TMEiC

We drive industry

TMdrive®-MVe2 Series Product Application Guide

Energy Saving Medium Voltage Inverter

metals | cranes | mining | testing | oil & gas | renewable energy | power generation | cement

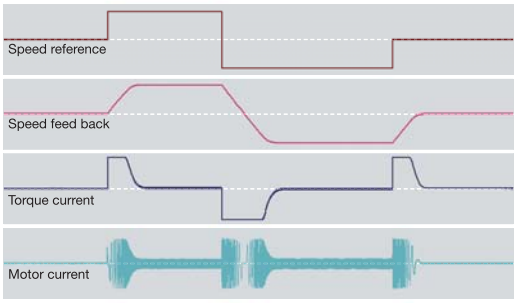
Energy Saving Medium Voltage Inverter

Improved Productivity	•	Regenerative Braking is standard.
	•	Fast acceleration/deceleration operations are available.
	•	High response and stable operations are available under sensorless vector control.
Energy Savings	•	Application of an inverter saves energy by enabling improved process control. Wasted energy can be reduced, resulting in a more efficient process.
Installation & Maintenance Cost Savings	•	Small footprint and height allows for economical transportation and installation.
	•	Reliability, life cycle cost and maintenance time minimized by using film capacitors and extended life fans.
Power Supply Friendly	•	The TMdrive-MVe2 has very low harmonic levels and low inrush currents.
	•	Unity (1.0) input power factor contributes to an electricity cost reduction and a smaller power supply requirement for on-site power capacity.
Simple Commissioning, Operation & Troubleshooting	•	The Auto-tune function assists with commissioning, allowing for a shorter startup time and lower commissioning costs. TMEIC's Drive Navigator software make troubleshooting simple and can help reduce downtime.

Improved Productivity

Rapid acceleration/deceleration

The standard regenerative braking function provides for rapid acceleration/deceleration operation with quick speed response.



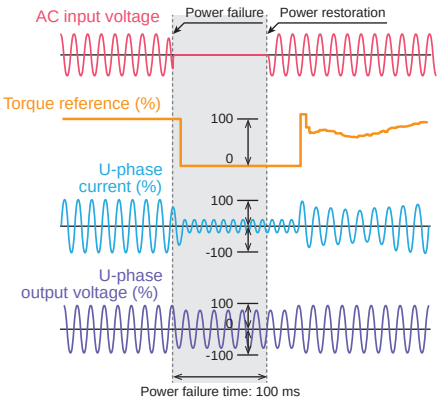
Stable speed control without a speed sensor

- A speed sensor is not required, improving reliability
- Sensorless vector control using a theory of vector operations achieves stable speed control
- For applications requiring a large starting torque, vector control using a speed sensor is available
- An auto-tuning function is standard

Robust protection against power supply fluctuations

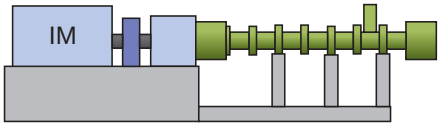
- Wide operating range in the event of a voltage drop. The rated voltage output is available when the power supply voltage drops. (Only limited by the overload capacity.)
- Ride-through control during an instantaneous power failure is available for a duration as high as 2 seconds When a power failure for 2 seconds or shorter occurs, torque output is reduced to zero without tripping, and then returns after power returns.
- Automatic restart can be performed after power failure for 2 seconds or longer. (Automatic re-acceleration of the load is possible.)

<Non-stop control during power failure>



Enhanced applications

- Since the TMdrive-MVe2 output current contains extremely low harmonic content, torque ripples are negligible. By suppressing the torsional vibration torque caused by resonance of mechanical systems, stable control of the machine is assured.



Extruder (constant-torque)

- TMdrive-MVe2 supports constant-torque loads, such as extruders or mixers (which require high starting torque), or conveyors and reciprocating compressors, etc., (which may require regenerative function).
- TMdrive-MVe2 can be used as a motor soft starter in an application with a large inertia, which may be susceptible to problems with voltage drop, starting frequency, etc. when the motor is started by commercial power supply. Multiple motors can be started independently with the appropriate switchgear lineup.
- TMdrive-MVe2 can control induction or synchronous motors.

Short MTTR

Drawer type cell inverters shorten MTTR to 30 minutes.

Power Supply Friendly

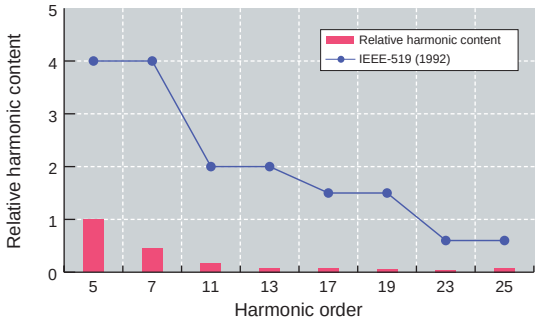
Input harmonic mitigation

The PWM converter arrangement of the TMdrive-MVe2 performs better than IEEE-519 requirements, without the use of harmonic filters.

In fact, the TMdrive-MVe2 outperforms a 36 pulse system, with only 2% current distortion!

Lower order harmonics (like the fifth and seventh) are reduced as compared to diode converters.

<Input current waveform>



TMdrive-MVe2 relative harmonic content on the input side **(actual load test measurements of the 1600 kVA frame)**

Order	5th	7th	11th	13th	17th	19th	23rd	25th
Relative harmonic content (%)	1.0	0.45	0.16	.08	0.08	0.06	0.04	0.08
IEEE-519 (1992) (%)	4.0	4.0	2.0	2.0	1.5	1.5	0.6	0.6

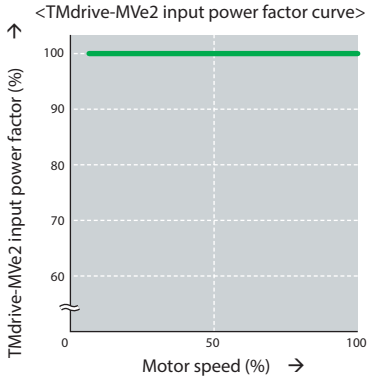
High input power factor

The PWM converter enables operations with unity (1.0) power factor across the entire speed range.

Utility charges will be reduced as compared with drives operating at a lagging power factor. For example, a diode converter operating with a 95% power factor will require almost 5% more current than a comparable drive operating at 1.0 power factor.

Since power factor correction equipment is not required, capital investment costs can be saved. Even when the load fluctuates, stable input power factor is assured.

<TMdrive-MVe2 input power factor curve>



* Example of the actual load test result of the standard 4-pole motor in our factory

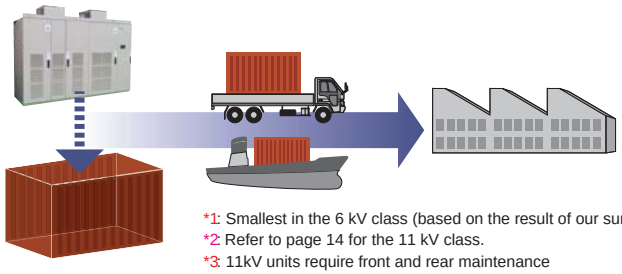
Excitation inrush current reduction

A pre-charge reactor circuit is utilized for larger frames to limit the excitation inrush current for the input transformer and reduce the voltage drop in the system.

Installation and Maintenance Cost Savings

Compact Footprint

- The compact design contributes to significant construction cost reduction (the enclosure height is 2100 mm up to 6.6 kV-3000 kVA class)*2
- Units up to 6.6 kV-1600 kVA*2 can be transported as a single enclosure, simplifying transport, unloading and installation.
- Single enclosure makes Installation safe and straightforward
- For export to overseas destinations, the low-height enclosure allows transportation in general-purpose containers, making transportation easy and lowering costs.
- The TMdrive-MVe2 is designed for front maintenance, resulting in a smaller footprint and saving floor space.*3
- Transformer can be mounted remotely from the power electronics when space is limited.



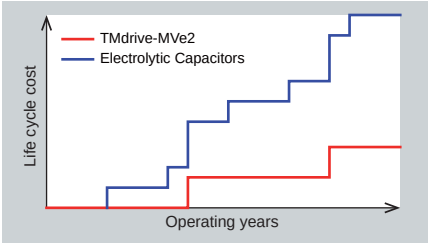
*1: Smallest in the 6 kV class (based on the result of our survey)
*2: Refer to page 14 for the 11 kV class.
*3: 11kV units require front and rear maintenance

Reduced load on air conditioning systems

- When there is limited space in the switchroom, the input transformer can be installed externally (optional). The switchroom heating load can be reduced (by 50%), which reduces the load to the air conditioning system.
- Operating costs of the air conditioning system are reduced significantly

Lower Maintenance Costs

- Maintenance-free film capacitors used for DC bus energy storage do not need replacement, significantly reducing the operating cost compared to electrolytic capacitors.
- Extended life ventilation fans are used, reducing maintenance costs and down time.
  - Conventional Fans: 3 year life
  - TMdrive-MVe2 Fans: 7 year life

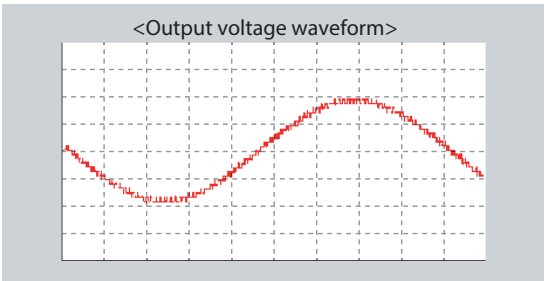



Film capacitor


Cell inverters

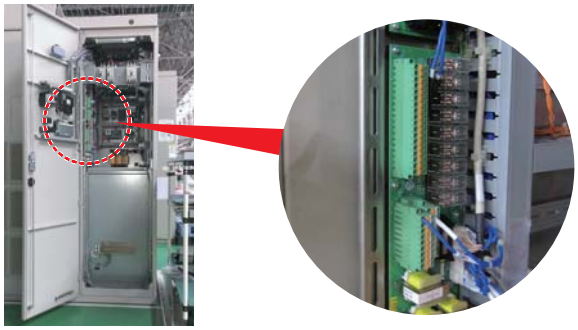
Can be used with existing motors

- The multilevel PWM output waveform approximates a sine wave, reducing voltage steps and peaks.
- By utilizing a proprietary switching shift control, an output filter is not required. Motors do not require surge protection.



Easy wiring of control circuit

- Insertion type spring terminals are used for the control circuit. The terminals are highly reliable and facilitate easy wiring. Terminals to suit ring-type crimp lugs are also available (option).



Energy Savings

Energy savings with speed control

- In variable torque load applications such as fans, pumps or blowers, variable speed operation of inverters achieves significant energy saving effect as compared to the constant speed operation using a commercial power supply (50 Hz or 60 Hz).
- When motor speed control is used in an applications such as a fans, pumps or blowers:
  Air volume (flow) is proportional to Speed
  Required power is proportional to $(\text{Speed})^3$. For example, when 80% air volume (flow) is required, significant power saving can be achieved by performing the speed control: Required power = $(80\%)3 \approx 50\%$

Pump Application

Boiler Application

Conveyor Application

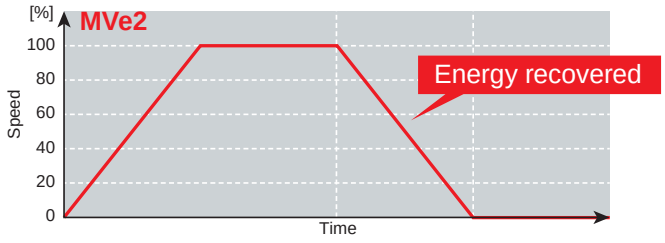
Regenerative power feedback to the power supply

The power regeneration function enables stopping of large inertia loads in a short time. During deceleration, the rotational energy is returned to the power supply, which contributes to a reduction in energy consumption and a reduction in electricity costs.

Calculation examples

A machine which decelerates with
1500 kW power in 15 minutes, with a 25% torque
→ Each time it is stopped,
power equivalent to 50 kWh is generated.*1

*1 Mechanical losses and losses in the motor and the inverter are not included.

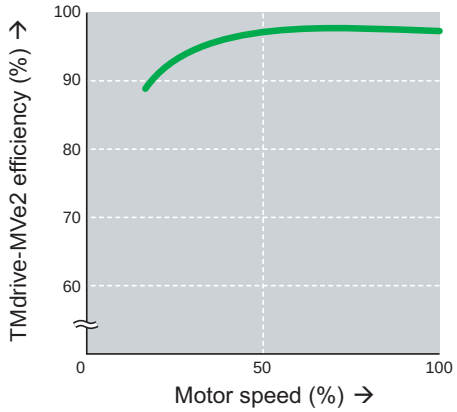


Regenerative Braking of a conveyor application allows saving of energy during each conveyor stop. Regenerative operation of downhill conveyors allows long term energy savings.

High Efficiency

The TMdrive-MVe2 has low switching losses of the main circuit elements. Low input side harmonic currents not only result in low losses, but also contributes to improvement of the efficiency of the equipment as a whole by eliminating harmonic filters or power factor improving capacitors.*
TMdrive-MVe2 variable speed drive system has conversion efficiency of 97%.
* At rated speed and full load.

<TMdrive-MVe2 efficiency curve> (with input transformer)



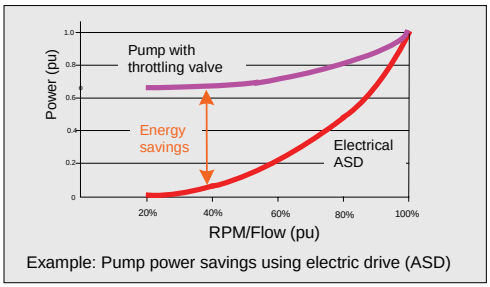
* Example of the actual load test result of the standard 4-pole motor in our factory

Energy Savings Payback Analysis

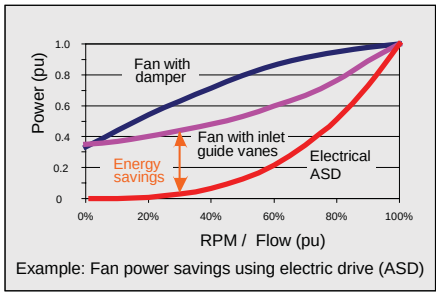
Replacing a mechanical speed control device with an adjustable speed drive usually produces large energy savings, plus a reduction in maintenance costs. This appendix outlines how the energy savings can be calculated as follows:

1. Calculate the cost of energy used by the electric drive speed control system, outlined on this page.
2. Calculate the cost of energy used by the mechanical speed control system, as outlined on this page.

The difference is the **energy cost savings**. Typical power consumption curves for pumps and fans are shown below.

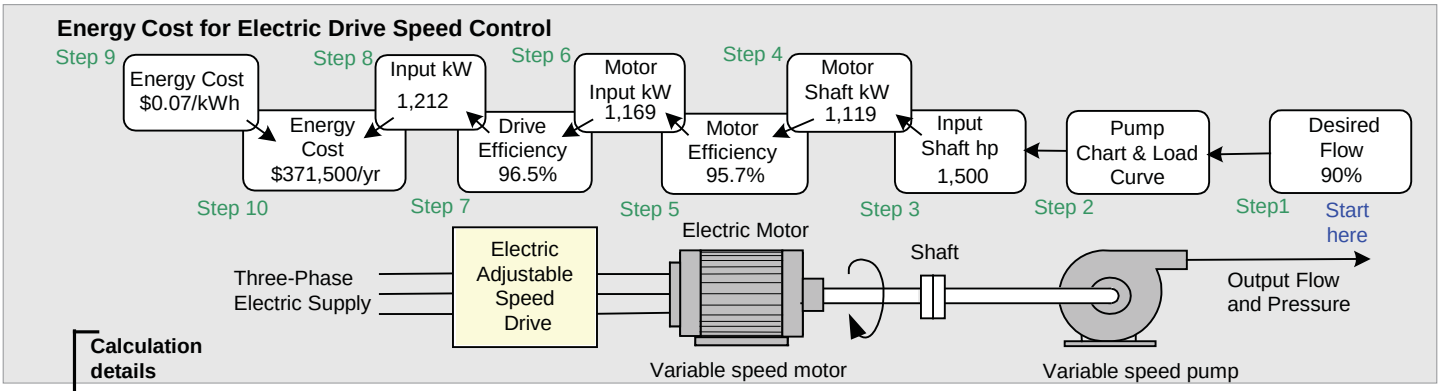


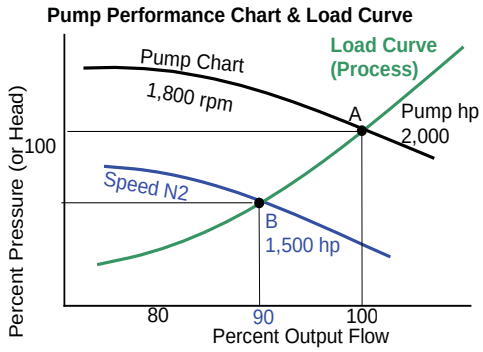
Example: Pump power savings using electric drive (ASD)



Example: Fan power savings using electric drive (ASD)

Below is an example of the energy cost calculation for a pump driven by a motor and electric drive. Since energy consumption varies with speed and flow, you need the load profile table which shows the number of hours running at the various flows. Refer to the example below.



Step 1	Select the desired pump output flow, for example, 90%, and number of hours/ day at this flow, for example, 12.		Overlay the load pressure-flow curve on the pump chart and find the pump input shaft horsepower at the 90% flow (point B). You need the load profile. See example below. Pump input power at N2 rpm = 1,500 hp at point B, 90% flow. Daily Load Profile (example) Operation Hours/Day: 5, 12, 5, 1, 1 Percent Flow: 100%, 90%, 80%, 70%, 60%
Step 2	Obtain the variable speed pump performance chart and the load pressure-flow curve, which is the flow resistance of the process being fed.		
Step 3	Find the pump input power		
Step 4	Convert the input shaft hp to shaft KW	Conversion: Horsepower x 0.746 = kW	Input shaft kW = 1,500 hp x 0.746 = 1,119 kW
Step 5 **Step 6**	Obtain the electric motor efficiency	Example: Induction motor efficiency 95.7% from manufacturer's data sheets (find each at RPM)	Motor input power = 1,119 kW/0.957 Efficiency = 1,169 kW
Step 7 **Step 8**	Obtain the adjustable speed drive efficiency	Example: Drive efficiency 96.5% from manufacturer's data sheets (find each at RPM)	Drive input power = 1,169 kW/0.965 Efficiency = 1,212 kW
Step 9 **Step 10**	Obtain the electric power cost	Example: Energy cost - $0.07/kWh. Calculate cost for the hours at this flow from load profile; in this example it is 12 hours/day.	Energy cost = 1,212 kW x 0.07$kWh x 12 hrs/day x 356 days/year = $371,500 per year. (Repeat calculation for other flows in load profile and total).

Simple Commissioning, Operation & Troubleshooting

An LCD keypad is included for operator interface. The inverter status can be monitored on the easy-to-view display screen.
Parameter setting and troubleshooting can be also performed easily.

Operation Panel

Main functions
- Parameter input/change
- Display mode switching
- Location/remote switching

Discharge check LED

Fault reset switch

Interlock switch

LCD Graphic Keypad Display
<240X64 dots, monochrome>
- Operating status display
- Fault information display
- Parameter display

Operation status indicator (LED)

Ethernet connector

Analog output check pins
- Current feedback output - 2 channels
- Analog output for measurement/ monitoring - 5 channels

Multilingual Touch Display (option)

An optional touch screen display is available with 9 languages built in. The graphic display is easy to read and understand. It contains all of the same functions as the standard keypad.

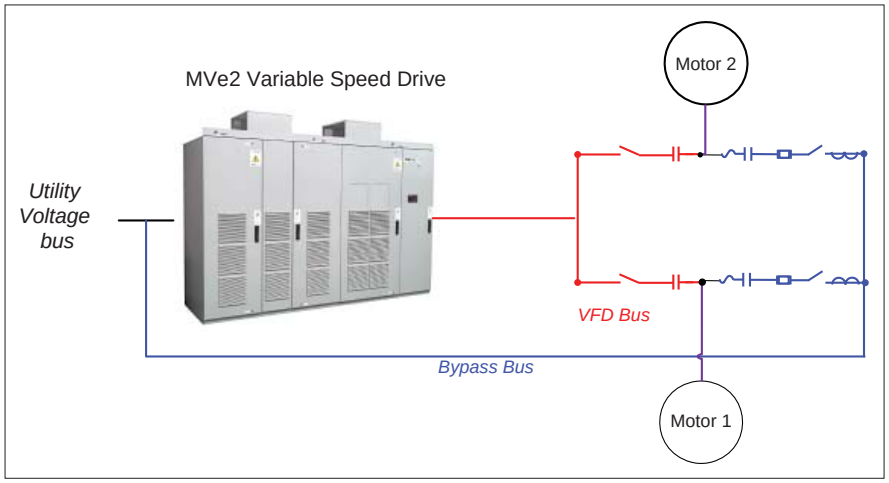
Drive Troubleshooting

This screen displays a drive first fault and shows selected trend displays to assist in determining the cause. The fastest trend displays four variables sampled at a rate of 333 microseconds. The other two slower trends are sampled at 1 millisecond and 100 milliseconds

Available Troubleshooting Functions:
- First fault display
- Operation preparation display
- Fault trace back
- Trouble records
- Fault history display
- Online manual

Control of multiple motors with a single drive

With the appropriate switchgear lineup, the TM-MVe2 control can automatically accelerate the connected motor to match the incoming utility voltage, frequency and phase. The load can then be connected to the power source with no surges in torque or current. This allows for sequential starting of multiple motors with any of the motors operating under variable speed control.

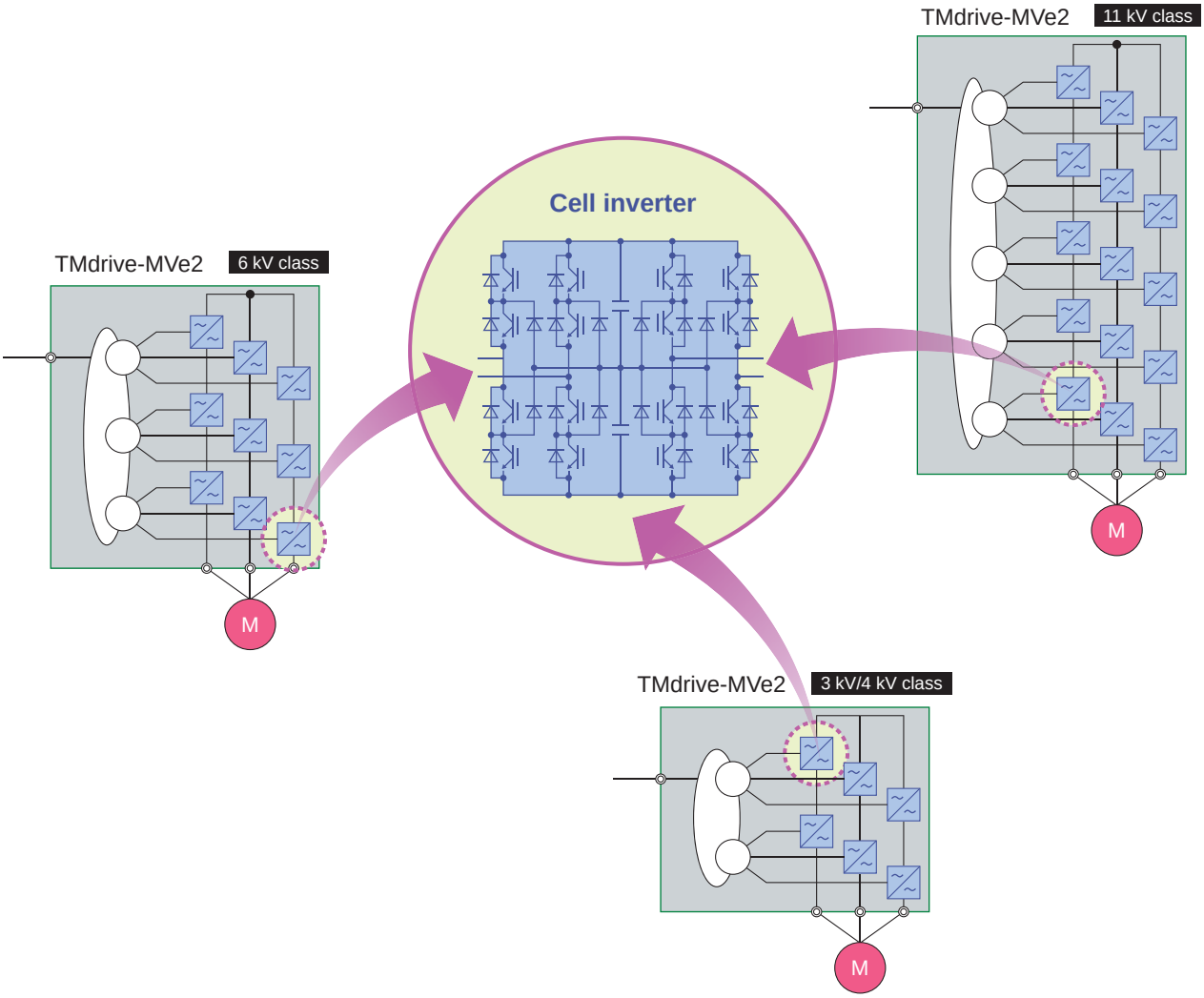


Circuit Configuration

Main Circuit Configuration

The TMdrive-MVe2 consists of a dedicated input transformer and a single phase IGBT inverters (cell inverters).

Six cell inverters are connected for 3 kV/4 kV class, nine inverters for 6 kV class, and fifteen inverters for 11 kV class, which allows three-phase high voltage AC output of 3 kV, 4 kV, 6 kV, and 11 kV respectively.

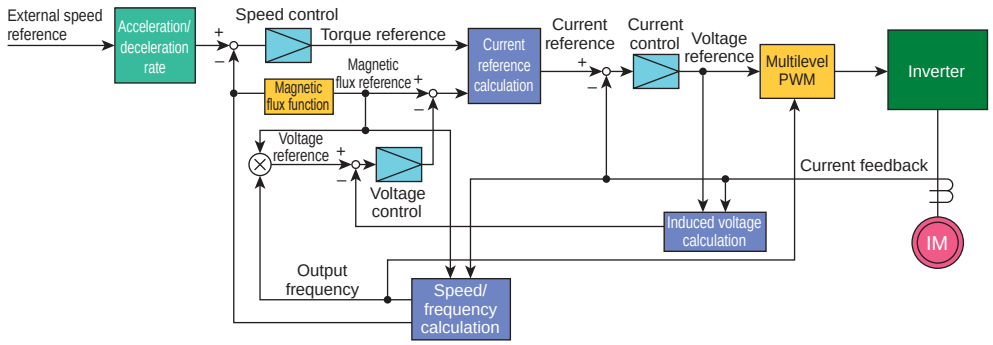


Control Block Diagram

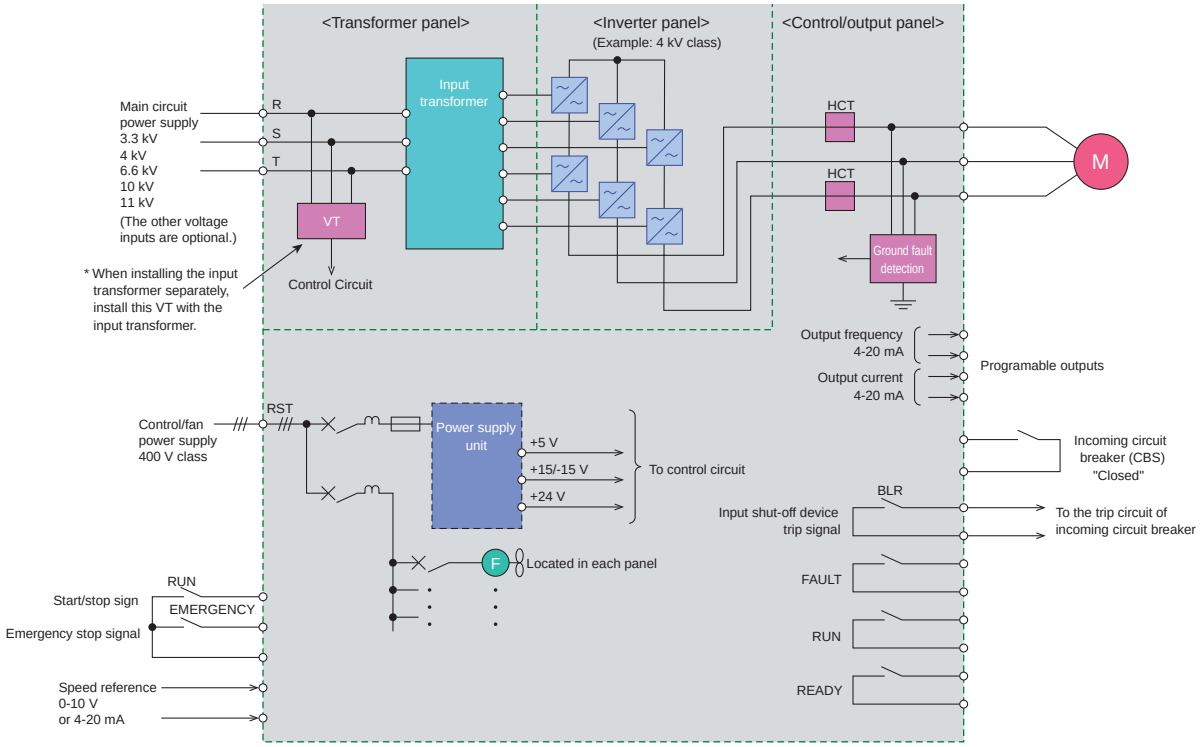
The sensorless vector control offers strong and smooth operations.

The 32 bit microcomputer is specially designed for power electronics and allows for extremely reliable operation.

(Vector control with a speed sensor is also available depending on accuracy or high starting torque requirements. An open loop type V/f control is also available.)



Standard connection diagram



Standard Interface

Customer ➔ Inverter		
Main circuit power supply	Main circuit power supply	400V-50 Hz/440 V-60 Hz/Other options
Control/fan power supply*	Control/fan power supply	Dry contact: 24 VDC-12 mA
Start/stop signal	“Closed” to operate, “opened” to stop	Dry contact: 24 VDC-12 mA
Emergency stop signal	“Closed” during normal operation, “opened to initiate an emergency stop (coast-to-stop)	Dry contact: 24 VDC-12 mA
Incoming contactor status signal (or CBS)	“Closed” when the circuit breaker is closed	Dry contact: 24 VDC-12 mA (if an output contactor is installed)
Output circuit breaker status signal (or CBS)	“Closed” when the circuit breaker is closed	Input impedance 1M (0-10 V)
Speed reference signal	0-10 V = 0-100% or 4-20 mA = 0-100%	Input impedance 10 (4-20 mA)

* Separate step-down transformer for the control power supply (from 440 V to 120 V) (option)

Inverter ➔ Customer		
Operation ready signal	“Closed” when inverter is ready for operation	Dry contact (max. 220 VAC-0.8 A, 110 VDC-0.2 A, 24 VDC-1.5 A)
Running signal	“Closed” when the inverter is running	Dry contact (max. 220 VAC-0.8 A, 110 VDC-0.2 A, 24 VDC-1.5 A)
Fault signal	“Closed” when an inverter fault occurs	Dry contact (max. 220 VAC-0.8 A, 110 VDC-0.2 A, 24 VDC-1.5 A)
Emergency stop signal	“Closed” when an inverter fault occurs (for tripping incoming circuit breaker)	Dry contact (max. 220 VAC-0.8 A, 110 VDC-0.2 A, 24 VDC-1.5 A)
Incoming circuit breaker trip signal	4-20 mA = 0-125% current	Dry contact: 24 VDC-12 mA (if an output contactor is installed)
Output current	“Closed” when the circuit breaker is closed	Resistive load 500 Ω or lower
Motor speed	4-20 mA = 0 to 125% speed	Resistive load 500 Ω or lower

Standard Specifications

Standard Rating

Item											
3.3/3.0 kV	At 3.3 kV output (kVA)	200	300	400	600	800	950	1100	1300	1500	
	Cell frame (frame)	100			200		300		400		
	Overload (60 sec.)	110%									
	Rated current (A)	35	53	70	105	140	166	192	227	263	
	Applicable motor output (kW)*1	160	250	320	450	650	750	900	1000	1250	
4.16 kV	At 4.16 kV output (kVA)	500	1000	1380	1890						
	Cell frame (frame)	100	200	300	400						
	Overload (60 sec.)	110%									
	Rated Current (A)	69	138	191	262						
	Applicable motor output (kW*1)	400	810	1120	1600						
6.6/6.0 kV	At 6.6 kV output (kVA)	400	600	800	1000	1200	1400	1600	1990	2200	2600	3000
	Cell frame (frame)	100			200				300		400	
	Overload (60 sec.)	110%										
	Rated Current (A)	35	53	70	87	105	122	140	166	192	227	262
	Applicable motor output (kW*1)	315	450	650	810	1000	1130	1250	1600	1800	2250	2500
11 kV	At 11 kV output (kVA)	660	990	1320	2000	2640	3080	3630	4290	5000		
	Cell frame (frame)	100			200		300		400			
	Overload (60 sec.)	110%										
	Rated Current (A)	35	53	70	105	139	162	191	226	263		
	Applicable motor output (kW*1)	500	800	1000	1600	2040	2500	2800	3500	3860		

*1 Approximate value for the standard 4-pole motor

Standard Specifications List

Item			
Output	Output frequency (Hz)	Rated output frequency of 120 Hz max for 3.3kV/4kV/6.6 kV; 72 Hz max for 11 kv	
	Overload capacity	110 % - 60 seconds	
Input	Main circuit	Three-phase	3000, 3300, 4160, 6000, 6600, 11000 V - 50/60 Hz
	Control/fan circuit	400 - 50 Hz/440 V-60 Hz/Other options available	
	Permissible function	Voltage: ±10%, frequency: ±5 %	
Input power factor/regenerative capacity		Fundamental wave power factor of approximately pf=1.0, regenerative capacity of 80%	
Control Functions	Control method	Sensorless vector control, vector control with sensor, or V/f control + Multilevel PWM (Pulse Width Modulation)	
	Frequency accuracy	±0.5% for maximum output frequency (for the analog frequency reference input)	
	Load torque characteristic	Variable torque load, constant-torque load	
	Acceleration/deceleration time	0.1 to 3270 seconds, individual setting possible (Setting depends on the load GD2)	
	Primary control functions	Soft stall (Programmable speed reduction for fans and pumps during periods of overload), Ride-through control during instantaneous power failures, break point acceleration/ deceleration function, specific frequency evasion function, continuous operation function during speed reference loss, total run time display function	
	Primary protective functions	Current limit, overcurrent, overvoltage, overload, load side ground fault, undervoltage, CPU error, cooling fan fault, etc.	
	Transmission (option)	DeviceNet, ProfiBus-DP, Modbus-RTU, TC-net I/O, CC-Link	

Standard Specifications List

Display Functions	Display	LCD display (240×64 dots) 4 LED indicators (READY, RUN, ALARM/FAULT, Discharge check)
	Push buttons	NAVIGATION key, CONTROL key, Operation, stop, fault reset, interlock (drive run inhibit)
Input Transformer		Class H, dry type, TMdrive-MVe2 dedicated specifications (External options available)
Structure	Enclosure	IP30 (except for the cooling fan opening) (Options available)
	Enclosure Structure	Steel-plate, semi-closed, self-supporting enclosure structure for a front maintenance. 11 kV requires maintenance from front and rear.
	Cooling System	Forced air cooling by a ceiling fan
	Finish Color	Munsell 5Y7/1, leather-tone finish
Ambient Conditions	Ambient Temperature	0 to 40°C (Higher temperatures with derating)
	Humidity	85% or less (no dew condensation)
	Altitude	Up to 1000 m (Higher with derating)
	Vibration	0.5 G or less (10 to 50 Hz)
	Installation Location	Indoor (free from corrosive gas, dust and dirt)
Load Pattern		Fans, blowers, pumps, compressors, extruders, fan pumps, mixers, conveyors, etc.
Applicable Standards		Electrical standards: JEC, IEC Component and others: JIS, JEC, JEM

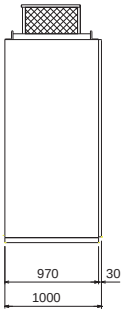
Option	
Control method	Vector control with sensor (encoder)
	Automatic restart control after power failure (between 2 seconds and 6 seconds), synchronous transfer to and from commercial power supply (shock-less switching over between power supplies)
Maintenance tools	Personal computer application software for maintenance and adjustment (OS: Windows®7 Professional 32-bit version)
Others	Multi-language display on the operation panel (supports nine languages), SM control, soft start, separate step-down transformer for the control power supply (from 400 V to 200 V), duplex cooling fan
	Specified painting color
	Outlet, control panel illumination light, space heater, separate input transformer, excitation inrush current limit circuit (small-capacity)

* For installing the transformer separately or using the excitation inrush current limit circuit, contact your sales representative for the enclosure size.

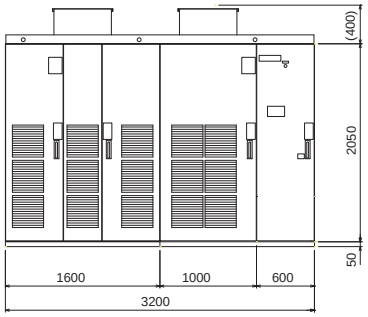
Outline Dimensions

●6.6 kV–400/600/800 kVA

Left side view



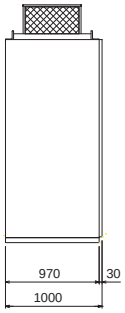
Front view



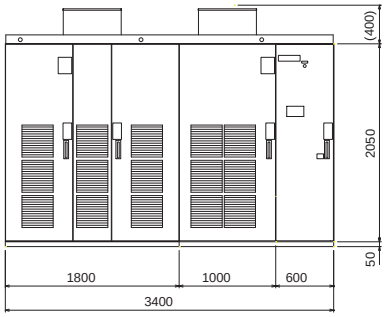
Approx. mass: 3400 kg

●6.6 kV–1000/1200/1400/1600 kVA

Left side view



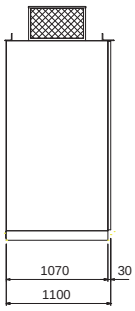
Front view



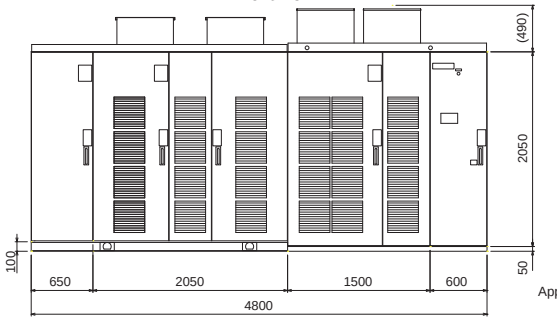
Approx. mass: 4700 kg

●6.6 kV–1900/2200/2600/3000 kVA

Left side view



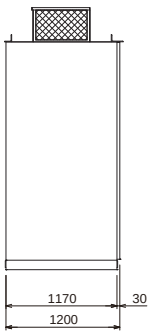
Front view



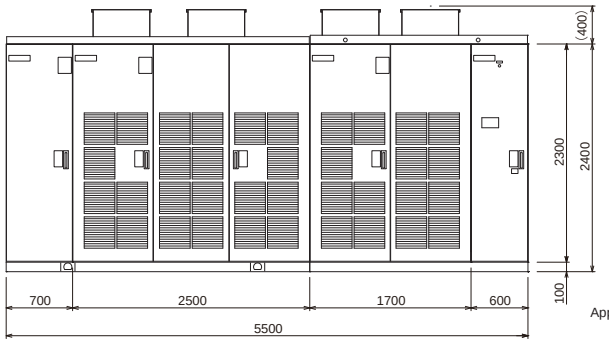
Approx. mass: <1900/2200 kVA> 6750 kg
<2600/3000 kVA> 7150 kg

●11 kV–660/990/1320/2000/2640 kVA

Left side view



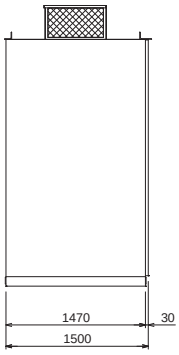
Front view



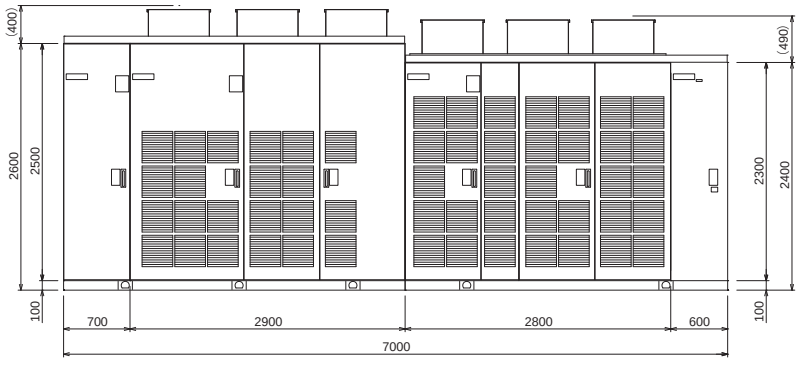
Approx. mass: <660/990/1320kVA> 7800 kg
<2000/2640kVA> 8000 kg

●11 kV–3080/3630/4290/5000 kVA

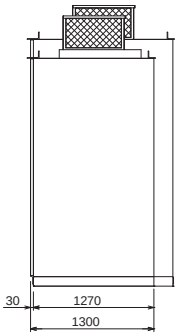
Left side view



Front view

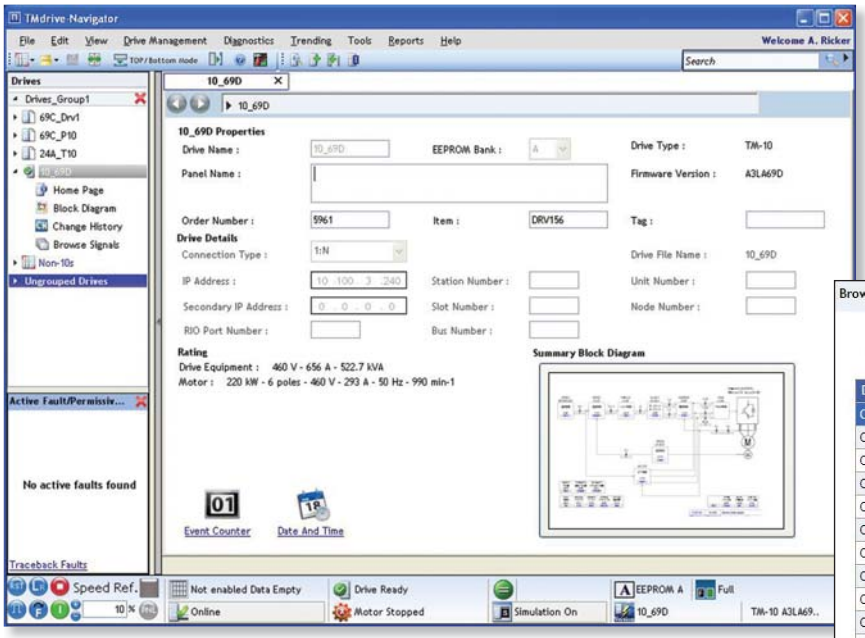


Right side view

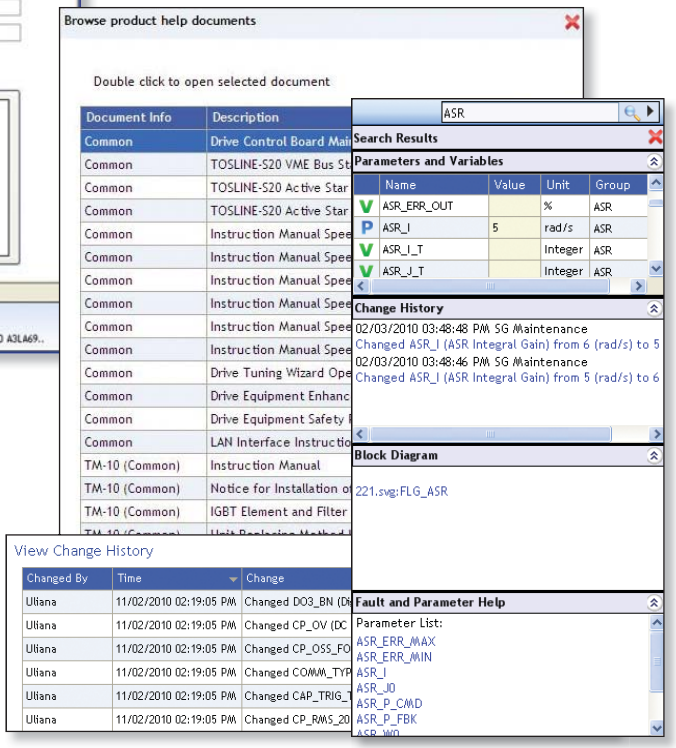


Approx. mass: <3080/3630kVA> 13350 kg
<4290/5000kVA> 13500 kg

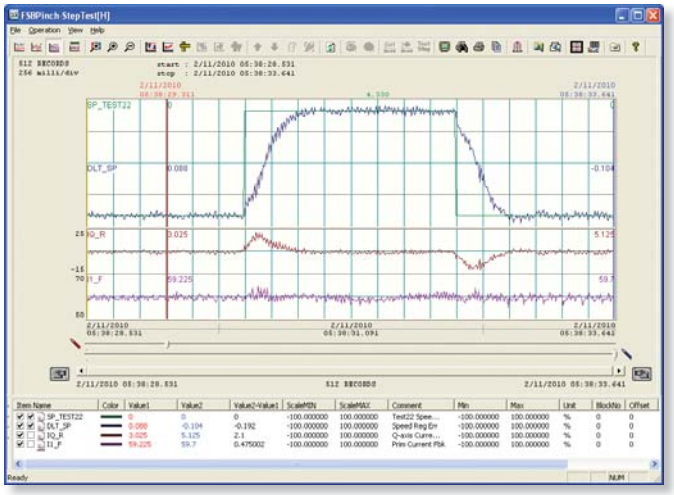
TMdrive-Navigator



The TMdrive-Navigator tool helps you maintain TMEIC drives yourself. Engineers and technicians are empowered to understand how the drive works and what the drive is doing. Any user can easily access current drive expertise and know-how.



Desktop-like search technology links topical signal lists, block diagrams, help files, product documentation, change history, and user notes. Windows techniques facilitate navigation within a drive and across the system. The status of all drives is always in view.



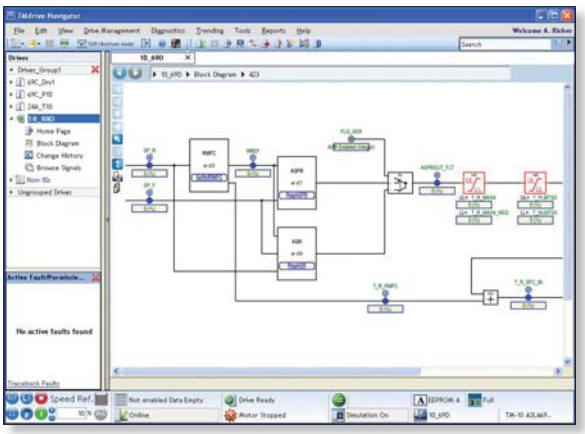
High speed data is automatically captured and saved in the event of a drive fault. Users can also capture high speed data based on their own trigger conditions or perform high resolution real-time trending.

Fault data can be automatically “pushed” to key users. The client-server architecture allows access to high performance data from remote locations – with the same resolution as if you were in the plant.

Live block diagrams provide a real-time graphical view of drive functions. Functions can be configured directly from the graphical view.

Product documentation is integrated right into the tool. Users can even capture their own notes to benefit future troubleshooting.

Wizards support tuning of drive functions.

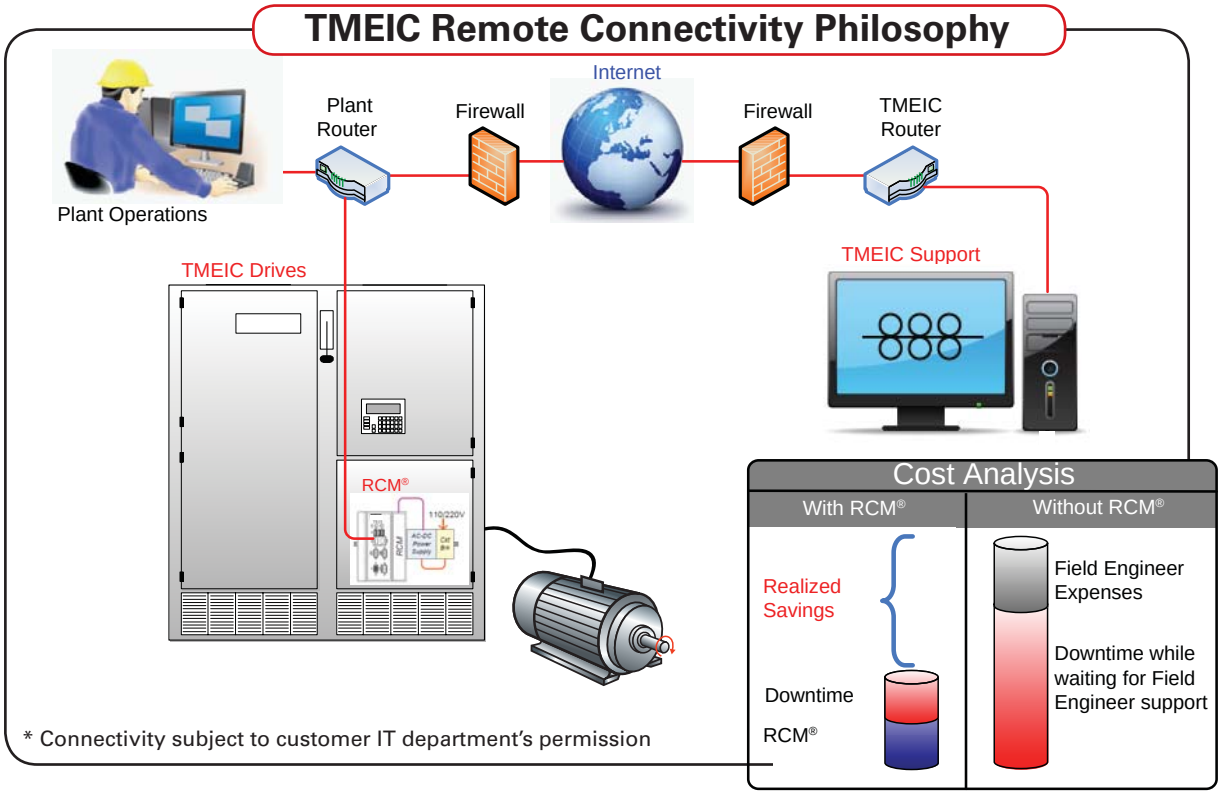


Compatible with:
- OS Windows 7
- Professional 32 bit

Remote Connectivity RCM®

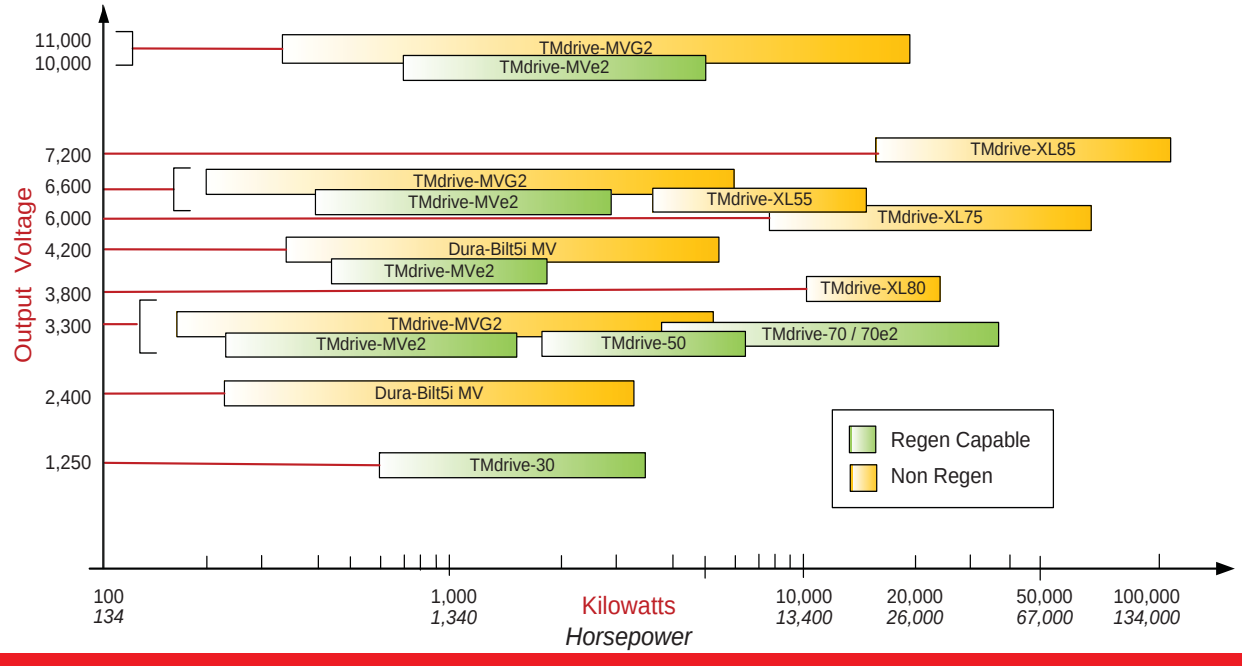
At TMEIC, we provide highly-reliable automation systems. Sometimes even the best systems can experience faults. For events we can't foresee, TMEIC offers remote connectivity with RCM® - protection for your investment, by reducing downtime, lowering repair costs and providing peace of mind.

Remote drive connectivity requires an internet connection between your plant and TMEIC for retrieval of fault logs and files for diagnosing drive problems. The RCM® enables seamless integration between your drives and our support engineers.



Features	Benefits
• **Reduced downtime & Mean-Time-to-Repair**	**Quick support saves thousands of $ in lost production** TMEIC engineers can quickly connect* to the drive and diagnose many issues in a matter of minutes.
• **Secured connection**	**Customer-controlled access** All remote activity is conducted with permission of the customer. Drive start/stop is not permitted remotely.
• **Fault Upload Utility**	**Proprietary Fault Upload Software** RCM® can monitor key real-time parameters. Historical drive faults are pushed automatically to the computer. This enables TMEIC engineers to analyze the issue resulting in the fault and provide a more coherent solution.
• **Industrial computer**	**Ruggedized computer for the most demanding applications** Fan-less computer withstands high vibration and temperature ranges in a small DIN-rail mounted footprint
• **Multiple ethernet/ serial ports**	**Flexible connectivity** The module can be connected to two separate LAN's along with a host of serial-talking/ USB devices.

TMEIC AC Drives Offer Complete Coverage



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