Project Engineering

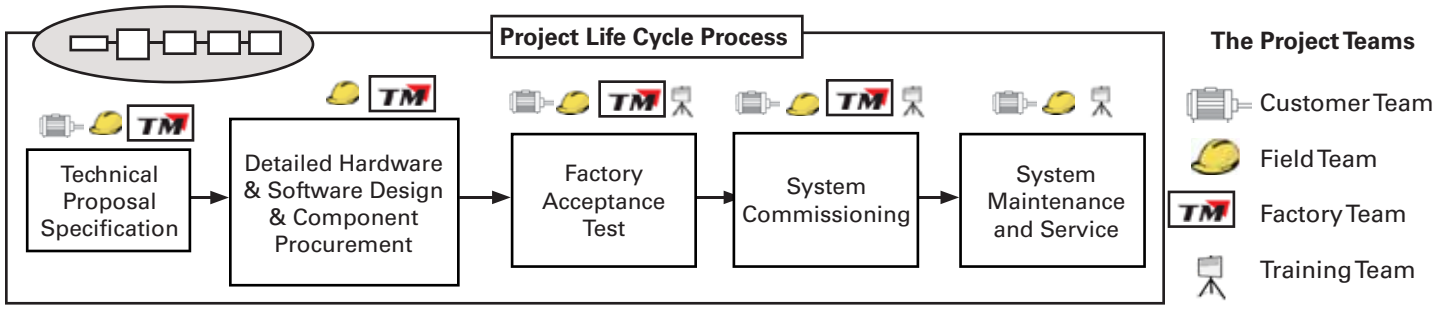
General Industries Team

Experienced Drive Engineering Team
The drive engineering team's experience in the mining industry was gained through years of working in mines with technicians and mechanical suppliers. This engineering background, coupled with state-of-the-art technology, enables TMEIC to consistently meet the very demanding requirements of the industry.

Experienced drive engineers jointly define the drive equipment and control strategy with your engineers and the OEM. This is followed by detailed design of the system, control logic, and configuration of the drives.

Local Commissioning Team Ensures Knowledgeable Ongoing Service
Our globally-based field organization has extensive experience in the industry providing you with a strong service presence for startup and ongoing service work.

Project Life Cycle Process Minimizes Risk



We understand that delay in your equipment commissioning is very expensive, so we take steps to hold our startup schedule. Our project engineering is based on the Project Life Cycle Process illustrated above and described in the following pages.

- Project management provides a single point of contact from initial order to final commissioning.
- Complete factory tests are conducted including applying power to the drive bridges and exercising the control system using motor and load simulators.
- The local commissioning engineers are included in the project team, allowing a seamless transition from the factory to your mine.

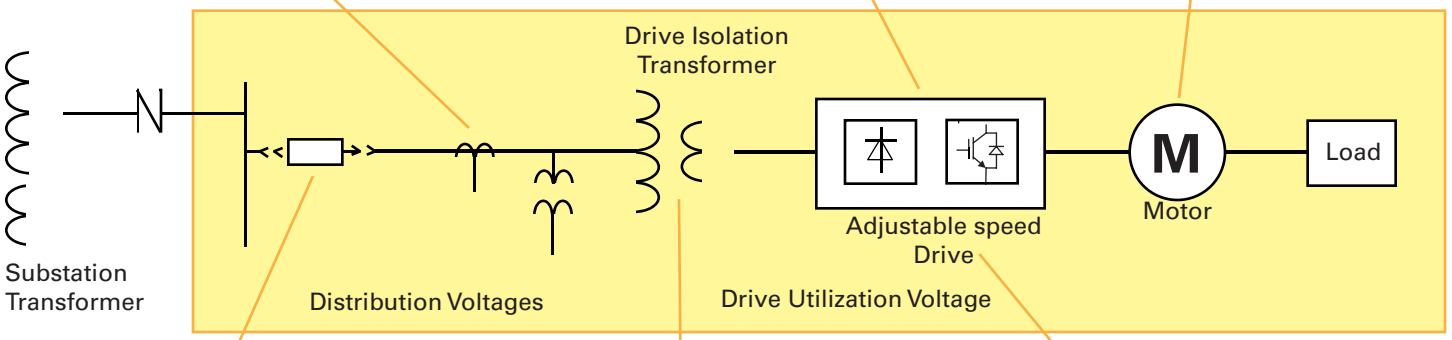
The Medium Voltage VFD System

TMEIC application engineers consider the system from the medium voltage switchgear to the adjustable speed drive and motor, sizing and selecting required equipment for the optimal drive solution. A typical MV VFD system is shown below.

Instrumentation for equipment metering, monitoring, protection and control is selected:
- Amp transducer and ammeter
- Watt and Watt-hr transducers
- Phase CTs and phase overcurrent relay
- Ground sensor CT and relay
- Power quality monitor

Selection of optional drive associated equipment
- Heat exchangers if required
- Air conditioned equipment house if required
- Switchgear if motor is to be synchronized with the line
- PLC for logic control
- Reactor for use with an LCI

Selection of the motor
- Induction, synchronous, wound rotor or dc motor
- Motor specs including power, torque, voltage, current, and speed
- Selection of exciter for sync motor
- Required motor protection devices
- Optional tachometer
- Optional Torsional analysis



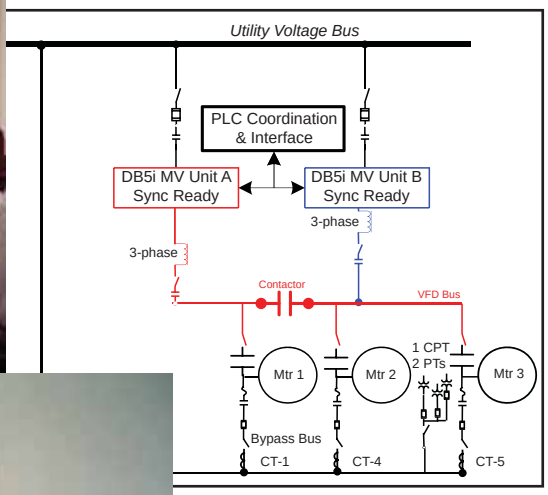
Breaker

MV Switchgear is selected for the application considering:
- The type, such as vacuum or SF6
- The size for the current and voltage
- The CTs, PTs, and protective relays to operate the breaker
- The enclosure for outdoor or indoor
- The environment, such as temperature and humidity

Drive Isolation transformers, input and output, are selected for the application considering:
- The type, such as dry or liquid filled
- Size for the kVA and voltage
- Cooling, if required
- The enclosure for outdoor or indoor
- The environment, such as temperature and humidity

Selection of the best adjustable speed drive for the application:
- Continuous and overload torque and power requirements
- Type of load, including constant or variable torque, regenerative
- Drive and motor voltage
- Power system compatibility
- Overall efficiency of the ASD and motor combination
- Harmonic analysis

Project Planning and Specification



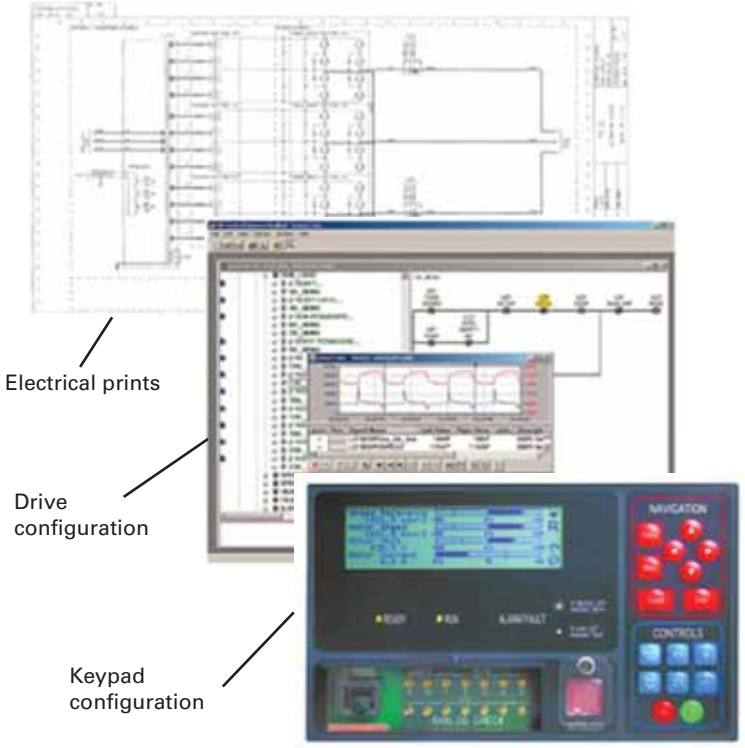
During all phases of your project planning, TMEIC assists you by supplying information, training, guide-form specifications, and general advice. Experienced drive application engineers prepare a technical proposal that includes:

- Customized system architecture for your project.
- Detailed equipment specifications for the drives, motors, exciters, transformers, switchgear, and housings.
- Thorough description of the PLC and other control functions.
- Formal bid documentation.

Detailed Hardware/Software Design and Procurement

Based on the proposal specification, the project engineering team proceeds with four main tasks:

- **Control Software Design.** Control engineers configure the drives and PLC controller logic, if a PLC is required for the application. The illustration shows a typical toolbox logic function diagram in Relay Ladder Diagram format. The software tool is used for drive configuration, tuning, sequencing, and drive diagnostics.
- **Optional HMI Screen Design.** Interface screens for maintenance and drive control can be configured. For example, the configurable keypad shown here provides real-time drive data and operator interaction.
- **Hardware Design.** All equipment is specified to meet the project requirements, and a complete set of elementary diagrams, layout, and outline drawings is created.
- **Component Procurement.** We work with our parent and partner suppliers to source the most cost effective system components for your application.

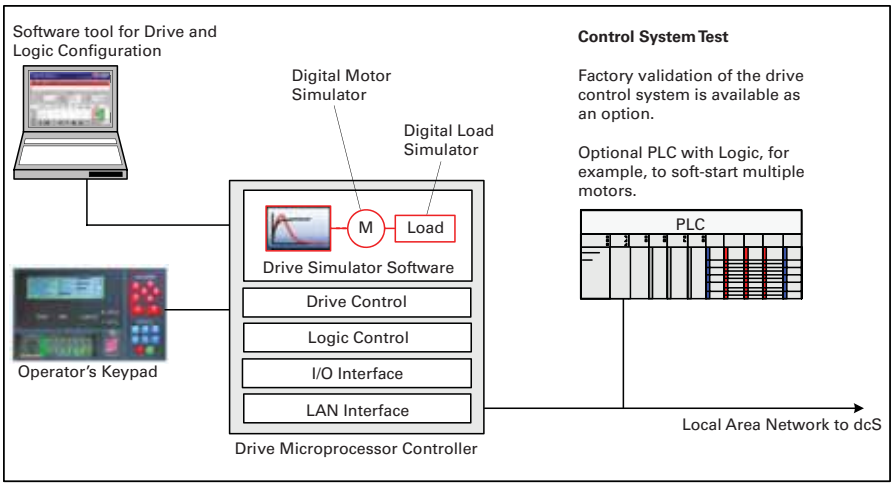


Drive and System Test

Understanding the importance of a thorough drive and system test, the TMEIC engineering team conducts factory tests before shipment. Drive tests in the factory typically include:

- Full voltage and current check of power cells, insulation, and control circuits.
- Acceleration and run test with unloaded motor.
- Full current test into a reactor (ac drives).
- Validation of all I/O interfaces.
- Validation of the drive test modes and any special logic, or optional PLC using motor and load simulator.

Dura-Bilt5i MV Drive Testing



System Commissioning

In the commissioning phase, the TMEIC team includes the field engineers you know and trust, alongside the engineer who designed and tested the system. This overlap of teams between engineering design and the site ensures a smooth and on-schedule startup.

The TMEIC service engineer, who is responsible for startup and commissioning, and for any future service required at the site, is part of the project team and participates in the factory system test to become familiar with the system. Commissioning is supported by TMEIC design and service engineers.

Complete & Detailed System Documentation
Along with the hardware and software, TMEIC delivers complete system documentation:

- An electronic instruction book with all the prints on CD with a hyperlink index;
- Recommended wiring and grounding procedures;
- Renewal parts list; and
- Standard third-party vendor documentation.
- Validation of the drive test modes and any special logic, or optional PLC using motor & load simulator.

Global Customer Support Network

Comprehensive technical service is provided by our Customer Support Organization, staffed by TMEIC service engineers with offices and spare parts depots across the globe.

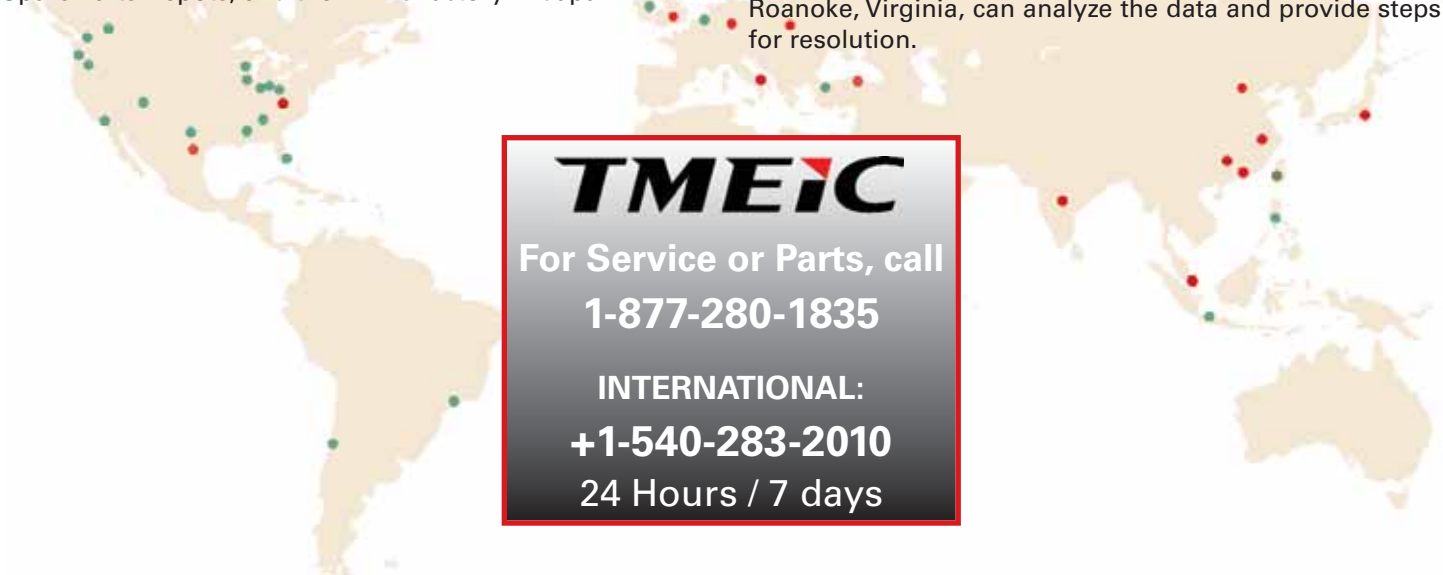
In North and South America
Customers are supported by the TMEIC Corporation service personnel, design engineers and Spare Parts Depot in Virginia, and the TMEIC Factory in Japan.

In Europe
TMEIC service engineers service all drive systems in Europe, supported by the European TMEIC Spare Parts Depot.

In Asia and the Pacific Rim
TMEIC services drive systems throughout China, India and the Pacific Rim, supported by multiple Field Engineers, Spare Parts Depots, and the TMEIC factory in Japan.

Remote Drive Diagnostics
TMEIC Corporation supports drive customers through the ***Remote Connectivity Module (RCM)***, a remote diagnostic service link with the TMEIC design and service engineers in Roanoke, Virginia. The RCM enables seamless integration between your drives and our engineers.

Remote System Diagnostics
TMEIC's remote system diagnostics tool, included in level 1 software, offers a quick path to problem resolution. System faults are automatically identified, and provide an integrated view of product, process and system information. TMEIC design and service engineers in Roanoke, Virginia, can analyze the data and provide steps for resolution.



TMEIC

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1-877-280-1835

INTERNATIONAL:

+1-540-283-2010

24 Hours / 7 days

Drive Training at our Training Center or in Your Facility

Customer engineers, maintenance and operations personnel are trained on the drives and control system at the TMEIC Training Center in Virginia. This world-class facility features large classrooms and fully-equipped training labs.

Classroom and hands-on training consists of 50% class time and 50% hands-on lab time. Topics include:

- Overview of the drive system
- Function of the main assemblies
- Technical details of the components
- Drive and control system tools
- System diagnostics and service

As an alternative to the standard factory training in Virginia, TMEIC can offer a course tailored to your project and held at your location. In this case, a project engineer trains your operators, maintenance technicians and engineers in your facility.

A Family of Drives up to 11 kV

TMdrive-DC

TMdrive-10e2

TMdrive-10SPR

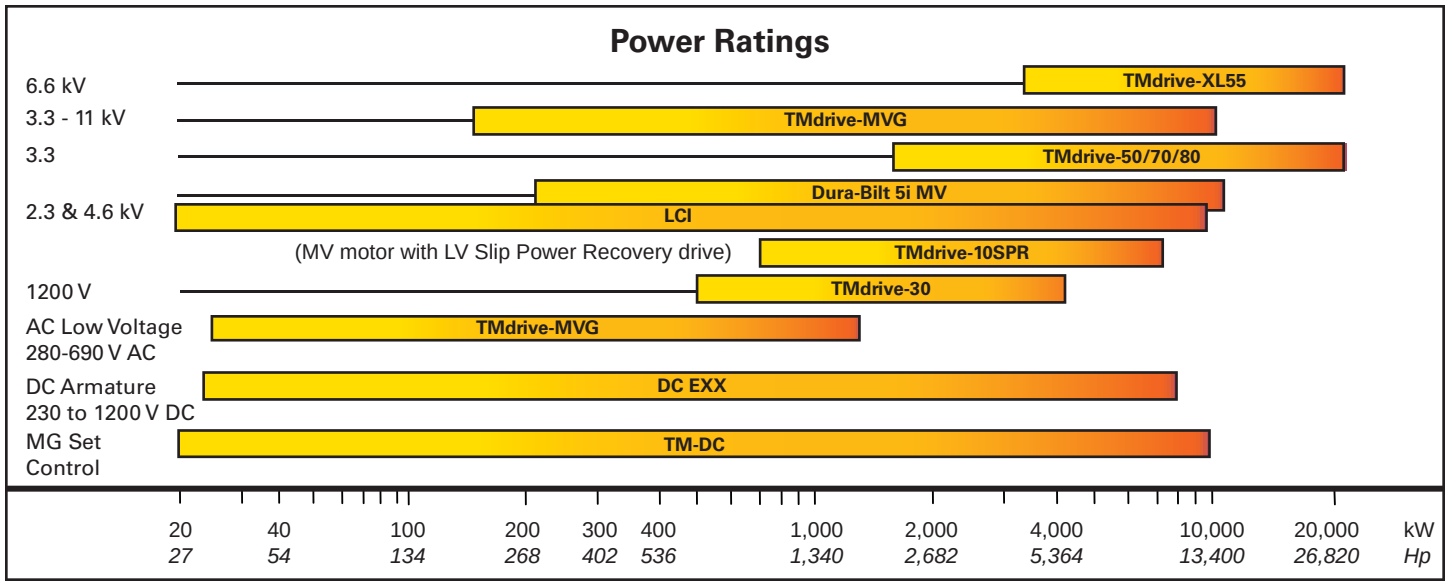
TMdrive-30

TMdrive-70

Dura-Bilt5i MV

TMdrive-XL55

TMdrive-MVG



TMEIC's Family of AC and DC System Drives

Over 50 years of Drive Experience. Starting with dc drives, we later introduced ac drives, such as the the new technology Tosvert, Dura-Bilt 5i MV, and TMdrives. Since 1979 over 2 million hp of TMEIC ac drives have been installed and are in service, representing the largest installed base of MV drives of any manufacturer.

AC drive Voltages up to 11 kV. The family of ac drives offers voltages from 380 V with the TMdrive-10 up to 11kV with the TMdrive-MVG. The dc drive family covers 230 to 1200 vdc

Significant Investment in Drive Technology. TMEIC's Dura-Bilt and TMdrive products represent a large investment in LV and MV drive technology, including development of semiconductor devices such as the IEGT and GCT.

The Highest Reliability. TMEIC drives provide the highest reliability based on field experience and customer satisfaction survey results.

Configuration Software. The TMdrive Navigator world-class configuration software is used on all TMEIC drives. Live block diagrams and tune-up wizards streamline commissioning and maintenance activities.

Spare Parts Stock. TMEIC's parts depots stock the line of LV and MV drive parts to provide rapid delivery to your facility anywhere in the world.

TMdrive®-10 Low Voltage System Drive

The TMdrive-10 family of low voltage ac system drives has an integral dc bus structure with a wide variety of inverters (dc to ac) and converters (ac to dc) to match diverse needs. There are four voltage levels – 440, 460, 575, and 690 V ac.

Converter power level ranges are:
- Non-regenerative, 150 kW – 3600 kW
- Regenerative, 100 kW – 1417 kW

Inverter power level ranges are:
- With dc disconnects, 3.1 kW – 1182 kW
- Without dc disconnects, 141 kW – 1454 kW

Draw-out Inverter trays stack eight to a 32-inch wide cabinet. The power level ranges are:
- Single high trays, 3.1 kW – 63 kW
- Double high trays, 101 kW – 106 kW

Inverter power bridges use Insulated Gate Bipolar Transistors (IGBT). The type of modulation is two-level voltage using pulse width modulation (PWM).

TMdrive®-10SPR Slip Power Recovery for Wound Rotor Motors

The Slip Power Recovery (SPR) version of the TMdrive-10 provides speed control of a wound rotor motor and efficient recovery of slip power from the rotor. This is discussed in Application 4 on page 10. Features of the SPR include:

- Significant energy savings and low cost of ownership
- The highest efficiency adjustable speed drive
- Pulse width modulated converter
- Reliability
- High power factor operation
- High MV Motor: for wound rotor motors, from pulse width modulated converter 1,000 – 10,000 hp

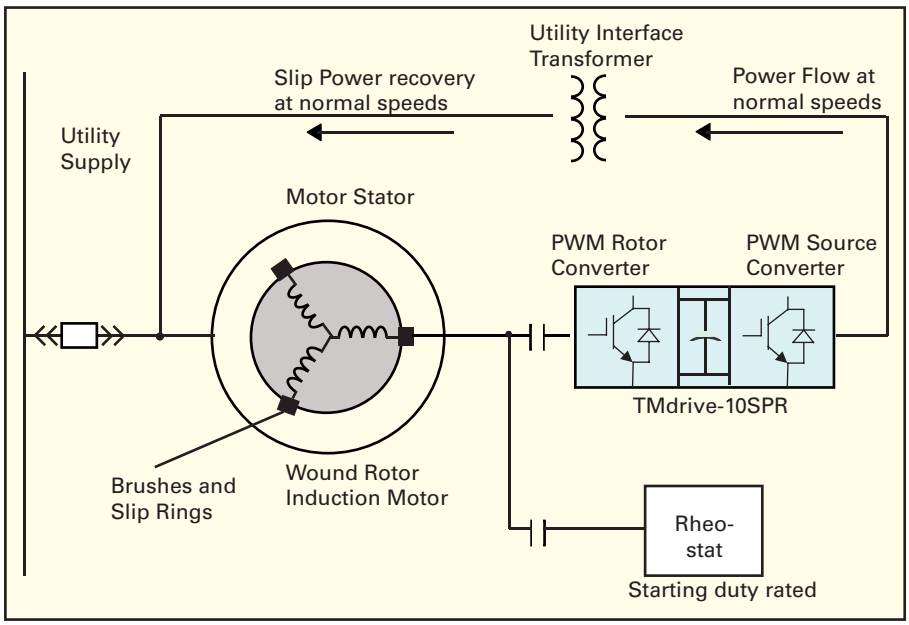
Speed Range: depends on rotor voltage; super synchronous speed operation is available

I/O, LAN Interface, & Cabinet Size: same as TMdrive-10.

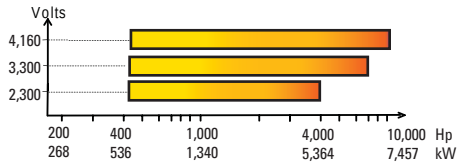
SPR Operation

The TMdrive-10SPR takes power out of the rotor to reduce the motor speed. At reduced speeds, power flows out of the rotor through the SPR to the transformer and back into the supply, instead of being dissipated in the rheostat.

The SPR is the highest efficiency VFD because only a fraction of the motor power goes through the drive. During startup the rheostat is connected to the rotor and the SPR is disconnected. Once up to minimum speed, the SPR drive is connected and the rheostat disconnected. The motor speed is then controlled by the SPR.



Dura-Bilt5i MV™ Medium Voltage System Drive



Operator Keypad: Keypad provides real time drive data and manual control of drive.

Motors: Drive works with an induction motor or synchronous motor.

The Dura-Bilt5i MV delivers simple operation in a robust and compact design, providing a cost effective solution for a broad range of medium voltage applications.

The Dura-Bilt5i MV delivers value through low cost of ownership and high reliability. Dual drive configurations are possible; power levels available include:

- **2000 Series** – 2,300 Volts Out, 200 to 3,000 hp
- **3000 Series** – 3,300 Volts Out, 300 to 4,000 hp
- **4000 Series** – 4,160 Volts Out, 400 to 10,000 hp
- **4000 MTX Series** - 4160 Volts Out, NEMA 3R Outdoor enclosure for 0 to 50° C ambient

Rugged design features for high reliability include:

- Inverter heat pipe cooling for largest size
- Diode rectifier converter with 24-pulse circuit for low input current distortion
- Neutral point clamped pulse width modulated inverter using medium voltage IGBTs

Cabinet Size: 900 hp drive is 74 in. (1,880 mm) long
6,000 hp drive is 222 in. (5,639 mm) long
Cabinet height is 104 in. (2,642 mm)

Integral Transformer: Copper wound transformer with electrostatic shield, rated for 115° C rise.

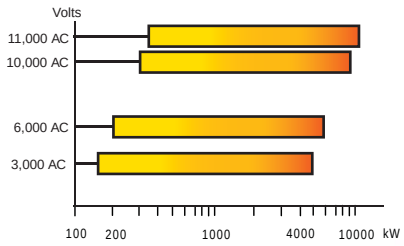
DC Bus Capacitors: Bus capacitors are oil-filled for long life.

Synchronization: Closed transfer synchronizing control.

Access: Roll out inverter phase leg assemblies.

Features	Benefits
Medium voltage IGBTs Each inverter uses 3,300 Volt Insulated Gate Bipolar Transistors (IGBTs).	**Rock-solid reliability** High power IGBTs allow a simpler, more reliable inverter design with fewer power switches.
24-pulse converter Each phase leg of the converter includes a 24-pulse diode rectifier.	**Power system friendly** The converter produces less Total Harmonic Distortion (THD) than the IEEE 519-1992 specification, without requiring filters.
Heat pipe cooling technology Each of the three inverter legs use heat pipe cooling for the IGBTs.	**Compact Quiet Design** The heat pipe cooling system maintains good semi-conductor working temperature, reduces fan noise, and saves valuable floor space in your plant.
Windows-Based configuration and maintenance tool • Animated block diagrams • Drive tune up wizards • Integrated trend window	**Faster commissioning and maintenance** This world-class software tool improves productivity in commissioning and maintenance and can be used on all TMEIC drive products.

TMdrive®-MVG up to 11.0 kV



The TMdrive-MVG is a medium voltage, ac fed drive designed for high efficiency and motor-friendly operation in a broad range of industrial applications.

High reliability, low harmonic distortion, and high power factor operation are designed into the MV drive. Modular drawable cell inverters minimize the time required for any maintenance activities.

The TMdrive-MVG is available in these voltage classes:

3.3 kV Voltage class: 3,000 – 3,300 V ac

6.6 kV Voltage class: 6,000 – 6,600 V ac

10.0 kV Voltage class: 10,000 V ac

11.0 kV Voltage class: 11,000 V ac

Five Cabinet Sizes are available for each class, some examples:

3.3 kV: 200-400 kVA, 83 in wide, 106 in. high, 36 in. deep
2400-3000 kVA, 182 in wide, 114 in. high, 52 in. deep

6.6 kV: 400-800 kVA, 126 in wide, 106 in. high, 36 in. deep
4800-6000 kVA, 248 in wide, 114 in. high, 56 in. deep

Features

A clean wave input converter

Using the multiple winding input transformer, the TMdrive-MVG has a multi-pulse rectification and more than meets the requirements of IEEE-519 (1992). This reduces the harmonic voltage distortion on the power source and protects the other equipment in the plant.

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 negligible torque ripple on the output shaft and very little risk of torsional load resonance.

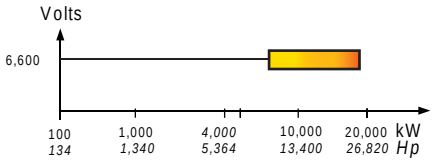
A higher efficiency than conventional drives

Actual factory load tests show the drive efficiency is approximately 97% (design efficiency is approximately 97% design value). This high efficiency is a result of:

- Lowest 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 6 kV motor without an output transformer.

Inverter Cell Module
Removed from rack

TMdrive®-XL55 Medium Voltage Drive



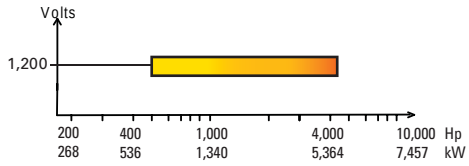
The TMdrive-XL55 is available for 6.0 – 6.6 kV voltage class.

The TMdrive-XL55 is a general-purpose, medium voltage, variable-frequency ac drive for industrial power ratings up to 16 MVA. Featuring high-quality Japanese design and manufacture, high reliability, low harmonic distortion, and high power factor operation are designed into the drive.

Benefits of the TMdrive-XL55 include:

- Highly reliable operation and expected 87,000 hour (10-year) drive MTBF, based on field experience with over 700 medium voltage drive installations.
- Considerable energy savings, in particular on flow control applications - efficiency approximately 98.6%
- Diode rectifier ensures power factor greater than 95% in speed control range - capacitors not required for power factor correction
- Motor-friendly waveform from the multiple level drive output waveform is suitable for standard motors
- Synchronous transfer to line option with no interruption to motor current
  - Allows control of multiple motors with one drive
  - No motor current or torque transients when the motor transitions to the ac line
- Remote input isolation transformer
  - Less power loss in drive room
  - Less total space required
  - Simplified design and installation

TMdrive®-30 Medium Voltage Drives



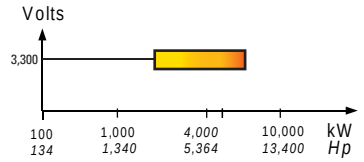
The TMdrive-30 is a medium voltage, dc-fed system drive for high power applications. The drive is available in two voltage levels – 1100 V and 1250 V ac.

Benefits of the TMdrive-30 include:

Converter power level ranges are:
- Non-regenerative, 3300 kW
- Regenerative (Thyristor), 3300 – 6000 kW
- Regenerative (IGBT), 1733 – 3465 kW

Inverter power level ranges:
- IGBT, 2000 – 4000 kVA
- Common dc bus circulates motoring and regen power on the drive dc bus for optimum use of conversion equipment and power factor control.
- TMdrive-30's ruggedized design enables application in demanding environments like draglines and is suited for cyclic loads.
- Rack out power modules facilitate fast inspection and maintenance.

TMdrive®-50 Medium Voltage Drives



The TMdrive-50 is designed for high-power applications
High-power, precision-controlled processes are ideally suited for the TMdrive-50 with its efficient high current IGBT power devices and control cards common to the drive family. Flexible arrangement of converter, inverter and cooling units allows for maximum power density, resulting in minimum floor space and installation cost.

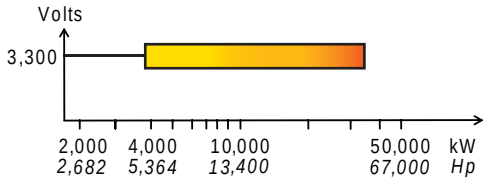
3,000 – 6,000 Frame: 3,300 Volts out, motor power 2,000 – 6,000 hp

Cabinet Size: 79 inches (2,000 mm) long, 94 inches (2388 mm) high.

Design features for high reliability:

- Water cooling technology for the power bridge reduces footprint
- Medium Voltage Insulated Gate Bipolar Transistor (IGBT) provides power at unity power factor and low harmonics
- Modular Design for power bridges minimizes maintenance time
- Control signal is voltage, not current. IGBT requires very low power to switch.
- High switching speeds less than 2 µ second - low switching losses and accurate control
- Simple switching circuitry - gate driver hardware is compact.

TMdrive®-70 Medium Voltage Drives



The TMdirve-70 is designed for high-power applications
High reliability, design simplicity and high efficiency, the TMdrive-70 is perfect for compressor, fan and pumping applications. It provides accurate speed control and high efficiency while eliminating the need for high maintenance mechanical flow control devices.

Design features for high reliability:

- Water cooled, draw-out phase leg assemblies with quick disconnect fittings reduce drive footprint
- Converter and inverter use medium voltage IEGT power semiconductors with high-speed switching to provide near unity power factor to the load
- Regenerative IEGT converter available
- Pulse Width Modulation using fixed pulse pattern control reduces switching losses
- Modular design - power bridge assemblies are draw-out modules. Quick disconnects minimize maintenance time.
- Motor and power-system friendly - high speed switching (500 Hz) coupled with the three-level bridge design delivers a smooth sine wave to the motor and power system.

Frame Size	Volts Out	Motor Power (hp)
8,000	3,300	5,000-10,000
10,000	3,300	13,000
20,000	3,300	26,000
40,000	3,300	52,000

Frame Size	Cabinet Length inches (mm)	Cabinet Height inches (mm)
8,000 - 10,000	126 (3,200)	94 (2,388)
20,000	220 (5,600)	94 (2,388)
40,000, plus a second cabinet	252 (6,400) 189 (4,800)	94 (2,388) 94 (2,388)

Medium Voltage Motor and Drives Systems School

TMEIC Corporation is pleased to offer its tuition-free MV Motor and Drives Systems School to its customers. These schools are offered regularly in Roanoke, Virginia, and other cities.

Course Topics:

- Medium Voltage (MV) induction and synchronous motors
- Fundamentals of variable frequency drives
- MV drive characteristics, payback, and specifications
- MV power systems design concepts
- MV switchgear, starters, transformers, reactors, and substations
- MV system protection
- Real-world industrial application stories from the mining, cement, oil & gas, petrochemical and water & waste water industries
- Equipment demonstrations

For details and registration for our next school, please visit our Web site at www.tmeic.com.

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