

# PowerFlex™ 7000

POWERFUL  
PERFORMANCE

FLEXIBLE  
CONTROL



*Allen-Bradley*

## Reliability Starts Here.

PowerFlex™ 7000  
Family of MV Drives



**Rockwell  
Automation**



# PowerFlex™ 7000

## Your success depends on it.

### Superior Evolution

As products evolve and technology advances, our customers demand drives that are more cost effective, more reliable, simpler to use and easier to maintain. Rockwell Automation has met these demands with the PowerFlex™ 7000 medium voltage AC drives by building upon the experience of the world's largest installed base of medium voltage drives, proven power semiconductor technology, and commonality across the PowerFlex™ Family of Drives.

### Superior Reliability

Most medium voltage drives commonly control the very heartbeat of an industrial process. Reliability is not simply a wish, it is a demand. That's why the PowerFlex™ 7000 uses advanced medium voltage symmetrical gate commutated thyristor power semiconductors with an integrated gate drive to reduce the unit's component count to the lowest of any medium voltage drive available – to give you the utmost in reliability.





## Lower Total Cost of Ownership

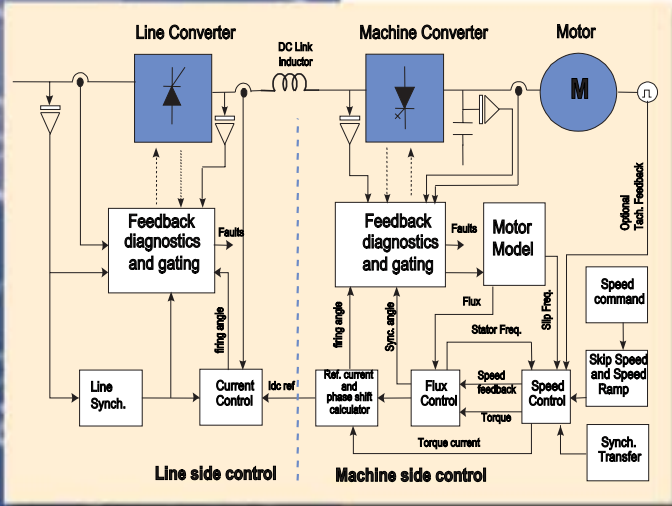
Cost-effective ownership of a medium voltage drive extends far beyond the initial purchase price. It spans the entire life of the unit and includes every aspect of its operation and upkeep. PowerFlex™ 7000 makes saving time and money a reality right from the start with features like pre-programmed parameters that are set at the factory for your specific application. Lengthy installation and commissioning cycles, can now be reduced to just a few hours. The advanced power components in the PowerFlex™ 7000 also translate to savings by enabling a reduction in component count and a more reliable drive, meaning less downtime and fewer spare parts for your stockroom.

## Ease of Use

From start to finish the PowerFlex™ 7000 drive was designed to be easier to commission, operate and maintain. All PowerFlex™ drives feature a user-friendly operator interface with an interactive set-up wizard that guides you through the commissioning process with a series of easy-to-follow prompts. The patented\* PowerCage™ module further simplifies drive operations by enabling faster and easier power device replacement since it does not need to be removed from the drive. In a matter of minutes a new device can be installed.



# Technology so Advanced . . .



## A Simple, Reliable Power Structure

The PowerFlex™ 7000 PWM drive with 6.5-kV-rated Symmetrical Gate Commutated Thyristors (SGCT) has the fewest number of inverter switching devices of any other MV drive topology. The power structure is fuseless, inherently regenerative, and utilizes a current limiting DC link inductor. The result is a simple, rugged product with very low component count, and optimum reliability.

## Sensorless Direct Vector Control

Sensorless direct vector control measures motor flux rather than predicting it. The motor torque can be changed quickly without affecting motor flux, similar to a DC machine. This control method provides superior performance over standard volts-per-hertz type drives. Full vector control with tachometer feedback is also available for applications running continuously below six hertz.

## SGCT - The Ideal Power Semiconductor Switch for MV Drives

The Symmetrical Gate Commutated Thyristor with integrated gate drive, high switching frequency, and double-sided cooling is an ideal power semiconductor switch for MV drive applications. A Pulse Width Modulation (PWM) switching pattern for the SGCTs is optimized for the lowest possible conduction and switching losses, resulting in a compact and efficient inverter design. The unique characteristics of the SGCT and the PowerFlex™ 7000 topology make it possible to cost effectively apply this versatile component into both the PWM inverter and PWM rectifier.



## Power Semiconductor Comparisons

	MV SGCT	MV GTO	MV IGBT	MV IGCT	LV IGBT
Conduction Losses	Low	Low	High	Low	Medium
Switching Losses	Low	Low	Medium	Low	Low
Switching Frequency	High	Low	High	High	High
PIV Rating (Volts)	6500	6500	3300	6500	1700
Gate Drive	Integral	Separate	Synchronized with IGBT	Integral	Synchronized with IGBT
Failure Rate	Low	Low	High	Low	Low
Failure Mode	No-rupture, no-arc	No-rupture, no-arc	Rupture, arc	No-rupture, no-arc	Rupture, arc
Cooling	Double sided	Double sided	Single sided	Double sided	Single sided
Thermal Stress	Low	Low	High	Low	High
Parts Count	Low	Medium	Medium-High	Medium-High	Very High



## . . . it's Simple.

### Innovative PowerCage™ \*

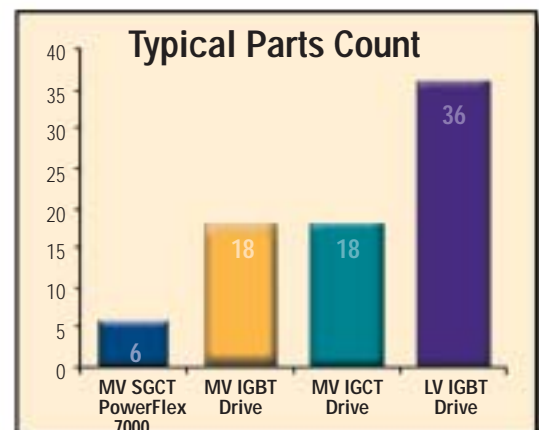
At the heart of the PowerFlex™ 7000 drive is an innovative PowerCage™ that houses the main power components in a compact, modular package. The Air Cooled design uses an advanced heatsink design that works in conjunction with a high pressure air flow pattern to ensure high efficiency heat transfer and reduction of thermal stress. On the Liquid Cooled design an innovative chillblock is used to transfer the heat. Both cooling technologies use the same PowerCage design. These unique arrangements means that components can be replaced without removing the PowerCage™ and without any special tools in less than five minutes. The PowerCage™ - just another example of higher reliability, ease of use and lower total cost of operation.

### Low Parts Count

The PowerFlex™ 7000 requires only six inverter SGCTs (@2300V). Other drives require anywhere from 18 to 36 power semiconductor switches if IGBTs or IGCTs are used. The superior characteristics of the SGCT combined with the fewest number of components makes the PowerFlex™ 7000 drive inherently more reliable.



**Best Components x Fewest Components = Highest Reliability**



\* Patent Pending

# PowerFlex™ 7000 MV Drives The Choice is Simple...

“B” Frame

“A” Frame



- A** PowerCage™ modules on the rectifier and inverter reduce manufacturing time and allow easy access to main power components for quick replacement.
- B** 6.5 kV SGCT power semiconductors have the best overall characteristics including low parts count, high reliability, low losses, and wide KVA range.

# "C" Frame



**C** **Operator interface Terminal** with large 16-line, 40 character LCD display includes a set-up wizard for easy commissioning, monitoring, and troubleshooting.

**D** **Easy access** to line and load cable terminations. Top and bottom cable direction is accommodated as standard.

**E** **Rugged DC link inductor** limits fault current and eliminates nuisance trips.

**F** **A compact enclosure**, with front access to all components, saves on valuable floor space in new and retrofit installations.

**G** **Temperature sensing** and feedback on rectifier and inverter modules provide early warning of overtemperature conditions

**H** **Common Control Boards** Identical line and machine side control boards used for asynchronous and synchronous drives.

- Floating point Digital Signal Processors (DPS) For high speed
- internal processing
- Field Programmable Gate Arrays (FPGA) used for high speed diagnostics and fault handling.
- External I/O with 16 digital inputs and 16 digital outputs.
- Customer Interface Board communicates via DPI or SCANPort. Available with RS-232/485 serial interface, DeviceNet, ControlNet, or Remote I/O.

**I** **Integral cooling fan** provides efficient heat transfer from power components.

**J** **Integral Pumping Cabinet** Closed loop coolant system

- liquid ethyl-glycol de-ionized water mixture
- low conductivity
- 90% of VFD losses expelled to the atmosphere

**K** **Liquid Cooled Powercage** design incorporates same concept as air cooled drive for front access, easy component replacement, and no special tools.

**L** **Coolant Pumps** Redundant pumping system with automatic change over on pump failure

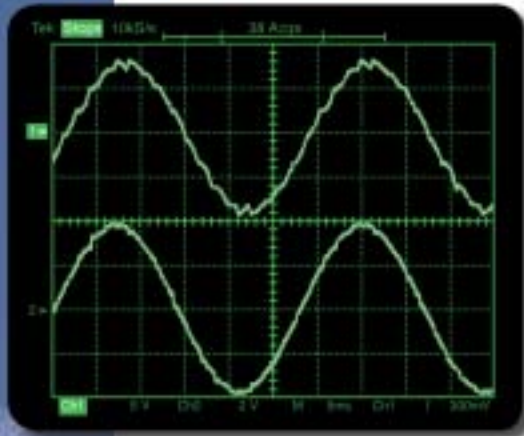
**M** **De-ionizer cartridge** includes replaceable filter

**N** **Integral DC Link inductor** liquid cooled for optimum size reduction and maximum efficiency

# Power Quality . . .

## Lower Line Harmonics without Increasing Complexity

Most MV drives on the market today attempt to reduce line side harmonics by increasing the rectifier pulse number through parallel rectifiers and phase shifting transformers. These drives have a higher component count, higher complexity and higher number of connections from the transformer to the drive. The PowerFlex™ 7000 MV drive has several solutions that meet IEEE 519-1992 Harmonic Guidelines without increasing component count or complexity.



Input Waveforms with 18-Pulse Rectifier:  
Line current (top),  
Line voltage (bottom),  
4160V, 933 kW, 60 Hz

## 6-Pulse Rectifier with Optional Harmonic Filter

The 6-pulse rectifier with an optional harmonic filter is the most economical solution for harmonic reduction. It is ideal for installations where the drive is a small percentage of total plant load. The 6-pulse rectifier is also available with an AC line reactor for new motor applications.

## 18-Pulse Rectifier

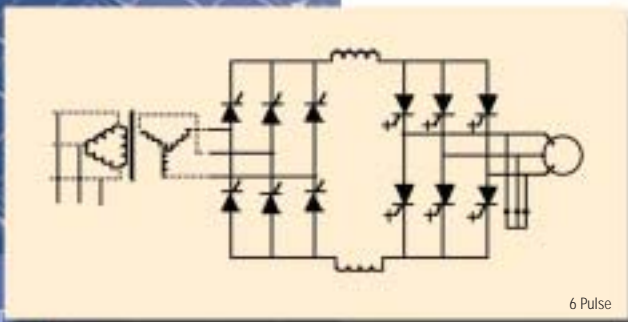
The 18-pulse rectifier in the PowerFlex™ 7000 meets IEEE 519-1992 Harmonic Guidelines at the primary of the drive isolation transformer. Low complexity, high system efficiency, and ease of use is maintained with series rectifiers and only three secondary windings on the transformer.

## PWM Rectifier

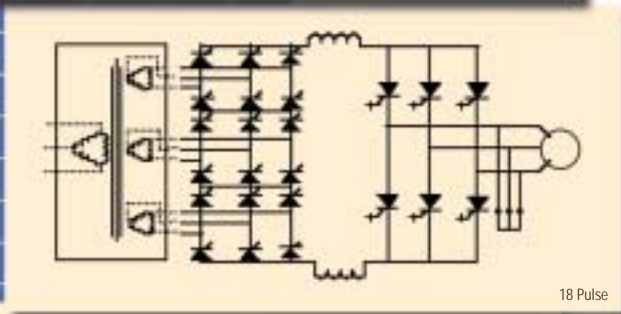
The PWM rectifier meets IEEE 519-1992 Harmonic Guidelines, provides near unity power factor, and optimizes drive performance. This power quality solution is available with an AC line reactor or isolation transformer, resulting in maximum flexibility.

## Elimination of the Drive Isolation Transformer

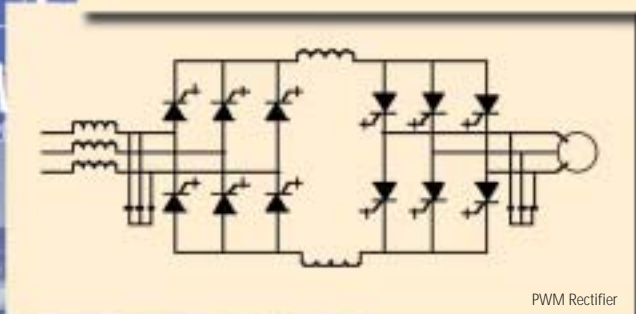
Elimination of the Drive Isolation Transformer on 6-Pulse and PWM rectifier designs for new motor applications results in the ultimate drive solution guaranteeing a high system efficiency, a small footprint, and a reduced total cost of operation.



6 Pulse



18 Pulse



PWM Rectifier



# ... We know Your reputation depends on it.

## Compatible with Standard Motors without Derating

Motor-friendly waveforms have been the trademark of Allen-Bradley MV drives since 1990. The PowerFlex™ 7000 third generation MV drive is no exception with near sinusoidal output current and voltage waveforms at all speeds and loads. Standard induction or synchronous motors are compatible without derating. Inverter duty motors are not required.

## No Additional Heating or Voltage Stress to Motor Insulation Compared to Fixed Speed Operation

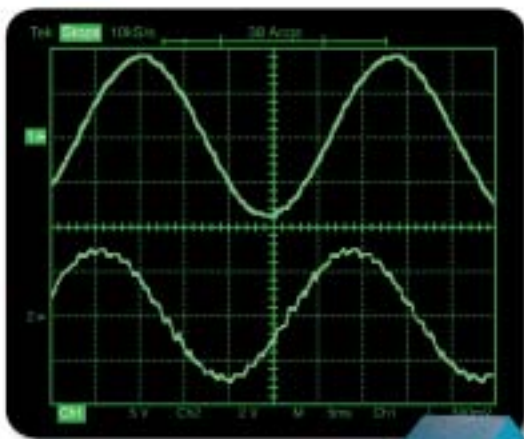
The PWM switching pattern in the PowerFlex™ 7000 serves to reduce all of the harmonics going to the motor, especially at lower operating frequencies. The PWM works in combination with a small integral capacitor to reduce the large order harmonics at higher frequencies. The end result is... no additional motor heating or voltage stress to motor insulation compared to fixed speed operation.

## Virtually Unlimited Motor Cable Distance

While some variable frequency drives have limitations in motor cable distance due to high switching frequencies or capacitive coupling, the cable distance with the PowerFlex™ 7000 is virtually unlimited. This technology is capable of controlling motors as far away as 15 kilometers from the drive.

## Quiet, Smooth Motor Operation

You will be impressed by how quiet and smooth your motor operates with the PowerFlex™ 7000 drive. The quality of the voltage and current waveforms results in very low audible noise. In fact, your motor will operate with less audible noise connected to this drive than across-the-line operation. Just one more reason why the PowerFlex™ 7000 drive is best suited for your medium voltage motors.



Motor waveforms @ full load and full speed:  
Motor current (top),  
Motor voltage (bottom),  
4160V, 933 kW, 60 Hz



# Easy to use Operator Interface

## PowerFlex™ 7000 Operator Interface Terminal

16-line, 40-character display in the menu driven screens for performing various drive operations such as set-up, monitoring, and troubleshooting.

Membrane keypad includes function keys, cursor selection keys, and number keys for menu navigation, item selection and data entry.

Standard operator device cluster includes, start, stop, and emergency stop pushbuttons, local/remote selector switch and local speed potentiometer.

## Welcome to the PowerFlex™ 7000 Set-up Wizard

Everything about the PowerFlex™ 7000 operator interface terminal is user friendly right from the greeting on the opening screen. The terminal is designed for the greatest ease of use for start-up, monitoring and troubleshooting. The set-up wizard helps the user to set the required parameter menus by asking questions or prompting selections for desired operation. Warnings and comments appear complete with help text to keep the user on the right track. The set-up wizard combined with the auto-tuning feature allows the drive to be tuned to the motor and load as quickly and accurately as possible, resulting in fast start-ups, smooth operation, and less down time.

## Large Text and Graphic Display Area

The operator interface terminal features a 16-line, 40-character, LCD display that makes text and graphics easy to read. Bar chart meters are configurable for common process variables including speed, voltage and load.

## Drive Identity Module Pre-loads Order Data

A drive identity module, unique to every PowerFlex™ 7000 drive, captures order data from our automated business systems. The order data provides information to the drive firmware about specific drive hardware and application details. This results in less set-up time at the factory and at the end site, saving you time and money.



# PowerFlex™ 7000 MV Drive Family



## PowerFlex 7000 "A" Frame

- Low end power range, 150-900 kW (200-1200hp)
- 2400 to 6600V nominal supply voltage ratings
- Air cooling
- Compact packaging for smallest footprint requirements
- Three input configurations for optimum installation flexibility:
  - 1) Base drive with provision for connecting to indoor or outdoor transformer
  - 2) Base drive with integral isolation transformer
  - 3) Base drive with integral line reactor and input starter
- Normal duty service rating for variable torque loads
- Two rectifier types:
  - 1) PWM rectifier (active front end) for low line harmonics, high power factor and commonality of parts
  - 2) Basic 6 pulse rectifier for the lowest cost solution
- 3 Cables in / 3 cables out for lower installation costs



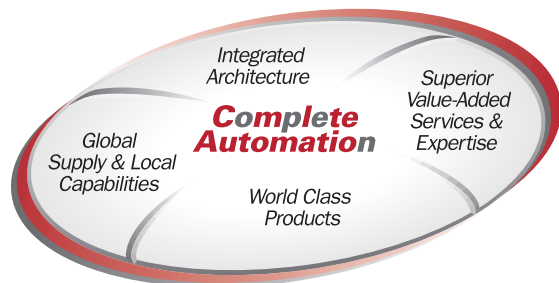
## PowerFlex 7000 "B" Frame

- Low and Medium power range, 150-4100 kW (200-5500hp)
- 2400 to 6600V nominal supply voltage ratings
- Air cooling
- Small footprint for medium power range
- Normal duty service rating (for variable torque loads, 110% overload for 1 minute every 10 minutes)
- Heavy duty service rating (for constant torque loads, 150% overload for 1 minute every 10 minutes)
- Three rectifier types:
  - 1) PWM rectifier (active front end) for low line harmonics, high power factor and commonality of parts
  - 2) 18 Pulse rectifier for low line harmonics and connection to a high voltage distribution system
  - 3) Basic 6 pulse rectifier for the lowest cost solution
- 3 Cables in / 3 cables out (6 pulse and PWM rectifier)
- 9 Cables in / 3 cables out (18 pulse rectifier)



## PowerFlex 7000 "C" Frame

- High end power range, 2240-6770 kW (3000-9000hp)
- 4160 to 6600V nominal supply voltage ratings
- Closed loop liquid cooling system with liquid to air or liquid to liquid style heat exchangers
- Small integrated package for high end power range
- Normal duty service rating (for variable torque loads, 110% overload for 1 minute every 10 minutes)
- Heavy duty service rating (for constant torque loads, 150% overload for 1 minute every 10 minutes)
- Two rectifier types:
  - 1) PWM rectifier (active front end) for low line harmonics, high power factor and commonality of parts
  - 2) 18 Pulse rectifier for low line harmonics and connection to a high voltage distribution system
- 3 Cables in / 3 cables out (PWM rectifier)
- 9 Cables in / 3 cables out (18 pulse rectifier)



The Powerflex™ 7000 is a world-class product that will help to provide you with a single solution for virtually all of your Medium Voltage speed control requirements. Its common design and control interface functions with the rest of the PowerFlex™ family of drives will help save you time and money in set-up, integration, and maintenance of your automation system.

For Allen-Bradley Drives support, there are specialists at locations across North America and around the world. We also offer Global Technical Services, specializing in a full spectrum of value-added services and expertise to help simplify maintenance and enhance productivity.

Rockwell Automation is committed to helping you meet ever-changing customer demands for more, less expensive product in less time. Our capabilities enable us to become your "Complete Automation™" partner.

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DeviceNet is a trademark of the Open DeviceNet Vendor Association.

ControlNet is a trademark of ControlNet International, Ltd.

## Specifications

Design Standards	CSA, UL, IEC, IEEE, NEMA, ANSI
Inverter Type	PWM
Inverter Switch	Symmetrical Gate Commutated Thyristor (SGCT)
Power Rating	150-6700 kW (200-9000 hp)
Motor Type	Asynchronous, Synchronous
Input Voltage Tolerance	+/- 10% of Nominal Line Voltage
Input Frequency	50 / 60 Hz, +/- 10%
Output Voltage Rating	0 - 2300, 0 - 3300, 0 - 4160, 0 - 6600
Output Frequency	0 - 75 Hz
Output Waveform	Near Sinusoidal Current & Voltage
Rectifier Designs	6 Pulse, 18 Pulse, PWM
Input Protection	Metal Oxide Varistors
Efficiency	> 98.0%
Availability	> 99.9%
Modulation Technique	Pulse Width Modulation (PWM) / Selective Harmonic Elimination (SHE)
Control Method	Sensorless Direct Vector (Full Vector Control Optional)
Tuning Method	Automatic Self-Tuning Control
Overload Capability	110% - 1 Minute / 150% - 1 Minute
Speed Regulation	0.1% Open Loop 0.01% with Shaft Encoder
Operator Interface	40-Character / 16-Line LCD
Analog Inputs	(1) Isolated, (1) Non-isolated 4 - 20 Ma / 0 - 10V
Analog Outputs	(1) Isolated, (7) Non-isolated 4 - 20 Ma / 0 - 10V
External I/O	16 Digital Inputs / 16 Digital Outputs
Communication Interface	RS-232, Remote I/O, DeviceNet, ControlNet
Enclosure	IEC Type IP21 (NEMA 1 with gasket)
Ambient Temp.	0 - 40° C (32 - 104° F)
Cooling	Forced air or Liquid
Relative Humidity	95% Non-condensing
Altitude	1000m (3300 feet) above sea level without derating
Paint	Powder Epoxy

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