 25D	12	Consult Factory	11	95.5H X 90W X 25D	18016
700	J	Consult Factory	J	Consult Factory	12	Consult Factory	12	Consult Factory	21019
800	J	Consult Factory	J	Consult Factory	13	Consult Factory	12	Consult Factory	24021

[1] *Indicates that bottom conduit access may be limited or not available. (Standard conduit access is top in, bottom out.)*

[2] *Estimated heat loss is approximate for drive and converter, excluding any special options.*

[3] *Dimensions provided are for Standard Packaged units ONLY. Any deviation will change the size. Please contact the factory or your local authorized Allen-Bradley distributor for new dimensions. Standard 18-Pulse drives includes: Inverter, Converter, 18-Pulse Diode Bridge with Autotransformer, Input Line Reactor, Circuit breaker and Fuses or Fused Disconnect.*

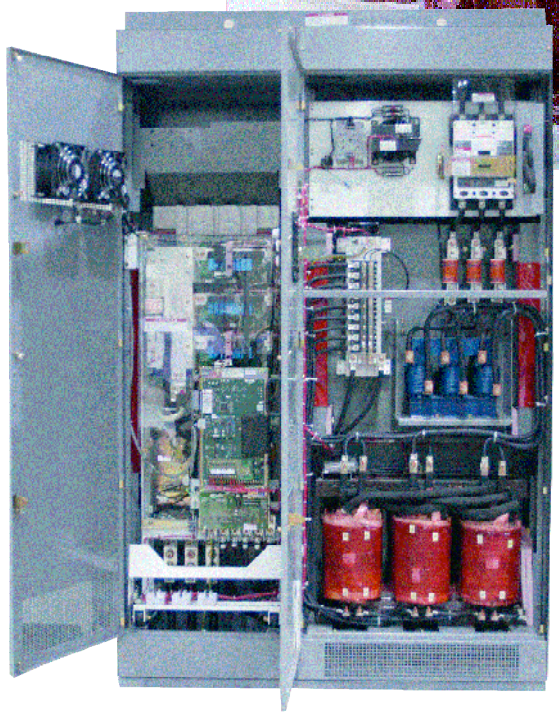
Note: *PowerFlex 700 H Frames 10,11 and 12 dimensions include a 4 inch exhaust vent riser making the cabinet height 95.5" tall.*

LOW VOLTAGE

MOTOR CONTROL CENTER HARMONIC SOLUTIONS

REDUCE YOUR INSTALLATION COSTS AND TIME

The MCC drive package features a full-rated continuous horizontal bus, and an innovative small footprint. By maximizing critical floor space, the drive package is ideal for new retrofit needs. The larger horsepower drive packages feature an exclusive roll-out design for ease of installation and servicing helping to reduce installation costs and time. The Allen-Bradley CENTERLINE® Motor Control Center (MCC) 18-Pulse drive package uses a standard Allen-Bradley® 1336 PLUS II design with the front end replaced by a separate 18-Pulse converter bridge and phase shifting autotransformer.



ADD VALUE TO YOUR INVESTMENT

- Patented phase shifting autotransformer design
- NEMA 1 rated with ventilation
- Available 40-250 HP at 480 Volts
- Diode converter bridge
- Manual bypass available (additional space required)

MEET YOUR MCC NEEDS

- Meets IEEE 519-1992 at the drive input terminals
- UL/cUL listed meeting industry standards
- Industry exclusive design includes horizontal power bus and compact roll-out drive (75-250 HP) design for ease of installation and servicing
- As required, active filters can be packaged into a Motor Control Center line-up

ENCLOSURE DIMENSIONS

NEMA 1, MCC LOW VOLTAGE ENGINEERED 18-PULSE PACKAGED DRIVE DIMENSIONS[1]

HP	Constant Torque		Variable Torque	
	Frame	Dimensions (inches)	Frame	Dimensions (inches)
40	C	90H X 45W X 20D	C	90H X 45W X 20D
50	C	90H X 45W X 20D	C	90H X 45W X 20D
60	C	90H X 45W X 20D	C	90H X 45W X 20D
75	D	90H X 50W X 20D	D	90H X 50W X 20D
100	D	90H X 50W X 20D	D	90H X 50W X 20D
125	D	90H X 50W X 20D	D	90H X 50W X 20D
150	E	90H X 55W X 25D	D	90H X 50W X 20D
200	E	90H X 55W X 25D	E	90H X 55W X 25D
250	E	90H X 60W X 25D	E	90H X 60W X 25D

[1] *Dimensions provided are for Standard Packaged units ONLY. Any deviation will change the size. Please contact the factory or your local authorized Allen-Bradley distributor for new dimensions. Standard 18-Pulse drives includes: Inverter, Converter, 18-Pulse Diode Bridge with Autotransformer, Input Line Reactor and Circuit breaker. Does not include an active filter.*

MEDIUM VOLTAGE

HARMONIC SOLUTIONS

POWER QUALITY WITH THE PowerFlex® 7000…

LOWER YOUR LINE HARMONICS SIMPLY AND EASILY

Reducing line side harmonics helps protect your facility's power quality. The PowerFlex 7000 Medium Voltage drive has several solutions to address harmonic concerns without increasing component count or complexity. The latest evolution of the PowerFlex 7000 Medium Voltage AC drive includes active front-end and "Direct-to-Drive" technology, allowing you to connect utility power directly to the drive without an isolation transformer. The Direct-to-Drive Active Front End rectifier uses semiconductor switching to reduce line current harmonic levels that comply with IEEE standards. This technology reduces the drive size, helps lower installation costs, increases energy savings, and provides a commonality in spare parts.

YOUR FACILITY DEPENDS ON IT…

COMPATIBLE WITH STANDARD MOTORS WITHOUT DERATING

The PowerFlex 7000 third generation Medium Voltage Drive delivers quality power with near sinusoidal output current and voltage waveforms at many speeds and loads. Standard induction or synchronous motors are compatible without derating. Best of all, inverter duty motors are not required.

REDUCE ADDITIONAL HEATING AND VOLTAGE STRESS TO MOTOR

In addition to mitigating Common Mode Voltage, The PowerFlex 7000 with Direct-to-Drive technology does not generate dv/dt or Reflected Wave Voltage Stress on Motors. This means that your motor investment will be protected with increased longevity.

INCREASE MOTOR CABLE DISTANCE

High switching frequencies can limit motor cable distances. With Rockwell Automation's technology you can control the motor from as far away as almost 50,000 feet. As a result, you get control when and where you need it.

QUIET, SMOOTH OPERATION

Quality voltage and current waveforms result in less audible noise when connected to this drive compared to across-the-line operation, creating a healthier, more productive environment.

HARMONIC MITIGATION AND COMPLIANCE

APPLICATION GUIDELINES

1 Take time to understand the benefits and drawbacks of each type of mitigation solution to assure you meet the requirements of the application and that you can live with any negative effects created by the chosen harmonic solution.

2 Perform a preliminary harmonic analysis on your system and explore the effects of using various harmonic mitigation methods.

3 Identify the required Point of Common Coupling (PCC) and apply most cost-effective mitigation techniques for that application.

4 Add a line reactor (or DC link choke if possible) to all unbuffered 6-pulse drives.

5 Never use power factor correction capacitors at the input (or output) of a drive, or in parallel with passive filters.

6 For passive filters on generator power, select a filter with a dropout contactor terminal block for the filter capacitors. This will limit the leading power factor at no-load operation.

7 For an even number of equally sized drives, consider a pseudo 12-pulse solution by placing half of the load of a phase shifting delta-wye (delta-star) transformer.

8 Design the system to isolate linear and non-linear loads and create two systems with 5% and 10% voltage distortion limits.

9 If the application requires regenerative operation and harmonic compliance, consider an active front-end.
J Consider use of an active filter on a multiple drive system or MCC lineup to correct for harmonic distortion.

HARMONIC MITIGATION SOLUTIONS CHECK-LIST

✓ *Good* ? *Need to confirm application* X *May not meet IEEE 519-1992 Standards*

	6-Pulse Drive		18-Pulse Drive		Passive Filter		Active Filter		Active Front-End	
Typical Current Harmonic Distortion (ITHD)	20 - 45%		4.5 - 6%		5 - 8%		3 - 5%		3 - 5%	
Meet IEEE Special Applications	No	X	Yes	✓	Marginal		Yes	✓	Yes	✓
Meet IEEE General Applications	No	X	Yes	✓	Yes	✓	Yes	✓	Yes	✓
Meet IEEE Dedicated Applications	Yes	✓	Yes	✓	Yes	✓	Yes	✓	Yes	✓
Effect of 1% Voltage Unbalance	Large	X	Moderate		Minimal	✓	Minimal	✓	Minimal	✓
Potential Low DC Bus	No		No		Yes	?	No		No	
Potential System Resonance	No		No		Yes	?	No		No	
Typical Total Power Factor, no/full load	0.75 - 0.95		0.90 - 0.99	✓	0.3 - 1 lead	?	0.90 - 0.99	✓	0.8 - 1 lead	
Efficiency	97%	✓	96.5%	✓	96.5%	✓	96%		96 - 97.5%	✓
Cost Effective	Good	✓	>150 HP	✓	<150 HP	✓	Lg. System		Regen, MV	
Overall Size (Relative to 6-Pulse Drive)	1.0		3.3		2 - 6		3.5 - 5		1.5 - 2.5	✓
Reliability	High	✓	High	✓	Medium		Medium		Medium	

For further information: **http://www.ab.com/drives/custom_configured/harmonic_mitigation.html** or **http://www.ab.com/drives/techpapers/page8.htm**

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