TMdrive™-50 Product Application Guide

Medium Voltage 3-Level IGBT System Drive
The Insulated Gate Bipolar Transistor (IGBT) is used in the converter and inverter. The following set of features and associated benefits details how this device lowers your cost of ownership versus previous main drive technology.

### Features

- **The control signal is voltage, not current**
- **High switching speeds less than 2 µ sec**
- **Simple switching circuitry**

### Benefits

- The IGBT requires very low power to switch so control circuits are small, with few components and therefore low failure rate.
- Very low switching losses and accurate control.
- Gate driver hardware is compact. Careful design has allowed traditional IGBT snubber components to be removed.
Bringing Reliable Control To System 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.

Coordinated drive systems are an integral part of numerous manufacturing processes in the metals industry. TMdrive system drives address all of these applications with a robust control platform and a common Microsoft Windows-based tool. The tool supports local and remote connectivity, and is an invaluable asset for system and process analysis.

Due to its high reliability, simplicity of design and high efficiency, the TMdrive-50 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. The TMdrive-50 is also well suited for applications like grinding mills and mine hoists, where high overloads and impacts are a part of everyday operations.
State-of-the-Art Technology:

• High Voltage Insulated Gate Bipolar Transistors (IGBT) – based converter provides power to the process at unity power factor and low harmonics

• Water-cooling technology for the power bridge reduces the footprint of the equipment saving valuable space in your factory

• Modular design for power bridge minimizes the time required for any maintenance activities

Control Functions

Each inverter and regenerative converter shares a common set of control boards. The primary control board performs several functions:

• Speed and torque regulation
• Sequencing
• I/O mapping
• Diagnostic data gathering

A mounting bracket is provided for an optional LAN interface board.

I/O Board

All TMdrive products share a common I/O board. The I/O board supports an encoder, 24 V dc I/O, 115 V ac inputs, and analog I/O, standard. In addition, a resolver interface option can be provided. All I/O are terminated to a two-piece modular terminal block for ease of maintenance.

Typical Inverter Waveforms

- Voltage Line
- Current
The converter generates dc power for the inverter. The inverter then creates variable frequency ac power to control the induction or synchronous motor. The dc power between the converter and inverter is conveyed on a solid copper bus behind the phase leg assemblies in both cabinets. For common bus systems this bus is extended to adjacent cases.

**IGBT Three-Level Phase Leg Assembly**
The drive has a total of six phase leg assemblies. These are organized as twelve identical half legs each containing two IGBT switches.

**dc Bus**

**Main Power**
3-Phase motor and transformer are made in the rear. Bottom entry is supported.

**Cooling Water Interface**
JIS-10K40A fittings are provided for connecting cooling water for de-ionized cooling loop. Water interface shown here is for “separate” type water conditioner.

**Main Capacitors**
Dry Type Film capacitors are used to provide long life under all service conditions and duty cycles.
Drive Details

TMdrive-50 Frame 3000

TMdrive-50 Frame 6000
Drive Specifications

1. Above dimensions do not include channel-base support – 50 mm (2 in).

2. Above is for induction motor drive, additional field exciter panel is required for synchronous motor.

3. Required maintenance access space is 2000 mm (79 in) at front and 1500 mm (59 in) at rear of panel, air exhaust space is 1000 (40 in) above panel.

4. For separate cooling type, flange connection (JIS-10K40A) is required at bottom rear of inverter and converter panels.

5. Outside cooling water inlet temperature is 10-32°C.

6. Amps are standard values; they will vary with voltage, type of load, and other control.

7. Control power is 50 or 60 Hz, 200/220 V, 3.0 kVA per bank.

8. Converter and inverter cable entrance is from bottom.

9. Indoor environment: no corrosive gas or dust, altitude below 1000 m, ambient temperature 0-40°C, relative humidity 5-95%, no condensation.

10. This initial charge inrush is 42 kVA for 10 seconds for each bank.

---

<table>
<thead>
<tr>
<th>Banks</th>
<th>Frame kVA</th>
<th>Weight kg (lbs)</th>
<th>Control Power kVA</th>
<th>Motor Current A ac</th>
<th>Allowable Overload % (60 sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3000</td>
<td>3300 (7275)</td>
<td>3.0</td>
<td>510</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>437</td>
<td>175</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>382</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>340</td>
<td>225</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>306</td>
<td>250</td>
</tr>
<tr>
<td>2</td>
<td>6000</td>
<td>5800 (12787)</td>
<td>6.0</td>
<td>1020</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>874</td>
<td>175</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>764</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>680</td>
<td>225</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>612</td>
<td>250</td>
</tr>
</tbody>
</table>

Notes

---

- Banks Frame kVA Weight kg (lbs) Control Power kVA Motor Current A ac Allowable Overload % (60 sec)

- 2375 mm (94 in)

   Width: 2000 mm (79 in) Depth: 1650 mm (65 in)

- 2375 mm (94 in)

   Width: 3200 mm (126 in) Depth: 1650 mm (65 in)
Modular Assembly

Three-Level Phase Leg Assembly for Both Converter and Inverter

- Flexible Water Cooling Tubes are easy to manage when performing maintenance.
- Slide-out Half Power Leg allows easy manipulation of power modules without the need for special tools or lifting devices.
- IGBT Gate Drive
- Self-sealing quick couplers allow the water cooling circuit to be disconnected without tools or water loss.
- Dual IGBT Assembly common to inverter and converter section.
Environmental (Inverters and Converters)

- **Operating Air Temperature**: 0 to 40°C (32 to 104°F) at rated load
- **Storage Temperature**: -20 to 55°C (-13 to 131°F)
- **Humidity**: 5 to 95% relative humidity
- **Altitude**: 0 to 1000 m above sea level
- **Vibration**: 10-50 Hz, <0.5 G
- **Operating Water Temperature**: 10°C - 32°C at inlet
- **Outlet temperature is inlet + 6°C**

Mechanical (Inverters and Converters)

- **Enclosure**: IP 20 (NEMA 1), JEM-1267, IEC-60529
- **Cable Entrance**: Bottom
- **Wire Colors**: Per CSA/UL and CE
- **Short Circuit Ratings**: 100 kA for ac and dc buswork
- **25 kA for control power**
- **Acoustic Noise**: 66-68 dB @ 150% OL,
  1 m from cabinet in all directions,
  1.5 m in height above the floor

Motor Control

**With Speed Sensor (Resolver or Encoder)**
- **Speed regulator accuracy**: +/- 0.01%
- **Maximum speed response**: 60 rad/sec
- **Torque linearity**: +/- 10% Synchronous motors
- **Torque linearity**: +/- 3% with temperature sensor
- **Maximum Torque current response**: 600 rad/sec
- **Torque range**: 0-400% of rated motor torque
- **Maximum flux control range**: 20%-100%

**Without Speed Sensor (Induction Motor Only)**
- **Speed regulator accuracy**: +/- 0.1% with temperature sensor
- **Maximum speed regulator response**: 20 rad/sec
- **Minimum continuous speed**: 3%
- **Torque linearity**: +/- 10%
- **Maximum Torque current response**: 600 rad/sec
- **Torque range**: 0-150% of rated motor torque
- **Maximum flux control range**: 75%-100%

Power Input/Output

- **Input Voltage**: 3550 V for Fixed Pulse Pattern type
  3100 V for Carrier Comparison type
- **Input Voltage Variation**: +/- 10%, Continuous operation below nominal requires derate
- **Input Frequency**: 50/60 Hz
- **Input Chopping**: Approx. 500 Hz
- **Input Harmonics**: IEEE 519 Compliant
- **Control Power**: Control and Blowers
  180-220 Vac, 50Hz 3-Phase
  198-242 Vac, 60 Hz 3-Phase
- **Pumps and Precharge**: 380-460 Vac, 50/60 Hz 3-Phase
- **Displacement Power Factor**: 0.98
- **Output Voltage**: 3400 V max
- **Output Frequency**: 0-60 Hz
  Continuous operation below 0.4 Hz requires derate
- **Output Chopping Frequency**: 512 Hz
- **Efficiency**: 98.5% at rated load
Advanced PWM Technology

Advanced PWM control brings enhanced efficiency and reduced harmonics to TMdrive-50 systems. Fixed pulse pattern gate control uses optimum gating sequences to almost eliminate switching losses in the IGBT device. Gating sequences are pre-computed for the control rather than computed at runtime. The result is performance that reduces losses and harmonics.
Field Supply Specifications

The TMdrive-50 converter can be configured in two modes, providing VAR Control within the limits of its current capacity.

One mode is the conventional PWM type normally set to hold unity power factor for all load conditions. (Shown in red)

Another mode is the Fixed Pattern type, providing voltage stability, improved harmonics and efficiency. The Fixed Pattern mode stabilizes line voltage by providing system VARs when line voltage is low and drawing VARs from the system when the voltage is high. By convention, VARs from the system are (+) and cause the line voltage to drop while VARs from the converter are (-) and cause the line voltage to rise. The relationship of line voltage, loads MW and converter MVAR is shown by the blue voltage lines depending on the measured line voltage.

Field Exciter Continuous Current Rating, dc Amps

<table>
<thead>
<tr>
<th>Type</th>
<th>50 Hz</th>
<th>60 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>150%</td>
<td>175%</td>
</tr>
<tr>
<td>1200 A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>1320</td>
<td>1200</td>
</tr>
<tr>
<td>30</td>
<td>1230</td>
<td>1100</td>
</tr>
<tr>
<td>60</td>
<td>1180</td>
<td>1040</td>
</tr>
<tr>
<td>120</td>
<td>1120</td>
<td>980</td>
</tr>
<tr>
<td>200 A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>2376</td>
<td>2160</td>
</tr>
<tr>
<td>30</td>
<td>2214</td>
<td>1980</td>
</tr>
<tr>
<td>60</td>
<td>2124</td>
<td>1872</td>
</tr>
<tr>
<td>120</td>
<td>2016</td>
<td>1764</td>
</tr>
</tbody>
</table>

Enhanced Converter Technology

TMdrive-50 VAR Control

Main Power module. One module is applied for the 1200A supply and two modules for the 2100A model.

Autonomous Crowbar prevents dangerous motor voltages from developing under certain fault conditions

Ground Fault detection module provides indication of insulation failure

AC Leg Fuses protect power bridge from faults on the ac line

DC Field Connection Bus

AC Connection Bus. AC voltages up to 500 Vac can be connected depending on required voltage

Frame Weight (lbs) Control Power KVA Voltage Vac (Vdc)

<table>
<thead>
<tr>
<th>Frame</th>
<th>Weight kg</th>
<th>Control Power</th>
<th>Voltage Vac</th>
</tr>
</thead>
<tbody>
<tr>
<td>2375 mm (94 in)</td>
<td>1200</td>
<td>300 (660)</td>
<td>0.5</td>
</tr>
<tr>
<td>800 mm (32 in) Depth: 950 mm (37 in)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2375 mm (94 in)</td>
<td>2100</td>
<td>700 (1540)</td>
<td>0.5</td>
</tr>
<tr>
<td>1200 mm (47 in) Depth: 950 mm (37 in)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Field Supply Specifications |

Enhanced Converter Technology

MVA vs. MW and Voltage
Applying the TMdrive-50 Starts With the Motor Design

Consideration must be given to motor design when applying the TMdrive-50. A primary constraint is the motor terminal voltage. It is important that the motor terminal voltage does not exceed 3400 Vac under any operating condition. Reserving voltage margin correctly is critical to success. Detailed motor design data is needed for correct application.

OL_V Overload derate. The rated motor voltage over the terminal voltage of the motor at maximum applied overload. Motors with no overload use 1.0.

RP_V Reduction in maximum voltage due to the dc Bus ripple of the drive at low frequencies. If the base frequency is below 5 Hz then this derate is 0.97, otherwise it is 1.0.

ST_V Field forcing margin needed when applying synchronous motors. Apply 0.94 for synchronous motor systems.

SP_V Speed margin. For motors that run above base speed this is the ratio of the terminal voltage at base speed over the terminal voltage at top speed under maximum overload at each point. Other motors use 1.0.

Maximum Rated Motor Voltage = 3400 x OL_V x RP_V x ST_V x SP_V

Experience has shown that the following maximum rated motor voltages apply based on the type of motor and the application.

<table>
<thead>
<tr>
<th>Induction (Maximum Voltage at max OL and top speed)</th>
<th>Synchronous Maximum Rated Motor Volts</th>
<th>Rated Motor Frequency</th>
<th>Overload Requirement</th>
<th>Example Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>3400</td>
<td>3300</td>
<td>60 Hz</td>
<td>100%</td>
<td>Pump or Fan</td>
</tr>
<tr>
<td>3300</td>
<td>3200</td>
<td>30 Hz</td>
<td>200%</td>
<td>Mine Hoist</td>
</tr>
<tr>
<td>3200</td>
<td>3100</td>
<td>5 Hz</td>
<td>225%</td>
<td>Mill Stand</td>
</tr>
</tbody>
</table>

TMdrive-50 Notes

1. Allocate a minimum of 1000 mm (40 in) above cabinet for fan maintenance.
2. Power rating data assumes ambient temperature of 0-40°C (32-104°F), altitude up to 1000 m (3280 ft) above sea level.
3. The specified current ratings are continuous to which the indicated overload may be applied for a maximum of 60 seconds.
4. Each cabinet requires 3-phase control power.
5. For high performance torque regulation, a temperature sensor is mounted in the motor.
6. All TMdrive-50 cabinets require 1500 mm (59 in) back access for connections and maintenance.
7. Speed and current regulator responses are computed per the adjacent figure in radians/s. Speed regulator responses shown are maximum available. Actual response will be limited by drive train mechanical conditions. Accuracy and linearity specifications shown are as measured under controlled conditions in our lab and while typical may not be achievable in all systems.
8. Water connections for separate type cooling systems are located near the floor in the rear of power converter cabinets. The flange is 1500 mm JIS-10K40A. Stainless piping is required for plumbing of the de-ionized loop.
9. dc Bus bar included in lineups is rated for one inverter only. For common bus systems, converters and inverters are arranged so that this limitation is not exceeded.
10. When output or input reactors are used to parallel systems then the dc Buses of those systems must be connected together.
11. Systems that share a common dc Bus must have the same winding configuration for their converter transformer secondaries.
12. Field supply enclosures are typically installed directly behind control enclosures within the lineup.
13. TMdrive-P50 converters require a minimum of 15% total input impedance.
14. Systems with a base frequency below 5 Hz may require additional 800 mm (32 in) capacitor panels for each dc link.
When specifying an inverter, start from the process requirements and work through the motor to the inverter. The following example illustrates this process.

1. Define process requirements.

2. Select motor based on process requirements and compute required inverter kVA.
   - 4000 kW (5360 hp)
   - 500 rpm, 3100 V
   - Efficiency = 0.965
   - Power factor = 1.00
   - Service factor = 1.0
   - Synchronous

   \[ I_{ac\,\text{inverter}} = \frac{kW_{\text{shaft}} \times 1000 \times SF_{\text{tr}}}{\sqrt{3} \times V_{\text{motor\,rated\,voltage}} \times EF_{\text{tr}} \times PF_{\text{tr}}} \]
   \[ = \frac{4000 \times 1000 \times 1.0}{\sqrt{3} \times 3150 \times 0.965 \times 1.0} \]
   \[ = 760 \, \text{amps} \]

3. Compute continuous current requirements for the inverter based on the selected motor.

4. Select inverter based on continuous current and overload requirements.

Scan the 150% entries in the inverter tables for a frame where the continuous current rating exceeds 760 amps. The 6000 frame meets this criterion (1020 amps) and is appropriate for this application.

<table>
<thead>
<tr>
<th>Current A ac</th>
<th>Allowable Overload %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1020</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>175</td>
</tr>
<tr>
<td></td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>225</td>
</tr>
<tr>
<td></td>
<td>250</td>
</tr>
</tbody>
</table>

The motor delivers constant torque from zero to base speed of 500 rpm and 4000 kW (5360 hp).

Duty cycle requires 150% for 10 sec. but has rms duty cycle of 4000 kW (5360 hp).
A Common Control To Reduce Cost Of Ownership

**Control Functions**
- Feedback And Status
- Speed Reference
- Speed/Torque
- Speed Feedback
- Resolver Input
- Speed Feedback
- Analog Outputs
- Analog Inputs
- Digital Outputs

**Instrumentation Interface**
- **Configuration**
  - RJ-45 Ethernet interface
  - 10 Mbps maximum
  - Drive Navigator option of TOSLINE™-S20 to Ethernet connection using V-Series controller as gateway
  - Toolbox option of ISBus™ to Ethernet using Innovation Series™ controller as gateway
- **Meter Outputs**
  - Motor current A and B, ±10 V
  - Quantity 5 configurable, ±10 V, 8-bit resolution

**I/O Interface**
- **Digital Inputs**
  - +24 V dc
  - 24-110 V dc
  - 48-120 V ac
  - Opto-coupled 20 mA
  - Quantity 6 configurable mapping
- **Digital Outputs**
  - -50 V dc
  - Open collector 70 mA
  - Quantity 6 user defined
- **Analog Inputs**
  - 10 V, 4-20 mA
  - Quantity 2 ±10 V or 4-20 mA
  - Differential 8 Ω input impedance
  - 12-bit resolution
  - Optional Quantity 2 ±10 V
  - 12-bit resolution
- **Analog Outputs**
  - -5 V
  - 10 V
  - Quantity 4 ±10 V, 10 mA max
  - User defined
  - 12-bit resolution
- **Speed Feedback**
  - Resolutions
  - Excitation frequency of 1 or 4 kHz
  - Source for resolvers is Tamagawa: www.tamagawa-seiki.co.jp

**LAN Interface Options**

**TOSLINE-S20**
- Supports run-time control (6 words in and 10 words out) from an Innovation Series controller or V Series controller
- Drives can directly exchange data between themselves (4 words)
- Fiber-optic bus in a star configuration
- 2 Mbps peer-to-peer protocol; bus scan time based on the number of nodes:
  - Quantity of Nodes: 2-3
  - Bus Scan Time: 1 ms
  - Quantity of Nodes: 4-5
  - Bus Scan Time: 2 ms
  - Quantity of Nodes: 6-8
  - Bus Scan Time: 4 ms
  - Quantity of Nodes: 9-64
  - Bus Scan Time: 25 ms

**ISBus**
- Supports both run-time control (10 words in and 10 words out) and Toolbox configuration/monitoring using the Innovation Series controller as a gateway between the ISBus and Ethernet
- RS-485 or optional fiber-optic bus in a synchronous ring configuration
- 5 Mbps master/follower (drive is the follower) protocol using copper or fiber; bus scan time based on the number of nodes:
  - Quantity of Nodes: 2-4
  - Bus Scan Time: 1 ms
  - Quantity of Nodes: 5-8
  - Bus Scan Time: 2 ms
  - Quantity of Nodes: 6-16
  - Bus Scan Time: 4 ms
  - Quantity of Nodes: 17-32
  - Bus Scan Time: 8 ms

**Modbus**
- Supports run-time control (fixed 10 words in/out) from a Modbus-RTU controller
- RS-485 copper bus
- 1.2 kbps to 57.6 kbps master/follower protocol; update rates up to 20 ms/node possible at the highest baud rate
- Number of nodes: 127 max per LAN

**Profibus-DP™**
- Supports run-time control (6 words in and out) from a Profibus-DP master controller
- Copper bus in a daisy-chain configuration
- 9.6 kbps to 12 Mbps master/follower protocol; bus scan time based on the number of nodes

**DeviceNet™**
- Supports run-time control (4 words in and 10 words out) from a DeviceNet master controller
- Copper bus in a daisy-chain configuration
- 125 kbps to 500 kbps master/follower protocol; bus scan time based on the number of nodes

*Note: 1 word = 16 bits*
Operator Interfaces

Standard Display (Inverters and Regenerative Converters)

Three-digit display alternates between speed and current while running, or a fault code when there is an error.

LED Indication
- Ready: On when the unit is ready to run
- Running: On when the unit is running
- Alarm/Fault: Blinking LED indicates alarm condition, while solid LED indicates a fault

Optional analog meters can be supplied in addition to either the standard or enhanced display. Up to four meters can be provided.

Interlock button disables the drive

RJ-45 Ethernet port is used for local toolbox connection

High Function Display
- LED 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

Keypad Option (Inverters and Regenerative Converters)

Easy-to-understand navigation buttons allow quick access to information without resorting to a PC-based tool

Switch to local mode and operate the equipment right from the keypad

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

RJ-45 Ethernet port is used for the local toolbox connection

Operator Interfaces
TMEIC AC Drives Offer Complete Coverage

Complete Coverage

TMEIC AC Drives Offer

575/690

440/460

3,600

7,200

Volts

5,4

13

134

kW

Regenerative Drive

Non-regenerative Drive

100,000

50,000

134,000

26,800

67,000

134,000

Hp

TMdrive-80

TMdrive-70

TMdrive-50

TMdrive-30

TMdrive-10

TMdrive-10e

TMdrive-MV

TMdrive-XL55

TMdrive-XL75

TMdrive-XL85

Toshiba Mitsubishi-Electric Industrial Systems Corporation

Global Office Locations:

TOShiba MITSUBISHI-ElectRiC InDUSTRIAL SYSTEMS CORPORATION
TOKYO SQUARE GARDEN.
3-1-1 Kyobashi, Chuo-ku,
Tokyo104-0001, Japan
Tel.: +81-3-3277-5914
Fax: +81-3-3277-4562
Web: www.tmeic.co.jp

TMEIC Corporation
Office: 1325 Electric Road, Suite 200
Roanoke, VA, United States 24018
Mailing: 2060 Cook Drive
Salem, VA, United States 24153
Tel.: +1-540-283-2000
Fax: +1-540-283-2001
Web: http://www.tmeic.com
Email: info@tmeic.com

TMEIC Europe Limited
6-9 The Square, Stockley Park
Uxbridge, Middelsex, UK, UB11 1FW
UK (London) Tel.: +44 870 950 7212
Italy (Bari) Tel: +39-080-504-6190
Germany (Frankfurt) Tel: +49-6968-194722
Poland (Krakow) Tel: +48-12432-3400
Email: info@tmeic.eu
Web: www.tmeic.com/Europe

TMEIC Industrial Systems India Private Limited
Unit # 03-04, Third Floor,
Block 2, Cyber Pearl, HITEC City, Madhapur,
Hyderabad, 500081, Andhra Pradesh, India
Tel.: +91-40-4434-0000
Fax: +91-40-4434-0034
Web: www.tmeic.com/India

All other products mentioned are registered trademarks and/or trademarks of their respective companies.

All specifications in this document are subject to change without notice. The above brochure is provided free of charge and without obligation to the reader or to TOSHIBA MITSUBISHI-ELECTRIC INDUSTRIAL SYSTEMS CORPORATION (TMEIC). TMEIC does not accept, nor imply, the acceptance of any liability with regard to the use of the information provided. TMEIC provides the information included herein as is and without warranty of any kind, express or implied, including but not limited to any implied statutory warranty of merchantability or fitness for particular purposes. The information is provided solely as a general reference to the potential benefits that may be attributable to the technology discussed. Individual results may vary. Independent analysis and testing of each application is required to determine the results and benefits to be achieved from the technology discussed.

If you have any questions regarding your project requirements, please contact TMEIC.