



## TMdrive<sup>®</sup>-MVe2 Product Application Guide

Medium Voltage Multilevel IGBT Drive  
Up to 5,500 HP (5,000 kVA), 3.3 kV to 11 kV

metals

cranes

mining

testing

oil & gas

renewable  
energy

power  
generation

cement

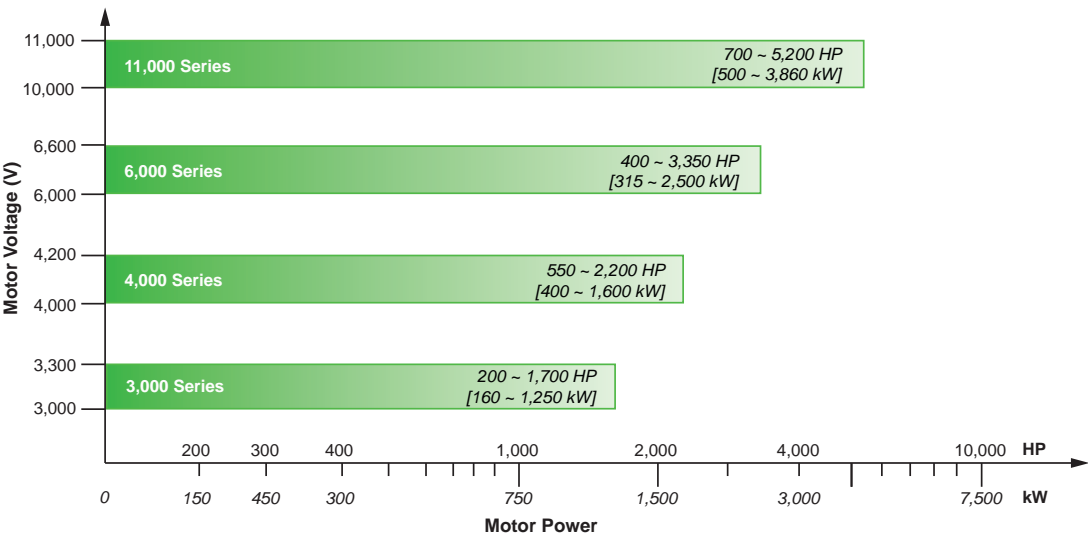
The TMdrive®-MVe2 is an enhancement to the family of TMEIC medium voltage general purpose drives offering:

- Regeneration
- Smaller footprint
- Unity line-side power factor
- Reduced part-count
- High availability



Design Feature	Customer Benefit
Active line side converter	<ul style="list-style-type: none"><li>• Unity (1.0) power factor across entire speed range</li><li>• Line side harmonics much lower than IEEE 519-2014</li><li>• Standard regenerative braking</li></ul>
Conservative electronic design & dry film-type capacitors	<ul style="list-style-type: none"><li>• Highly reliable operation, expected 16-year MTBF</li><li>• No need for periodic capacitor replacement</li></ul>
Multilevel drive output voltage waveform	<ul style="list-style-type: none"><li>• No derating of motor for voltage insulation or heating required</li><li>• Applies easily to existing motors without the need for an expensive output filter</li><li>• Eliminates the need for special VFD rated cables</li><li>• No Neutral Shift</li></ul>
Input isolation transformer with static shield included in drive package	<ul style="list-style-type: none"><li>• Simplifies design and installation</li><li>• Less total space required, plus easy integration in MCC building</li><li>• Better motor protection than transformerless design</li><li>• High frequency transients are attenuated</li></ul>
Power conversion module in a single drawer type package	<ul style="list-style-type: none"><li>• Reduction in spare parts</li><li>• Minimal personnel training for maintenance</li><li>• 30 minutes Mean Time to Repair (MTTR)</li></ul>
Synchronous bumpless transfer of the motor to the utility line	<ul style="list-style-type: none"><li>• Allows control of multiple motors with one drive</li><li>• No motor current or torque transients when the motor transitions to the AC line</li></ul>

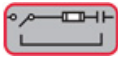
Covering a broad range of medium voltage drive applications



# A Look Inside

## Differentiating Features

- Compact design saves valuable floor space making retrofits of old equipment easier
- Compartmentalized panels provide voltage class segregation and top or bottom cable feeds
- Integral isolation transformer provides reliable operation and simplifies installation.
- Significant reduction in parts, reducing spare parts requirements



### Input Power Disconnect Option†

- A visible, bolted pressure, isolation switch offers mechanical interlocking to allow for maintenance personnel to service the drive.
- The fused (Class E rated) vacuum contactor provides critical fault current protection to the drive.

### Main Power Input

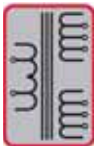
Four voltage levels are available:

- 3-3.3 kV, 3-phase, 50/60 Hz
- 4-4.16 kV, 3-phase, 50/60 Hz
- 6-6.6 kV, 3-phase, 50/60 Hz
- 10-11 kV, 3-phase, 50/60 Hz



### Internal Pre-Charge AC Reactor\*

An ac reactor and medium voltage contactor mitigate the transformer magnetizing inrush current, minimizing stress on the fusing and power components.



### Input Isolation Transformer Standard.

The input transformer has multiple secondary windings to feed IGBT inverters (cell inverters). This design provides galvanic isolation between the power system and the motor-inverter system. Electrostatic shield is standard.

### Kirk Key Interlocks†

For additional safety, Kirk key locks are provided standard on all drives.



### Filtered Air Intake

Washable input air filters have front access for periodic maintenance.

\* Available in select frame sizes

†For 4 kV drive, CSA listed in U.S. and Canada only.





## Blower Assemblies

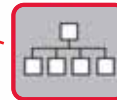
Quiet (<80 dB(A) at 1m), fans circulate air throughout enclosures pulling air from the front filter assemblies and venting it out the top of the cabinets. Redundant fan assemblies can be provided as an option.



## Control

Single 32-bit microprocessor-based control board combines several key drive functions:

- Power semiconductor gating
- Speed and torque regulation
- Motor and drive protection
- I/O mapping
- Diagnostic functions
- High speed data capture buffering
- Hosting of optional LAN interface
- Drive is configured from the TDrive-Navigator



## Communications

An optional communications card can be provided to connect the VFD to the DCS/SCADA system.



## Application Specific Controls

Each drive is matched to project requirements with custom control components.



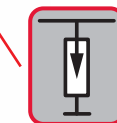
## Remote Connectivity Module Standard.

On-board Windows® based computer provides access to live variables, parameters & historical fault data.



## Power & Motor Cabling Terminations

Conveniently located power cable terminations can be accessed from the front or rear. A metal cover prevents exposure to live parts when drive is running.

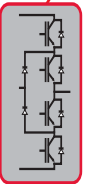


## Lightning Arrestors<sup>†</sup>

Incoming power is protected by distribution class lightning arrestors for suppression of transient surges.

## Control & Power Cables

Gland plates are provided to enable cable entry. Top and bottom entry options are selectable onsite.



## Inverter/Converter Phase-Leg Assemblies

Each modular phase leg assembly includes:

- Robust IGBTs
- Gate driver circuit board
- DC bus capacitors, dry-film type for long life
- Fiber optic link interface circuit board

A phase leg assembly can be easily racked out and replaced in 30 minutes in case of failure.



An optional lifter cart enables the operator to quickly rack-in/out the power modules.



Drawer type cell inverters shorten MTTR to 30 minutes



A convenient isolation switch kills the main power to the VFD to allow for safe servicing.



Aluminum mesh air filters can be removed and cleaned while the VFD is running.

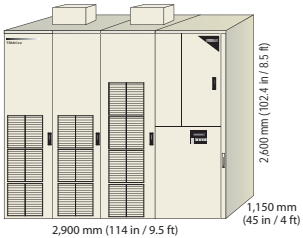
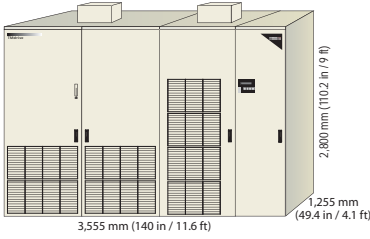
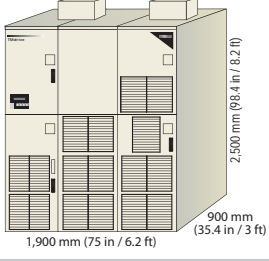
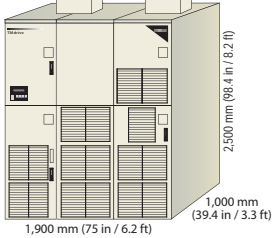
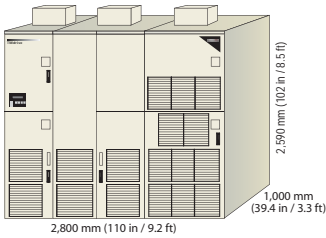
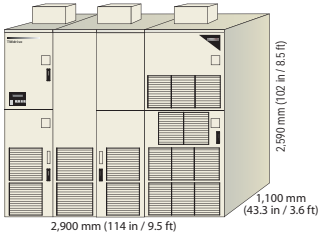
System configurations

...flexible and scalable.

The MVe2 can be applied to your process in flexible configurations.

Running duty		<p>When appropriately rated, the MVe2 can be applied for continuous duty applications providing:</p> <ul style="list-style-type: none"><li>• Speed/process control</li><li>• Quick deceleration</li><li>• Reduction in in-rush current</li><li>• Unity line side pf</li><li>• Constant/variable torque</li></ul>
Running and/or starting duty		<p>TMEIC provides integrated packing of:</p> <ul style="list-style-type: none"><li>• Industrial Control Building</li><li>• Output/Bypass Switchgear</li><li>• Motor Control Centers</li><li>• Control Systems</li></ul> <p>The MVe2 can be rated either for starting duty and/or running duty. With the appropriate switchgear lineup, the MVe2 control can automatically accelerate the connected motor to match the incoming utility voltage, frequency and phase. The load can then be bumplessly transferred to power source with no surges in torque or current. This allows for sequential starting of multiple motors with a single VFD. In a redundant arrangement, any motor can be started with either VFD, or can be configured as a hot-standby. Alternatively, the VFD can also capture the motor from the utility line and regain speed control.</p>

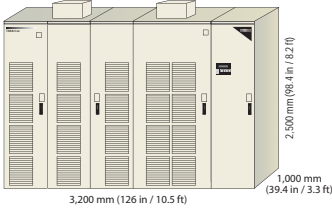
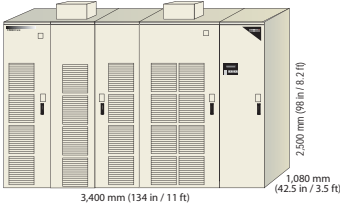
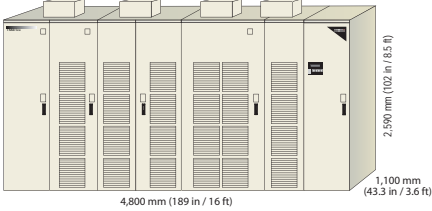
# Frame Sizes to Fit Your Application

4-4.16 kV <sup>†</sup>					
VFD Outline		Maximum Weight lbs. (kg)	Approximate Motor Shaft HP (kW) at 4.16 kV	Rated Output Current (A) 1 phase AC*	Inverter kVA output at 4.16 kV
	Frame 100	9,300 (4,218)	536 (400)	69	500
	Frame 200	9,300 (4,218)	1,085 (810)	138	1,000
	Frame 300	14,285 (6,480)	1,500 (1,120)	191	1,380
	Frame 400	14,285 (6,480)	2,145 (1,600)	262	1,890
3-3.3 kV					
VFD Outline		Maximum Weight lbs. (kg)	Approximate Motor Shaft HP (kW) at 3.3 kV	Rated Output Current (A) 1 phase AC*	Inverter kVA output at 3.3 kV
	Frame 100	8,400 (3,800)	220 (164)	35	200
			330 (246)	53	300
			440 (328)	70	400
	Frame 200	8,800 (4,000)	660 (492)	105	600
			880 (656)	140	800
	Frame 300	11,700 (5,300)	1,040 (776)	166	950
			1,200 (895)	192	1,100
	Frame 400	12,350 (5,600)	1,400 (1,044)	227	1,300
			1,650 (1,230)	263	1,500

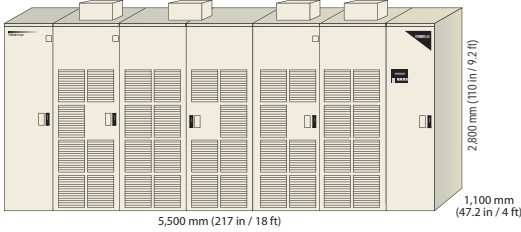
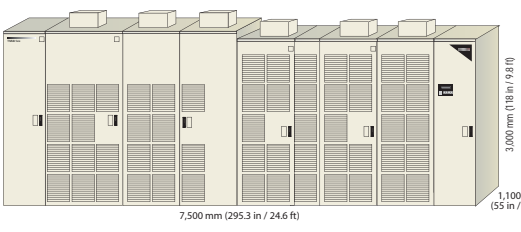
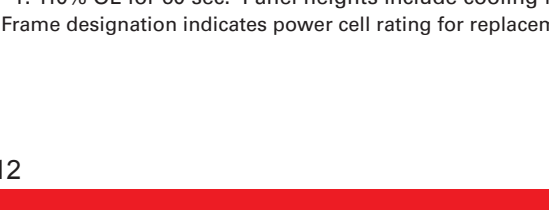
\* 1: 110% OL for 60 sec. Panel heights include cooling fans. VFD capable of 80% regeneration at nominal voltage at unity power factor.

<sup>†</sup> Applicable for CSA listed VFD in U.S. and Canada. Frame designation indicates power cell rating for replacement parts and other purposes.

# Frame Sizes to Fit Your Application

6-6.6 kV					
VFD Outline		Maximum Weight lbs. (kg)	Approximate Motor Shaft hp (kW) at 6.6 kV	Rated Output Current (A) I phase AC*	Inverter kVA output at 6.6 kV
	Frame 100	8,400 (3,800)	440 (328)	35	400
			660 (490)	53	600
			880 (656)	70	800
	Frame 200	10,360 (4,700)	1,320 (985)	105	1,200
			1,760 (1,312)	140	1,600
	Frame 300	15,000-15,800 (6,750-7,150)	2,085 (1,555)	166	1,900
			2,400 (1,790)	192	2,200
	Frame 400	15,000-15,800 (6,750-7,150)	2,850 (2,126)	227	2,600
			3,300 (2,460)	263	3,000

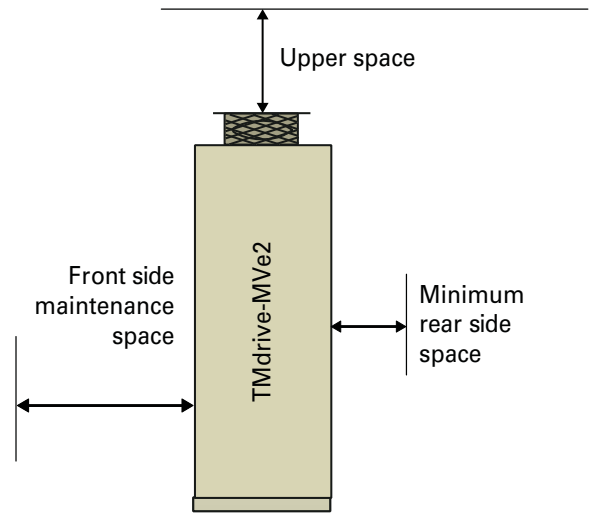
\* 1: 110% OL for 60 sec. Panel heights include cooling fans. VFD capable of 80% regeneration at nominal voltage at unity power factor. Frame designation indicates power cell rating for replacement parts and other purposes.

10-11 kV					
VFD Outline		Maximum Weight lbs. (kg)	Approximate Motor Shaft HP (kW) at 11 kV	Rated Output Current (A) I phase AC*	Inverter kVA output at 11 kV
	Frame 100	16,500 - 17,600 (7,800 - 8,000)	700 (522)	35	660
			1,100 (820)	53	990
			1,400 (1,044)	70	1,320
	Frame 200	16,500 - 17,600 (7,800 - 8,000)	2,200 (1,640)	105	2,000
			2,900 (2,160)	139	2,640
	Frame 300	29,500 - 29,800 (13,350 - 13,500)	3,400 (2,536)	162	3,080
			4,000 (2,984)	191	3,630
	Frame 400	29,500 - 29,800 (13,350 - 13,500)	4,700 (3,500)	226	4,290
			5,500 (4,100)	263	5,000

\*1: 110% OL for 60 sec. Panel heights include cooling fans VFD capable of 80% regeneration at nominal voltage at unity power factor. Frame designation indicates power cell rating for replacement parts and other purposes.

## Cabinet Minimum Clearance Space

Drive	Frame	Front Side Space	Rear Side Space	Upper Space
3-3.3 kV class	1, 2	1,700 mm (5.6 ft / 67 in)	—	300 mm (1 ft / 11.8 in)
	3, 4	1,700 mm (5.6 ft / 67 in)	—	210 mm (0.68 ft / 8.3 in)
4-4.16 kV class	1, 2, 3, 4	1,700 mm (5.6 ft / 67 in)	—	220 mm (0.72 ft / 8.7 in)
6-6.6 kV class	1, 2	1,700 mm (5.6 ft / 67 in)	—	300 mm (1 ft / 11.8 in)
	3, 4	1,700 mm (5.6 ft / 67 in)	—	210 mm (0.68 ft / 8.3 in)
10-11 kV class	1, 2	1,900 mm (6.2 ft / 75 in)	1,000 mm (3.3 ft / 40 in)	300 mm (1 ft / 11.8 in)
	3, 4	1,900 mm (6.2 ft / 75 in)	1,000 mm (3.3 ft / 40 in)	210 mm (0.68 ft / 8.3 in)



## Application Notes

- Inverter Power (kVA) =  $\frac{\text{Motor Shaft Power (kW)}}{\text{Motor pf} \times \text{Motor Eff}}$   
 Rated Output Current =  $\frac{\text{Inverter Power (kVA)}}{1.732 \times \text{Motor Voltage}_{(L-L)}}$ 
  - Ratings based on motor pf = 0.87, Motor Eff = 0.94, ambient temperature is 32°F–104°F (0°C–40°C)
  - Ratings based on a variable torque load (fans, pumps, centrifugal compressors)
  - For constant to secure load consult TMEIC.
  - Altitude above sea level is 0-3300 ft (1-1000 m).
- Optional bypass circuit can be separately mounted.
- Redundant cooling fans available as an option.
- No rear access required except for 10-11 kV VFDs or 13.8 kV VFDs.
- Incoming power cabling and motor cabling are bottom entry, top entry is standard for CSA design, option for IEC
- Air is pulled through the filters in the cabinet doors and vented out top.
- Available options include motor cooling fan control, cabinet space heater, sync motor control, smooth transfer to and from utility, motor space heater control, RTD, monitor redundant fans, output sine wave filters, and others.
- For conservative sizing of HVAC equipment, use 3kW of heat rejection per 100 hp of motor power.
- The panels include channel bases attached to the cabinets before shipment.
- This table presents only a sample of voltages and horsepower ratings. Other options such as 13.8 kV input are available.



# Specifications



## VFD Power Input

Mains input voltage	<ul style="list-style-type: none"> <li>Up to 13.8 kV, 3-phase, <math>\pm 10\%</math></li> <li>Complete power loss ride-thru of 300 ms.</li> </ul>
Input frequency	<ul style="list-style-type: none"> <li>50/60 Hz</li> <li><math>\pm 5\%</math></li> </ul>
Power factor	<ul style="list-style-type: none"> <li>Unity at all loads and speed</li> </ul>
Harmonics	<ul style="list-style-type: none"> <li>Lower than IEEE 519-2014 standard</li> <li>No line-side filters required, <math>&lt; 2\% I_{THD}</math></li> </ul>
Converter type	<ul style="list-style-type: none"> <li>AC fed active front end</li> </ul>
Power semiconductor technology	<ul style="list-style-type: none"> <li>Low loss IGBT</li> </ul>
Transformer	<ul style="list-style-type: none"> <li>Dry type, aluminum wound, H-type</li> </ul>
Auxiliary power	<ul style="list-style-type: none"> <li>Control power (internal)</li> <li>Fan power: 380V-690V (external)</li> </ul>



## VFD Power Output

Output Voltage	<ul style="list-style-type: none"> <li>3/3.3 kV, 4.16 kV, 6/6.6 kV, 10/11 kV</li> </ul>
Output Frequency	<ul style="list-style-type: none"> <li>0-120 Hz for 3/3.3 kV, 4.16 kV, 6/6.6 kV</li> <li>0-72 Hz for 10/11 kV inverters</li> </ul>
Output Voltage Levels	<ul style="list-style-type: none"> <li>9/17-levels for 3/3.3 kV, 4.16 kV</li> <li>13/25 levels for 6/6.6 kV</li> <li>21/41 levels for 10/11 kV</li> </ul>
Number of cell modules in series per phase	<ul style="list-style-type: none"> <li>2 for 3/3.3 kV and 4.16 kV</li> <li>3 for 6/6.6 kV, 5 for 10/11 kV</li> </ul>
Overall Efficiency	<ul style="list-style-type: none"> <li><math>&gt; 96.5\%</math></li> <li>Including auxiliaries &amp; isolation transformer</li> </ul>
Power Semiconductor Technology	<ul style="list-style-type: none"> <li>Low loss IGBT</li> </ul>



## Control I/O

Digital Input	Qty. (5)
Dedicated Function Input	Qty. (1)
Configurable (programmable) Function Input	Qty. (4)
Digital Relay Output	Qty. (8)
Digital 24V Outputs	Qty. (4)
Speed feedback encoder input	High resolution tach, 10 kHz, 5 or 15 V DC diff. input, A quad B, with marker
LAN interface options	Profibus-DP, DeviceNet™, or Modbus RTU, TC-Net I/O, CC-link. Others available.
Motor temperature sensor option	High resolution temperature protection relay: 100 Ohm platinum RTD, 14 channels



## Display and Diagnostics

PC Configuration	TMdrive-Navigator for configuration, local and remote monitoring, animated block diagrams, dynamic live and capture buffer based trending, fault diagnostics, commissioning wizard, and regulator tune-up wizards. Ethernet 10 Mbps point to point or multi-drop, each drive has its own IP address.
Keypad and Display	Backlit LCD, animated displays <ul style="list-style-type: none"> <li>Four configurable bar graphs</li> <li>Optional multilingual display</li> <li>Parameter editing</li> <li>Drive control</li> </ul>
<b>RCM®</b>	Remote Connectivity Module Fanless industrial computer in the VFD with proprietary fault upload software for troubleshooting and diagnostics

For specifications not mentioned here, contact TMEIC.




## Environmental

Operating Temperature	<ul style="list-style-type: none"> <li>0° to 40°C (32° to 104°F) at rated load</li> <li>Up to 50°C with derating</li> </ul>
Storage Temperature	<ul style="list-style-type: none"> <li>-25° to +70°C, indoor storage only</li> </ul>
Relative Humidity	<ul style="list-style-type: none"> <li>Up to 85%, non-condensing</li> </ul>
Altitude	<ul style="list-style-type: none"> <li>Up to 1000m (3300 ft)</li> <li>Higher altitude available with derating</li> </ul>
Vibration	<ul style="list-style-type: none"> <li>0.3G max</li> <li>2Hz&lt;f&lt;9Hz: Half amplitude sine wave is within 0.9m</li> <li>9Hz&lt;f&lt;100Hz: Vibration acceleration is <math>&lt; 3\text{m/s}^2</math></li> </ul>
Cooling	<ul style="list-style-type: none"> <li>Air-cooled with fans on top and air intake on front</li> <li>For 10/11kV inverter, air intake in rear also</li> </ul>



## Mechanical

Enclosure	<ul style="list-style-type: none"> <li>NEMA 1, Gasketed</li> <li>IP 30, except fan opening</li> <li>Color: Munsell 5Y7/1</li> </ul>
Cable Entrance	<ul style="list-style-type: none"> <li>Top or bottom</li> <li>Selectable on-site</li> </ul>
Noise	<ul style="list-style-type: none"> <li>~76-80 dBA at 3.1 ft from enclosure</li> </ul>
Mean Time To Repair (MTTR)	<ul style="list-style-type: none"> <li>30 minutes to replace power module</li> </ul>
Mean Time Between Failure (MTBF)	<ul style="list-style-type: none"> <li>16 years</li> </ul>
Code conformance	<ul style="list-style-type: none"> <li>Applicable IEC, JIS, JEM, UL, CSA and NEMA standards</li> </ul>
Equipment marking	<ul style="list-style-type: none"> <li> 4.16 kV variant only</li> </ul>



## Motor Control and Protection

Vector Control Accuracy	<ul style="list-style-type: none"> <li>Speed response: 20 rad/sec</li> <li>Speed regulation without speed sensor <math>\pm 0.5\%</math></li> <li>Speed Control Range: 5 - 100%</li> </ul>
Control	<ul style="list-style-type: none"> <li>Non-volatile memory for parameters and fault data</li> <li>Vector control with/without speed feedback, or Volts/Hz</li> <li>Designed to keep running after utility supply transient voltage drop outs of 300 ms</li> <li>Synchronous transfer to line (option)</li> <li>Synchronous motor control (option)</li> </ul>
Major Protective Functions	<ul style="list-style-type: none"> <li>Inverter overcurrent, overvoltage</li> <li>Cooling fan abnormal</li> <li>Motor ground fault</li> <li>Low or loss of system voltage</li> <li>Over-temperature</li> <li>DC bus voltage</li> <li>Voltage/current unbalance</li> <li>5/20 min. overload</li> <li>Loss of speed reference</li> <li>Input Voltage phase loss</li> <li>VFD output open</li> <li>Transformer overheat</li> </ul>