TMdrive™-MVG2 Product Guide

Medium Voltage Multilevel IGBT Drive
Up to 10,000 kVA at 11 kV
The TMdrive-MVG2 is a general-purpose, medium-voltage, variable-frequency AC drive for industrial power ratings up to 10 MW, in the voltage range of 3/3.3 kV, 6/6.6 kV, and 10/11 kV. Featuring high-quality Japanese design and manufacture, the TMdrive-MVG2 works with existing or new induction or synchronous motors and meets users’ basic system requirements as described below:

<table>
<thead>
<tr>
<th>Design Feature</th>
<th>Customer Benefit</th>
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<tbody>
<tr>
<td>• No electrolytic capacitor in main circuit is used. • Instead long-life film capacitors are used.</td>
<td>• Minimized maintenance and operating cost. • Replacement of capacitors is not required within product life.</td>
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<td>• Conservative design using 1700-volt IGBTs (Insulated Gate Bipolar Transistor)</td>
<td>• Highly reliable operation and expected 100,000 hour (12 years) drive MTBF, based on field of experience with the large global installed base of TMdrive-MVG family technology</td>
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<td>• High energy efficiency approx. 97%</td>
<td>• Considerable energy savings, in particular on flow control applications</td>
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<td>• Diode rectifier ensures power factor greater than 95% in the typical speed control range</td>
<td>• Capacitors are not required for power factor correction</td>
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<td>• Multiple level drive output waveform to the motor (21 levels for the 6.6 kV inverter, line to line voltage, peak to peak)</td>
<td>• No derating of motor for voltage insulation or heating is required due to motor-friendly waveform</td>
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<td>• Multi-pulse converter rectifier and phase shifted transformer: 3.3 kV Class: 18 pulse 10 kV Class: 48 pulse 6.6 kV Class: 30 pulse 11 kV Class: 54 pulse</td>
<td>• No harmonic filter required to provide lower harmonic distortion levels than IEEE-519-1992 guidelines</td>
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<td>• Designed to keep running after utility supply-transient voltage dropouts – up to 300 msec.</td>
<td>• Uninterrupted service for critical loads</td>
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<td>• Synchronous transfer to line option with no interruption to motor current (Additional equipment required)</td>
<td>• Allows control of multiple motors with one drive • No motor current or torque transients when the motor transitions to the AC line</td>
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<td>• Input isolation transformer included in the drive package</td>
<td>• Better protection of motor • Simplified installation • Lower cost installation • Mitigation of harmonics on the primary side</td>
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<td>• Direct drive voltage output level</td>
<td>• No output transformer required to match motor voltage, saving cost, mounting space, cabling, and energy • Allows easy retrofit of existing motors</td>
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Bringing Reliable Control to a Wide Variety of Industries

The TMdrive-MVG2's compartmentalized design streamlines installation, commissioning, and maintenance of medium-voltage drives in the cement industry. With a Mean Time Between Failure (MTBF) exceeding 100,000 hours (12 years), the MVG is engineered to deliver rock-solid performance in virtually any application, making the TMdrive-MVG a best choice of many consultants, end users, and cement plant builders all over the world, including:

- Raw mill fans, bag house fans
- Preheater fans, coal mill fans
- Grinding mills
- Rotary kilns

In the Oil and Gas Industry, the MVG family of drives can be seamlessly integrated with the rest of your pump station control system with a choice of either 3/3.3, 6/6.6, 10, or 11 kV. They can be applied to existing motors and cabling, making them an excellent fit in modernization/retrofit applications, including:

- Oil pumps
- Gas compressors
- Fans

Accurate torque control is a key in controlling large conveyors. The MVG2's flux vector algorithm provides the accuracy and response for this demanding application. Mining applications include:

- Raw material conveyor
- Grinding mills
- Pumps

Traditional mechanical methods of controlling flow are inefficient and require considerable maintenance. In the Power Generation Utilities Industry, the MVG2 provides more reliable, accurate, and energy-efficient control of flow while eliminating the maintenance associated with dampers, vanes, or valves on:

- Induced and forced draft fans
- Primary and secondary air fans
- Boiler feed water pumps
- Condensate extraction pumps

The metal-making part of the steel plant uses large air flows and requires high power levels supplied by the MVG2 to operate:

- Water gas fans
- BOF ID fans
- Dust collection fans
- Blast furnace blower fans
- Utility pumps
A Look on the Inside

MV Drive Technology for medium voltage operation:

- Series connected inverter cell architecture uses 1700 V IGBT inverters for best reliability and high energy efficiency
- Diode bridge rectifiers yield high power factor operation
- Multi-winding transformer produces low input power distortion
- Modular drawable power cell design minimizes the time required for any maintenance activities

Main Power Input
Four voltage levels are available:

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

Air Cooling
Forced air cooling system with:

- Intake through cabinet doors
- Upward flow through inverter cells and transformer
- Exhaust at top of cabinet

Input Transformer
The special input transformer has phase-shifted secondary windings to produce multi-pulse converter operation. This design exceeds the IEEE 519-1992 guidelines for input current distortion.

I/O Board
The I/O board supports encoder, 24 V dc I/O, 115 V ac inputs and analog I/O, standard. All I/O are terminated to a two-piece modular terminal block for ease of maintenance, located in right hand cabinet.

Cell Inverters
Example: Three banks of five series connected inverter cells, each containing:

- Diode bridge rectifier
- IGBT PWM inverter
- DC link long-life film capacitor
- Drawable module for ease of maintenance

Control Functions
A single set of control boards feeds all inverter cells. The primary control board performs several functions:

- Speed and torque regulation
- Sequencing
- I/O mapping
- Diagnostic data gathering
- Provision for optional LAN interface
**Switching Devices**
Switching devices are Insulated Gate Bipolar Transistors (IGBT)

**Control Board**
- Board passes Pulse Width Modulated control signal to the gate drivers
- Gate driver circuit boards connect directly to IGBTs

**Cooling Heat Sink**
Heat is transferred from the switching device heat sink to the cooling air

**Input Fuse**
Fused three-phase inputs to converter

**DC Link long-life capacitors**
No electrolytic capacitor in main circuit is used. Replacement of capacitors is not required within product life.

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**Inverter Cell Module Removed from Rack**

**Inverter Cell Module**

**Inverter Cell Module**

**Three-phase input**

**Diode bridge rectifier**

**Inverter with 1700 IGBTs**

**Single-phase output**

**DC link long-life film capacitor**

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**Slide-Out Inverter Modules**
Each inverter cell contains a three-phase diode converter and a single-phase IGBT inverter, connected by a DC bus. One cell module is shown opposite, drawn out of the rack on a slide for service. All the modules are the same; refer to the diagram below. The mean time to repair the drive (MTTR) is 30 minutes or less.
The TMdrive-MVG2 main circuit consists of an input transformer and single-phase PWM inverter cells. For 3 kV, three inverter cells are series connected to create an output with 7 output voltage levels.
## TMdrive-MVG2 Specifications

### 3.0/3.3 kV TMdrive-MVG2

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<th>3.3 kV Output kVA</th>
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<th>Approx. Motor Power kW @3.3 kV *2</th>
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Notes:

*1 1.25 PU or 1.1 PU overload, 60 sec rating; use Frame Amp rating for most acceptable match with motor

*2 Approximate capacity for 3.3 kV-based 4-pole induction motors

CF There are two banks; consult factory for dimensions and weights

Redundant cooling fans increase height
## TMdrive-MVG2 Specifications

### 6.0/6.6 kV TMdrive-MVG2

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<th>6.0 kV Output kVA</th>
<th>6.6 kV Output kVA</th>
<th>Approx. Motor Power HP @6.6 kV *4</th>
<th>Approx. Motor Power kW @6.6 kV *4</th>
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Notes:

*3 1.25 PU or 1.1 PU overload, 60 sec rating; use Frame Amp rating for most acceptable match with motor

*4 Approximate capacity for 6.6 kV-based 4-pole induction motors

CF There are two banks; consult factory for dimensions and weights

Redundant cooling fans increase height
## 10/11 kV TMdrive-MVG2

<table>
<thead>
<tr>
<th>Frame</th>
<th>Rated Output Current Amps *5</th>
<th>10 kV Output kVA</th>
<th>11 kV Output kVA</th>
<th>Approx. Motor Power HP @11 kV *6</th>
<th>Approx. Motor Power kW @11 kV *6</th>
<th>Panel Width mm (inch)</th>
<th>Panel Height with channel base mm (inch)</th>
<th>Panel Depth mm (inch)</th>
<th>Approx. Weight kg (lbs) @10 kV / 11 kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>125%</td>
<td>110%</td>
<td></td>
<td></td>
<td></td>
<td>5300 (209) / 5600 (221)</td>
<td>3060 (121)</td>
<td>1400 (56)</td>
<td>8280 (18210) / 8620 (19960)</td>
</tr>
<tr>
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<td>35</td>
<td>600</td>
<td>680</td>
<td>700</td>
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<tr>
<td>II</td>
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<td></td>
<td>6400 (252) / 6800 (268)</td>
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<td>1400 (56)</td>
<td>9590 (21090) / 10280 (22610)</td>
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<tr>
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<td></td>
<td>6900 (272) / 7500 (296)</td>
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<tr>
<td>IV</td>
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<td></td>
<td>7100 (280) / 7700 (304)</td>
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<td>1500 (60)</td>
<td>14960 (32900) / 15880 (34930)</td>
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<td>V</td>
<td>125%</td>
<td>110%</td>
<td></td>
<td></td>
<td></td>
<td>11600 (457)/ 12200 (481)</td>
<td>3100 (122)</td>
<td>1500 (60)</td>
<td>23630 (51980) / 24490 (53870)</td>
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<td>125%</td>
<td>110%</td>
<td></td>
<td></td>
<td></td>
<td>11600 (457)/ 12200 (481)</td>
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<td>CF 733</td>
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<td>13900</td>
<td>16200</td>
<td>12000</td>
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<td>VIII</td>
<td>CF 1024</td>
<td>CF 1024</td>
<td>17500</td>
<td>19500</td>
<td>21600</td>
<td>16000</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:
*5 1.25 PU or 1.1 PU overload, 60 sec rating; use Frame Amp rating for most acceptable match with motor
*6 Approximate capacity for 11 kV-based 4-pole induction motors
CF There are two banks; consult factory for dimensions and weights
Redundant cooling fans increase height
Cabinet Minimum Maintenance Space

<table>
<thead>
<tr>
<th>Drive Class</th>
<th>Frame</th>
<th>Front Side Space</th>
<th>Rear Side Space</th>
<th>Ceiling Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/3.3 kV</td>
<td>I</td>
<td>1600 mm (63 in)</td>
<td>20 mm (0.8 in)</td>
<td>3050</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>1600 mm (63 in)</td>
<td>20 mm (0.8 in)</td>
<td>3050</td>
</tr>
<tr>
<td></td>
<td>III, IV</td>
<td>1700 mm (67 in)</td>
<td>20 mm (0.8 in)</td>
<td>3100</td>
</tr>
<tr>
<td></td>
<td>V, VII</td>
<td>1700 mm (67 in)</td>
<td>20 mm (0.8 in)</td>
<td>3100</td>
</tr>
<tr>
<td></td>
<td>VI, VIII</td>
<td>1900 mm (75 in)</td>
<td>20 mm (0.8 in)</td>
<td>3100</td>
</tr>
<tr>
<td>6/6.6 kV</td>
<td>I</td>
<td>1600 mm (63 in)</td>
<td>20 mm (0.8 in)</td>
<td>3050</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>1600 mm (63 in)</td>
<td>20 mm (0.8 in)</td>
<td>3050</td>
</tr>
<tr>
<td></td>
<td>III, IV</td>
<td>1700 mm (67 in)</td>
<td>20 mm (0.8 in)</td>
<td>3100</td>
</tr>
<tr>
<td></td>
<td>V, VII</td>
<td>1700 mm (67 in)</td>
<td>20 mm (0.8 in)</td>
<td>3100</td>
</tr>
<tr>
<td></td>
<td>VI, VIII</td>
<td>1900 mm (75 in)</td>
<td>20 mm (0.8 in)</td>
<td>3100</td>
</tr>
<tr>
<td>10/11 kV</td>
<td>I</td>
<td>1800 mm (71 in)</td>
<td>600 mm (24 in)</td>
<td>3500</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>1800 mm (71 in)</td>
<td>600 mm (24 in)</td>
<td>3500</td>
</tr>
<tr>
<td></td>
<td>III, IV</td>
<td>1900 mm (75 in)</td>
<td>600 mm (24 in)</td>
<td>3550</td>
</tr>
<tr>
<td></td>
<td>V, VII</td>
<td>2000 mm (79 in)</td>
<td>600 mm (24 in)</td>
<td>3550</td>
</tr>
<tr>
<td></td>
<td>VI, VIII</td>
<td>2000 mm (79 in)</td>
<td>600 mm (24 in)</td>
<td>3550</td>
</tr>
</tbody>
</table>

Notes
1. kVA_{Inverter} = \frac{(\text{Power Mtr Shaft})}{(\text{Mtr PF} \times \text{Mtr Eff})}
   \quad \text{I_{Phase}} = \frac{(\text{kVA}_{Inverter}) \times (\text{1000})}{(1.732)} \times \text{(V Mtr Line to Line)}
   - Mtr PF = 0.87, Mtr Eff = 0.94, ambient temperature is 32°F–104°F (0°C–40°C).
   - Ratings based on a variable torque load (industrial fans and pumps).
   - Altitude above sea level is 0–3300 ft (0–1000 m).
   - Dimensions to top of cooling fans are for the nonredundant type fans.
2. An optional bypass circuit can be separately mounted.
3. Redundant cooling fans are available as an option; overall height increases.
4. No rear access is required except for 10/11 kV Class drives.
5. Incoming power cabling and motor cabling are bottom entry; top entry is an option.
6. Air is pulled in through the filters in the cabinet doors and vented out the top.
7. Available options include motor cooling fans and control, cabinet space heater, bypass power/control and dv/dt filter, HV input, sync motor control, smooth transfer to and from utility.
8. For conservative sizing of cooling equipment, heat rejection is 3 kW/100 kVA (3 kW/100 hp) of output power.
9. The panels are fixed to the channel bases and shipped.
Features of the TMdrive-MVG2

A Clean Wave Inverter
Using the multiple winding input transformer, the TMdrive-MVG2 has multi-pulse rectification and more than meets the requirements of IEEE-519 (1992). This reduces the harmonic current distortion on the power source and protects the other equipment in the plant. The harmonic current content measured in an actual load test is compared with IEEE-519 in the chart opposite.

A Clean Output Wave
As a result of the multilevel PWM control, the output waveform is close to a sine wave, and the heat loss caused by harmonics is negligible. In addition, harmonic currents in the motor are minimized so there is very little torque ripple on the output shaft.

A Higher Efficiency than Conventional Drives
Actual factory load tests show the drive efficiency is approximately 97% (design value). This high efficiency is a result of:
• A smaller number of switching semiconductors by using 1700 V IGBTs
• Lower switching frequencies using multilevel PWM control reduce the switching loss of each IGBT
• Direct connection of MV motor without an output transformer

A High Input Power Factor
Each inverter cell has a diode bridge rectifier. As a result, the input power factor is above 95% over the entire normal operating speed range, even when driving a multiple-pole induction motor of low power factor. With this high power factor, no power factor correction capacitor is required.

### Example: 6.6 kV drive at 6,000 kVA and 50 Hz

<table>
<thead>
<tr>
<th>Current</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>97.1%</td>
</tr>
<tr>
<td>75%</td>
<td>97.2%</td>
</tr>
<tr>
<td>50%</td>
<td>97.5%</td>
</tr>
</tbody>
</table>

Except for the consumption of control power and auxiliary power.

### Power Factor in Italic, Expressed in %

<table>
<thead>
<tr>
<th>Percent of Full Load</th>
<th>20</th>
<th>40</th>
<th>60</th>
<th>80</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>94.7%</td>
<td>*95.6%</td>
<td>*95.7%</td>
<td>95.8%</td>
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</tr>
<tr>
<td>40</td>
<td>96.6%</td>
<td>96.7%</td>
<td>*96.4%</td>
<td>96.2%</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>96.3%</td>
<td>96.4%</td>
<td>96.4%</td>
<td>96.4%</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>96.1%</td>
<td>96.8%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>97.1%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Examples of measured power factor
Common Control Boards to Reduce Cost of Ownership

Standard Connections

- Main Power Supply
- Control power for cooling fan: 380/400/415/440 Vac 3-phase – 50/60 Hz
- Control power supply: 200 Vac/3 Ph - 50 Hz; 220 Vac/3 Ph - 60 Hz. Option: 380/400/415/440 Vac – 50/60 Hz
- Output frequency 4-20 mA
- Output speed 4-20 mA
- To trip circuit of incoming CB

Control I/O

- Analog Inputs (2) ± 10 V or 4-20 mA, configurable, differential
- Analog Outputs (4) ± 10 V, 8-bit, configurable, 10 mA max
- Digital Inputs (2) 24–110 V dc or 48–120 V ac; (6) 24 V dc, configurable
- Digital Outputs (6) 24 V dc open collector 50 mA
- 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, ISBus, DeviceNet™, Modbus RTU
- Motor Temperature Sensor: High-resolution torque motor temperature feedback: 1 K Ohm platinum resistor or 100 Ohm platinum RTD; uses analog input with signal conditioner

Display and Diagnostics

- PC Configuration: Control System Drive 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, Parameter editing, Four configurable bar graphs, Drive control
- Instrumentation Interface: Two analog outputs dedicated to motor current feedback, plus five analog outputs that can be mapped to variables for external data logging and analysis

Additional Specifications

Power System Input and Harmonic Data
- Voltage: up to 11 kV, 3-phase, ±10% to ±10%
- Tolerates power dips up to 25% without tripping, complete power loss ride through of 300 msec
- 125% Overload (OL) for 60 seconds; other OL ratings available
- Frequency: 50 Hz or 60 Hz, ±5%
- Power factor (PF): 0.95 lag
- True PF: greater than 0.95 lag over 40-100% speed range
- Exceeds the IEEE 519-1992 standard for harmonics, without filters
- Bottom cable entry

Converter Type
- Dry type transformer
- Air cooled type
- Multi LV windings

Inverter
- Multilevel inverter cells:
  - three in series for 3.3 kV inverter
  - five in series for 6.6 kV inverter
  - eight in series for 10 kV inverter
  - nine in series for 11 kV inverter
- 0–72 Hz
- Up to 120 Hz, option for 3/3.3 and 6/6.6 kV
- For 10/11 kV, maximum frequency 72 Hz
- Multilevel output for motor-friendly waveform

Applicable Standards
- IEC61800-4, JIS, JEC, JEM

Control
- Nonvolatile memory for parameters and fault data
- Vector control with or without speed feedback, or Volts/Hz
- Designed to keep running after utility supply transient voltage drops of 300 ms
- Synchronous transfer to line option
- Synchronous motor control (option)

Vector Control Accuracy and Response
- Maximum speed regulator response: 20 rad/sec
- Speed regulation without speed sensor ± 0.5%
- Maximum torque current response: 500 rad/sec
- Torque accuracy: ± 3% with temp sensor, ± 10% without

Major Protective Functions
- Inverter overcurrent, overvoltage
- Low or loss of system voltage
- Motor ground fault
- Motor overload
- Cooling fan abnormal
- Over-temperature
- CPU error

Mechanical Specifications

Operating Environment and Needs
- Temperature: 0˚ to +40˚C
- Humidity: 85% maximum, noncondensing
- Altitude: Up to 1000 m (3300 ft) above sea level:
- Fan: 380/400/440 Vac, 3 phase, 50 Hz or 60 Hz

Cooling
- Air-cooled with fans on top

Sound
- Approx. 76-79 dB(A)@50Hz, at 3.1ft (1 m) from enclosure
- Approx. 80-83 dB(A)@60Hz, at 3.1ft (1 m) from enclosure

Enclosure
- IP30 except for fan openings (IEC 60529), NEMA gasketed equivalent
- Color: Munsell 5Y7/1 (Option: ANSI 61 gray, RAL7032 etc.)
# Drive/Motor Monitoring

## Operator Keypad

### High Function Display
- LCD backlight gives great visibility and long life
- Bar graphs, icons, menus, and digital values combine to provide concise status information, often eliminating the need for traditional analog meters

### Instrumentation Interface
- Two analog outputs are dedicated to motor current feedback
- Five analog outputs are mapped to variables for external data logging and analysis

### Multi-language Keypad – Optional Operator Interface (below)

The optional multi-language keypad is a touch-panel display with the same functionality as the standard keypad. Chinese version is shown here. The main features are:

- 5.7 inch (145 mm) LCD color display
- Choice of languages, touch selection:
  - English
  - Japanese
  - Chinese
  - Russian
  - Spanish
  - French
  - Portuguese
  - Italian
  - Korean
- The Ethernet communication with the drive, analog check pins, interlock button, and status LEDs are mounted separately
Drive Configuration

All the TMdrive family of drives are configured and commissioned with the Windows-based Drive Navigator. Wizards intelligently guide the user through the required steps. Included are live block diagrams, highly integrated help, and high-performance diagnostics. Several sets of drives can be maintained using Ethernet communication. The control block display opposite shows the main drive control functions together with real-time values of the important variables. Available Navigator functions include:

Parameter (Set Point) Control
- Loading and saving a parameter file
- Changing a parameter
- Comparing parameter files

Support Functions
- Control block display
- Snapshot function
- Step response test
- Response wave display

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
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, outlined on the next page.

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

Below is an example of the energy cost calculation for a pump driven by a motor and electric drive. The calculation for the mechanical system is similar and is described on the next page. 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.

**Energy Cost for Electric Drive Speed Control**

1. **Step 1** Select the desired pump output flow, for example 90%, and number of hours/day at this flow, for example 12.
2. **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. Find the pump input power.
3. **Step 3** Convert the input shaft horsepower to shaft kW. Conversion: Horsepower x 0.746 = kW
4. **Step 4** Obtain the electric motor efficiency. Example: Induction motor efficiency 95.7% from manufacturer’s data sheets (find at each RPM)
5. **Step 5** Obtain the adjustable speed drive efficiency. Example: Drive efficiency 96.5% from manufacturer’s data sheets (find at each RPM)
6. **Step 6** 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.
7. **Step 7** Obtain the adjustable speed drive efficiency. Example: Drive efficiency 96.5% from manufacturer’s data sheets (find at each RPM)
8. **Step 8** 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.
9. **Step 9** 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.
10. **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.

**Pump Performance Chart & Load Curve**

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.

Find the pump input power.

Motor input power = 1,169 kW / 0.957 Efficiency = 1,169 kW

Drive input power = 1,169 kW / 0.965 Efficiency = 1,212 kW

Energy cost = 1,212 kW x $0.07/kWh x 12 hrs/day x 365 days per year = $371,500 per year. (Repeat calculation for other flows in load profile and total).
TMEIC Drives Offer Complete Coverage

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