TOSVERT™ inverter dedicated to fan and pump for HVAC

VF-FS1

TOSHIBA

Transistor Inverter

Three-phase 200V class 0.4kW to 30kW
Three-phase 400V class 0.4kW to 30kW
DREAM INVERTER dedicated to fan and pump for HVAC

SPACE SAVING, ECO-FRIENDLY, NOISE-LESS and LONG LIFE
The VF-FS1 provides these features as standard

- **POINT 1** Half installation space and less wiring
- **POINT 2** Reactor-less harmonic reduction and high-frequency noise reduction
- **POINT 3** Long life and easy maintenance
- **POINT 4** Special softwares for fan and pump application are built-in
- **POINT 5** More energy saving and easier operation
- **POINT 6** Communications software and options

Totally enclosed box type for IP54

Applications:
- AHUs
- Ventilation fans
- Chillers
- Water pumps
etc.

Voltage class | Applicable Motor Output (kW)
--- | ---
3-phase 200V class (IP20/IP00) | 0.4, 0.75, 1.5, 2.2, 3.7, 5.5, 7.5, 11, 15, 18.5, 22, 30
3-phase 400V class (IP54) | 0.4, 0.75, 1.5, 2.2, 3.7, 5.5, 7.5, 11, 15, 18.5, 22, 30

Note: VF-FS1 is not applicable for apparatus which needs sudden deceleration and stop.

VF-FS1

TOSVERT™ inverter dedicated to fan and pump for HVAC

Compatible with the World's Main Standards
(CE marking, UL, CSA, C-tick)

TOSVERT™ is a trademark of TOSHIBA Corporation.
**POINT 1**

**Half installation space and less wiring**

- Reactor-less harmonic suppress technologies and built-in filter reduce 50% of installation space, save time and cost of wiring.
- And side-by-side installation realizes effective utilization of space in control panels.

**POINT 2**

**Reactor-less harmonics reduction and high-frequency noise reduction**

- Toshiba unique technologies suppress harmonics, particularly 5th and 7th harmonic current that affect power sources. And the power factor in all models has been improved. Harmonics are controlled within the Total Harmonic Distortion (THD) of international standard IEC61000-3-12 without any external reactor. (Rsce = 120)

**Harmonics reduction, Power factor improvement**

- The input current decreases 20%. Power factor : 99%
- Input current of existing model
- Output current of existing model
- Input current of FS1
- Output current of FS1

**High-frequency noise reduction**

- High-frequency noise is drastically reduced on models with built-in noise filters.
- Built-in noise filters are ideal for office, commercial facilities, and factories where special attention for peripheral devices are needed.
- Compared with existing model, less space and wiring are realized by incorporating filter in the panel.
- In addition, models with built-in EMC noise filter comply with the European EMC Directive as individual inverter units.

- Built-in EMC filter
- Effect of built-in filter

**POINT 3**

**Long life and easy maintenance**

- 15 years life designed main capacitors
- An alarm warns when the main circuit capacitors, circuit boards capacitors, or cooling fan needs to be replaced.
- Cooling fan’s On/Off control extend its life
- Easy replacement of cooling fan by one touch
- The inverter unit can be replaced by removable terminal block without disconnecting cables.

**Ideal functions are built-in for fan and pump application.**

- The local or remote operation can be selected by one touch.
- Bumpless function realize seamless operation between local and remote.
- Fire control enables forced operation in emergency.
- In case of emergency, forced control will run by specified frequency. The forced operation signal will be saved when the signal turns OFF.
- Motor does not stop in the event of the occurrence of a soft fault.
- Speed reference can manage on/off operation. (sleep function)
- Low current detection can notice a broken belt or low load for pump application
- PTC thermistor input
- Built-in RS485 (TOSHIBA/Modbus protocol) communication as standard. Optional fieldbuses for LONWORKS®, BACnet®, Metasys®N2 and APOGEE® FLN as built in option.

LoxWorks® is a registered trademark of Echelon Corporation.
BACnet® is a registered trademark of American Society of Heating, Refrigerating and Air-Conditioning Engineers, Incorporated.
Metasy®N2 is a registered trademark of Johnson Controls, Incorporated.
APOGEE® FLN is a registered trademark of Siemens Building Technologies, Incorporated.
More energy saving and easier operation

**More energy saving**

The advanced energy-saving mode optimizes fan and pump efficiency even at normally inefficient in low speeds.

The effect can be monitored by operation panel or through serial communication data.

![Graph showing output power vs. output frequency](image)

**Easy operation**

A wizard function enables setting the 10 most often used parameters quickly. It can be sequentially, such as installing the PC software.

- The coast stop
- The 3-wire operation
- External input UP/DOWN setting
- 4 to 20mA current input operation

The startup or adjustments are supported by the history function that displays the latest 5 changed parameters.

**Communications software and options**

**Communications software**

The PCM001Z communications software allows you to edit, monitor, and trace parameter data on a PC. It realizes easier data management for commissioning and maintenance.

**Options**

**USB communications conversion unit**

This is a unit that converts USB port signal to VF inverter serial port for data communication. Optional cables to USB and inverter unit are required. By using serial data communication, all parameters and monitoring data can be accessed for commissioning and maintenance.

**Network**

Built-in HVAC fieldbus options are available to communicate with a host controller for centralized control.

- LONWORKS®
- BACnet®
- Metasys® N2
- APOGEE® FLN

**LED extension panel**

The panel with 20 mm height LEDs displays frequency and parameters very clearly at sight. In addition, it can save and download up to three sets of individual parameters as a parameter writer.

**External EMC directive compliant noise reduction filter**

It can be complied to the following directives by installing this filter

- 400V class: IEC/EN61800-3, 1st Environment, C1
- 200V class: IEC/EN61800-3, 1st Environment, C2
### Standard Specifications

#### 200V class

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model name</td>
<td>TOSVERT</td>
</tr>
<tr>
<td>Voltage/current</td>
<td>±10% when the inverter is used continuously (load of 100%)</td>
</tr>
<tr>
<td>Rated output current</td>
<td>2.8 A</td>
</tr>
<tr>
<td>Voltage (AC) voltage</td>
<td>3-phase 200V to 240V</td>
</tr>
<tr>
<td>Voltage/current</td>
<td>110%±5% 180%±5%</td>
</tr>
<tr>
<td>Allowable fluctuation</td>
<td>Voltage ±10%, -15% Note 4), frequency 25%</td>
</tr>
<tr>
<td>Cooling method</td>
<td>Forced air-cooled</td>
</tr>
<tr>
<td>Built in the box</td>
<td>Basic Winder</td>
</tr>
</tbody>
</table>

#### 400V class

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model name</td>
<td>TOSVERT</td>
</tr>
<tr>
<td>Voltage/current</td>
<td>±10% when the inverter is used continuously (load of 100%)</td>
</tr>
<tr>
<td>Rated output current</td>
<td>1.4 A</td>
</tr>
<tr>
<td>Voltage (AC) voltage</td>
<td>3-phase 380V to 400V</td>
</tr>
<tr>
<td>Voltage/current</td>
<td>110%±5% 180%±5%</td>
</tr>
<tr>
<td>Allowable fluctuation</td>
<td>Voltage ±10%, -15% Note 4), frequency 25%</td>
</tr>
<tr>
<td>Cooling method</td>
<td>Forced air-cooled</td>
</tr>
<tr>
<td>Built in the box</td>
<td>Basic Winder</td>
</tr>
</tbody>
</table>

#### Common specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Note 1) Specify/IPM control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control system</td>
<td>��面1/5。</td>
</tr>
<tr>
<td>Output voltage adjustment</td>
<td>Adjustable within the range of 50 Hz to 60 Hz by connecting the supply voltage (not adjustable above the input voltage)</td>
</tr>
<tr>
<td>Output frequency range</td>
<td>Setting to 40kHz, default setting 0.5 Hz to 80 kHz, minimum frequency 300 Hz to 20kHz</td>
</tr>
<tr>
<td>Minimum setting steps of frequency</td>
<td>0.1 Hz, analog input (when the max. frequency is 100 Hz), 0.1 Hz, operation panel setting and communication setting</td>
</tr>
<tr>
<td>Frequency accuracy</td>
<td>Analog setting within ±0.1% of the max. frequency (10 Hz to 485°C)</td>
</tr>
<tr>
<td>Frequency setting signal</td>
<td>External frequency potentiometer (convertible to a potentiometer with a rated impedance of 1 - 1000Ω, 0 - 10VDC (input impedance 20kΩ, 4 - 20mA) (input impedance 20kΩ))</td>
</tr>
<tr>
<td>Terminal board base frequency</td>
<td>The characteristic can be set arbitrarily by two-point setting. Possible to select individually for three functions: analog input (VA and VB) and communication command</td>
</tr>
<tr>
<td>Frequency jump</td>
<td>Three frequencies can be set. Setting of the jump frequency and the range.</td>
</tr>
<tr>
<td>Upper- and lower-limit frequencies</td>
<td>Three frequencies can be set. Setting of the jump frequency and the range.</td>
</tr>
<tr>
<td>PID control</td>
<td>Setting of proportional gain, integral gain, differential gain and control time setting. Considering what the amount of proportioning amount and the amount of feedback agree</td>
</tr>
<tr>
<td>Acceleration/deceleration time</td>
<td>Selectable from among acceleration/deceleration 1 and 2 (0.0 - 3.0 Hz/sec). Auto-acceleration/deceleration function, S-pattern acceleration/deceleration 1 and 2 and S-pattern adjustable. Control of forced rapid deceleration and dynamic rapid deceleration</td>
</tr>
<tr>
<td>DC braking</td>
<td>Braking start-up frequency: 0 to maximum frequency, braking ratio: 0 to 100%. Braking time: 0 to 20 seconds, emergency DC braking</td>
</tr>
<tr>
<td>Input terminal function</td>
<td>Possible to select from among 57 functions, such as forward/reverse run signal input, operation base signal input and reset signal input, to assign to 4 input terminals. Logic selectable between sink and source</td>
</tr>
<tr>
<td>Input/output functions (programmable)</td>
<td>Possible to select from among 58 functions, such as upward/downward frequency signal output, low speed detection signal output, specified speed reach output and failure signal output, to assign to FL, WY, F, RX output terminals.</td>
</tr>
<tr>
<td>Forward/reverse run</td>
<td>The RUN and STOP keys on the operation panel are used to start and stop operation, respectively. The switching between forward run and reverse run can be done from one of the three control units: operation panel, terminal board and external control unit.</td>
</tr>
<tr>
<td>Resettable speed operation</td>
<td>Basic frequency + Speed operation possible by changing the combination of 2 controls on the terminal board.</td>
</tr>
<tr>
<td>Retry operation</td>
<td>Capable of restarting automatically after a check of the main circuit elements in case the protective function is activated. 10 times (Max) selectable with a parameter</td>
</tr>
<tr>
<td>Automatic reset operation</td>
<td>In case of a momentary power failure, the inverter restarts the normal operation of the control circuit and outputs a frequency appropriate to the rotational speed in order to restart the motor smoothly. This function can also be used when switching to commercial power.</td>
</tr>
<tr>
<td>Dropping function</td>
<td>The motor is allowed to stop: &quot;Stop&quot; according to the load torque current.</td>
</tr>
<tr>
<td>Failure detection signal</td>
<td>1 to control output. (250Ω±5% - 50kΩ±10%)</td>
</tr>
<tr>
<td>Protective function</td>
<td>Stall prevention, current limitation, output current, output short circuit, over-voltage, over-current limitation, undervoltage, ground fault, power supply phase failure, output phase failure, overvoltage protection by electronic thermal function, overcurrent at start-up, load side over-current at start-up, over-torque, undercurrent, overheating, cumulative operation time, life, alarm, emergency stop, various pre-alarms.</td>
</tr>
<tr>
<td>Electronic thermal characteristic</td>
<td>Switching between standard motor and constant-torque VF motor, switching between motors 1 and 2, setting of overload protection level 1 and 2, selection of overload stall.</td>
</tr>
<tr>
<td>Reset function</td>
<td>Function of resetting by closing contact or by turning off power or the operation panel. This function is also used to save and clear trip records.</td>
</tr>
<tr>
<td>Alarms</td>
<td>Stall prevention, overcurrent, overload, under-voltage, setting error, retry in process, overcurrent/power</td>
</tr>
<tr>
<td>Causes of failures</td>
<td>Over-current, overvoltage, short-circuit in load, ground fault, overload on inverter, current through arm at start-up, over-current through load at start-up, CPU fault, EEPROM fault, RAM fault, ROM fault, communication error.</td>
</tr>
<tr>
<td>Monitoring function</td>
<td>Selectable: Emergency stop, under-voltage, low voltage, over-torque, motor overload, overcurrent, operation frequency, operation frequency command, forward/reverse run, output current, voltage in DC section, output voltage, torque, torque current, load factor of inverter, input power, output power, power information, alarm information, information on output terminals, version of CPU, version of ECU, version of memory, PID feedback amount, frequency command (after PID), integral input power, integral output power, reset current, output signal, output speed, communication, normal state communication counter, causes of past trips 1 through 4, parts replacement alarm, cumulative operation time, alarm information.</td>
</tr>
<tr>
<td>Past trip monitoring function</td>
<td>Stamps data on the past four trips, number of trips that occurred in succession, operation frequency, direction of rotation, load current, input voltage, output voltage, information on input terminals, information on output terminals, and cumulative operation time when each trip occurred.</td>
</tr>
<tr>
<td>Display function</td>
<td>отношение, оперативная память, размер выходных данных, суммарное время, свободное место, процентное значение, вывод сведений о выходных данных.</td>
</tr>
<tr>
<td>Overtemperture</td>
<td>-10°C to 40°C (Note)</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-20°C to 45°C</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>20 to 95% (Non-condensation and repair)</td>
</tr>
</tbody>
</table>

### Contents of the product code

<table>
<thead>
<tr>
<th>Type</th>
<th>Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>F</td>
</tr>
<tr>
<td>F</td>
<td>S1</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>P</td>
<td>L</td>
</tr>
<tr>
<td>A</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

**Note 1**: ±10% when the inverter is used continuously (load of 100%).

**Note 2**: If you select "rev.3", the control panel and power can be connected with the rated output current of the inverter.
**Note 1:** To make it easier to grasp the dimensions of each inverter, dimensions common to all inverters in these figures are shown with numeric values but not with symbols.

Here are the meanings of the symbols used.

- **W:** Width
- **H:** Height
- **D:** Depth
- **W1:** Mounting dimension (horizontal)
- **H1:** Mounting dimension (vertical)
- **H2:** Height of EMC plate mounting area

**Note 2:** Here are the available EMC plates:

- **Fig. A:** EMP004Z (Approx. weight: 0.1kg)
- **Fig. B:** EMP005Z (Approx. weight: 0.3kg)
- **Fig. C:** EMP006Z (Approx. weight: 0.3kg)

**Note 3:** The models shown in Fig. A is fixed at two points: in the upper left and lower right corners.

---

**External Dimension**

<table>
<thead>
<tr>
<th>Voltage class</th>
<th>Applicable motor (kW)</th>
<th>Inverter type</th>
<th>Dimensions (mm)</th>
<th>Approx. weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-phase 200V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.4</td>
<td>VF-FS1-2004PM</td>
<td>107 130 150 93 121.5 13</td>
<td>A</td>
<td>1.2</td>
</tr>
<tr>
<td>0.75</td>
<td>VF-FS1-2007PM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td>VF-FS1-2015PM</td>
<td>142 170 150 130 157 14</td>
<td>B</td>
<td>2.1</td>
</tr>
<tr>
<td>2.2</td>
<td>VF-FS1-2022PM</td>
<td>180 220 170 160 210 12</td>
<td>C</td>
<td>4.3</td>
</tr>
<tr>
<td>5.5</td>
<td>VF-FS1-2055PM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.5</td>
<td>VF-FS1-2075PM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>VF-FS1-2110PM</td>
<td>245 310 190 225 295 19.5</td>
<td>D</td>
<td>6.6</td>
</tr>
<tr>
<td>15</td>
<td>VF-FS1-2150PM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18.5</td>
<td>VF-FS1-2220PM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>VF-FS1-2300PM</td>
<td>320 630 230 280 695 38</td>
<td>E</td>
<td>16.4</td>
</tr>
</tbody>
</table>

| 3-phase 400V  |                       |               |                 |                   |
| 0.75          | VF-FS1-4007PM         | 107 130 150 93 121.5 13 | A              | 1.4              |
| 1.5           | VF-FS1-4015PM         |               |                 |                   |
| 2.2           | VF-FS1-4022PM         | 142 170 150 130 157 14 | B              | 2.4              |
| 5.5           | VF-FS1-4055PM         | 180 220 170 160 210 12 | C              | 4.7              |
| 11            | VF-FS1-4110PM         |               |                 |                   |
| 15            | VF-FS1-4150PM         | 245 310 190 225 295 19.5 | D             | 9.0              |
| 18.5          | VF-FS1-4185PM         |               |                 |                   |
| 22            | VF-FS1-4220PM         |               |                 |                   |
| 30            | VF-FS1-4300PM         | 320 630 230 280 695 38 | E              | 16.4             |

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*Note 1: To make it easier to grasp the dimensions of each inverter, dimensions common to all inverters in these figures are shown with numeric values but not with symbols.*

*Note 2: Here are the available EMC plates.*

*Fig.A: EMP004Z (Approx. weight: 0.1kg)*

*Fig.B: EMP005Z (Approx. weight: 0.3kg)*

*Fig.C: EMP006Z (Approx. weight: 0.3kg)*

*Note 3: The models shown in Fig. A is fixed at two points: in the upper left and lower right corners.*
### Standard connection diagram

#### Main circuit terminal

<table>
<thead>
<tr>
<th>Terminal symbol</th>
<th>Input/output</th>
<th>Function</th>
<th>Terminal function</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>Input</td>
<td>GND</td>
<td>Grounding terminal for connecting inverter.</td>
</tr>
<tr>
<td>R</td>
<td>Input</td>
<td>GND</td>
<td>Grounding terminal for connecting inverter.</td>
</tr>
<tr>
<td>RES</td>
<td>Input</td>
<td>GND</td>
<td>Grounding terminal for connecting inverter.</td>
</tr>
<tr>
<td>RES</td>
<td>Input</td>
<td>Output</td>
<td>This inverter protective function is disabled if RES is CC is connected.</td>
</tr>
<tr>
<td>PLC</td>
<td>Input</td>
<td>Output</td>
<td>This inverter protective function is disabled if RES is CC is connected.</td>
</tr>
<tr>
<td>CC</td>
<td>Common/In/Out</td>
<td>Control circuit's equivalent terminal (2 terminals)</td>
<td>—</td>
</tr>
<tr>
<td>PP</td>
<td>Output</td>
<td>Analog power supply output</td>
<td>10Vdc (permmissible load current: 10mA)</td>
</tr>
</tbody>
</table>

#### Control circuit terminal

<table>
<thead>
<tr>
<th>Terminal symbol</th>
<th>Input/output</th>
<th>Function</th>
<th>Terminal function</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>Input</td>
<td>GND</td>
<td>No voltage contact input</td>
</tr>
<tr>
<td>R</td>
<td>Input</td>
<td>GND</td>
<td>24Vdc-5mA or less</td>
</tr>
<tr>
<td>RES</td>
<td>Input</td>
<td>GND</td>
<td>24Vdc (Insulation resistance: DC500V)</td>
</tr>
<tr>
<td>PLC</td>
<td>Input</td>
<td>GND</td>
<td>10Vdc (internal impedance: 30kΩ)</td>
</tr>
<tr>
<td>CC</td>
<td>Common/In/Out</td>
<td>Control circuit's equivalent terminal (2 terminals)</td>
<td>—</td>
</tr>
<tr>
<td>PP</td>
<td>Output</td>
<td>Analog power supply output</td>
<td>24Vdc-10mA</td>
</tr>
<tr>
<td>PLB</td>
<td>Output</td>
<td>Multifunction programmable relay contact output</td>
<td>250Vdc-1A (cos φ = 0.4)</td>
</tr>
<tr>
<td>PLC</td>
<td>Output</td>
<td>Output</td>
<td>Standard default settings detect and output low-speed signal output frequencies.</td>
</tr>
<tr>
<td>RY</td>
<td>Output</td>
<td>250Vdc-1A (cos φ = 0.1)</td>
<td>Multifunction programmable relay contact output.</td>
</tr>
</tbody>
</table>

#### Main circuit power supply

- 400V class: three-phase 380-480V, 50/60Hz
- 200V class: three-phase 200-240V, 50/60Hz

#### Wiring devices

<table>
<thead>
<tr>
<th>Voltage class</th>
<th>Capacity of applicable motor (kW)</th>
<th>Input current (A)</th>
<th>Wire size (See Note 4)</th>
<th>Neutral cable (mm²) (for the equipment)</th>
<th>Earth cable (mm²)</th>
<th>Rated current (A)</th>
<th>Standard current (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three-phase 200V class</td>
<td>0.4</td>
<td>0.4</td>
<td>1.6</td>
<td>1.6</td>
<td>1.6</td>
<td>25</td>
<td>3</td>
</tr>
<tr>
<td>Three-phase 400V class</td>
<td>0.4</td>
<td>0.4</td>
<td>1.6</td>
<td>1.6</td>
<td>1.6</td>
<td>25</td>
<td>3</td>
</tr>
</tbody>
</table>

Note 1: This is an example for use with the Toshiba’s type standard inverter. When using the product, consult with Toshiba.

Note 2: The wiring devices are set for use with standard low-voltage (LV) and high-voltage (HV) inverter main circuit.

Note 3: When using the inverter, the input and output currents are determined by the capacity of the applicable motor.

Note 4: The wiring devices are set for use with standard low-voltage (LV) and high-voltage (HV) inverter main circuit.
Basic functions

A wizard function can enable setting the 10 most often used parameters quickly. It can be sequentially, such as installing the PC software.

Title Function Adjustment range Default setting
--- --- --- ---
Base frequency voltage 1 40.0 (WP)/60.0 (WN) 50.0
Deceleration time 1 4: Energy-saving 5: - (Do not select) 6: PM motor control
Acceleration time 1 50-660 (400V class)
Forward/reverse run selection 0: Forward run 1: Reverse run 2: Forward run (F/R switching possible)

Extended parameters

About 170 extended parameters are available. For details on extended parameters, please visit our web site. (http://www.inverter.co.jp)

Peripheral devices

Power supply
Non-fuse breaker MCCB
Magnetic contactor MCC

EMC noise reduction filter (Compliant with European standards)
(1) Input AC reactor (ACL) (2) High-vibration noise reduction filter (3) Zero-phase reactor (F/R switching possible)

LED extension panel (4) EMC plate (5) DIN rail kit (6) Additional functions

Communications cable

Controller or other PLC.

Additional functions

Communications with BACnet

Communications with Metasys® N2

Communications with APOGEE® FLN

Communications with VIA2000

Communications with other PLC.
When wiring the inverter

- **Wiring precautions**
  1. **Installing a molded-case circuit breaker (MCCB)**
     - Install a molded-case circuit breaker (MCCB) on the inverter's power supply input to protect the wiring.
     - Avoid turning the molded-case circuit breaker on and off frequently to turn on/off the motor.
     - To turn on/off the motor frequently, close/break the control terminals F (or R) - CC.

- **Installing a magnetic contactor [MC] (primary side)**
  1. To prevent an automatic restart after the power interruption or overload relay has tripped, or actuation of the protective circuit, install an electro-magnetic contactor in the power supply.
  2. The inverter is provided with a failure detection relay (FL), so that, if its contacts are connected to the control circuit of the magnetic contactor on the primary side, the magnetic contactor will be opened when the protective circuit of the inverter is activated.
  3. The inverter can be used without a magnetic contactor. In this case, use an MCCB (equipped with a voltage-tripping device) for opening the primary circuit when the inverter protective circuit is activated.
  4. Avoid turning the magnetic contactor on and off frequently to turn on/off the motor.
  5. To turn on/off the motor frequently, close/break the control terminals F (or R) - CC.

- **Installing a magnetic contactor [MC] (secondary side)**
  1. As a rule, if a magnetic contactor is installed between the inverter and the motor, do not turn ON/OFF, while running. (If the secondary-side contactor is turned ON/OFF while running, a large current may flow in the inverter, causing inverter damage.)
  2. A magnetic contactor may be installed to change the motor or change to the commercial power source when the inverter is stopped. Always use an interlock with the magnetic contactor in this situation so that the commercial power supply is not applied to the inverter's output terminals.

- **External signal**
  1. Use a relay rated for low currents. Mount a surge suppressor on the excitation coil of the relay.
  2. When wiring the control circuit, use shielded wires or twisted pair cables.
  3. All control terminals, except FLA, FLB and FLC are electronic circuits. Therefore, input signal must insulate with power circuit.

- **Installing an overload relay**
  1. This V/F-1SET inverter has an electrothermal overload protective function. However, in the following cases, the thermal relay operation level must be adjusted or an overload relay matching the motor's characteristics must be installed between the inverter and the motor.
     a) When using a motor having a rated current different from that of the inverter.
     b) When driving several motors simultaneously.
     c) When using the inverter to control the operation of a constant-torque motor (VF motor), change the protective characteristic of the electrothermal relay according to the rating of the VF motor.
  3. In order to adequately protect a motor used for low-speed operation, we recommend the use of a motor equipped with an embedded thermal relay.

Power factor improvement capacitors

- Do not install a power factor improvement capacitors on the input or output side of the inverter.
- Installing a power factor improvement capacitor on the input or output side causes current containing harmonic components to flow into the power circuit, adversely affecting the capacitor itself or causing the inverter to trip. To improve the power factor, install an input AC reactor (optional) on the primary side of the inverter.

Installation of input AC reactors

- These devices are used to improve the input power factor and suppress high harmonic currents and surges. Install an input AC reactor when using the inverter under the following conditions.
  1. When the inverter is connected to the same power distribution system as a motor equipped with a power factor improvement capacitor.
  2. When the inverter is connected to the same power distribution system as that of distributed wave-producing systems, such as arc furnaces and large-capacity inverters.

When changing the motor speed

- **Application to standard motors**

Vibration

- When a motor is operated with an industrial inverter, it experiences more vibrations than when it is operated by the commercial power supply. The vibration can be reduced to an extremely small extent by the motor and the inverter system. If the base is weak, however, the vibration may increase at a slight load due to instability of the mechanical system.

Reduction gear, bell, chain

- Note that the lubrication capability of a reducer or a converter may be affected in the same way as the motor and the load machine may be affected by low speeds. When operating at a frequencies exceeding 60 Hz or higher, power transmission mechanisms such as reduction gear, belts and chains, may cause problems such as production of noise, a reduction in strength, or shortening of service life.

Frequency

- Before setting the maximum frequency to 60Hz or higher, confirm that this operating range is acceptable for the motor.

Application to special motors

Gear motor

- When using an industrial inverter to drive a gear motor, inquire of the motor manufacturer about its continuous operation range, since low-speed operation of a gear motor may cause insufficient lubrication.

Toshiba Gold Motor (High-efficiency power-saving motor)

- Inverter-driven operation of Toshiba Gold Motors is the best solution for saving energy. This is because these motors have improved efficiency, power factor, and noise/reduction characteristics when compared to standard motors.

Pole-changing motor

- Pole-changing motors can be driven by this inverter. Before changing poles, however, all the motor come to a complete stop.

Multipolar motors

- Note that multipolar motors (or more poles), which may be used for fans, etc., have higher rated current than 4-pole motors.

The current ratings of multipolar motors are relatively high. So, when selecting an inverter, you may need special attention to its current rating so that the current rating of the motor is below that of the inverter.

Single-phase motor

- Because single-phase motors are equipped with a centrifugal switch and capacitors for starting, they cannot be driven by an inverter. If only a single-phase, power system is available, a 3-phase motor can be driven by using a single-phase input inverter to convert it into a 3-phase 240V AC driving (a special inverter and a 3-phase motor are required.)

Braking motor

- When using a braking motor, if the braking circuit is directly connected to the inverter's output terminals, the brake cannot be released because of the lowered starting voltage. Therefore, when using a braking motor, connect the braking circuit to the inverter's power supply unit, as shown on the left. Usually, braking motors produce larger noise in low speed ranges.

Note: In the case of the circuit shown on the left, assign the function of detecting low speed signals to the F/R and RC terminals. Make sure the parameter FTS15 is set to 4 (factory default setting).
Selecting the capacity (model) of the inverter

**Selection**

**Capacity**

Refer to the applicable motor capacities listed in the standard specifications. When driving a high-pole motor, special motor, or multiple motors in parallel, select such an inverter that the sum of the motor rated current multiplied by 1.05 to 1.1 is less than the inverter’s rated output current value.

**Acceleration/deceleration times**

The actual acceleration and deceleration times of a motor driven by an inverter are determined by the torque and moment of inertia of the load, and can be calculated by the following equations.

The acceleration and deceleration times of an inverter can be set individually. In any case, however, they should be set longer than the respective values determined by the following equations.

**Allowable torque characteristics**

When a standard motor is combined with an inverter to perform variable speed operation, the motor temperature rises slightly higher than it normally does during commercial power supply operation. This is because the inverter output voltage has a sinusoidal approximate PWM waveform. In addition, the cooling becomes less effective at low speed, so the torque must be reduced according to the frequency. When constant-torque operation must be performed at low speeds, use a Toshiba VF motor designed specifically for use with inverters.

Starting characteristics

When a motor is driven by an inverter, its operation is restricted by the inverter’s overload current rating, so the starting characteristic is different from those obtained from commercial power supply operation. Although the starting torque is smaller with an inverter than with the commercial power supply, a high starting torque can be produced at low speeds by adjusting the V/f pattern torque boost amount or by employing vector control.

When a larger starting torque is necessary, select an inverter with a larger capacity and examine the possibility of increasing the motor capacity. If you need bigger starting torque, please consider both upgrading inverter rating and motor rating.

**Harmonic current and influence to power supply**

Harmonics are defined as sinusoidal waves that is multiple frequency of commercial power (base frequency: 50Hz or 60Hz). Commercial power including harmonics has a distorted waveform. Some electrical and electronic devices produce distorted waves in their rectifying and smoothing circuits on the input side. Harmonics produced by a device influence other electrical equipment and facilities in some cases (for example, overheating of phase advancing capacitors and reactors).

For this inverter, Toshiba unique technologies suppress harmonics, particularly 5th and 7th harmonic current that affected power sources. And the power factor in all models has been improved. Harmonics are controlled to within the Total Harmonic Distortion (THD) of international standard IEC61000-3-12 without any external reactor. (Place 212)

Optional AC reactor enables to comply with Partial Weighted Harmonic Distortion (PWHD) of IEC 61000-3-12. (Rsec >120)

Note 1. 100% of torque refers to the amount of torque that the motor produces when it is running at a 60Hz-synchronized speed. The starting torque is smaller in this case than that required when power is supplied from a commercial power line. So, the characteristics of the motor to be operated need to be taken into consideration.

Note 2. The maximum allowable torque at 50Hz can be calculated approximately by multiplying the maximum allowable torque at a base frequency of 60Hz by 0.8. (Rsec >120)

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**Conditions**

\[ \text{Acceleration time} = \left( \frac{JM + JL}{9.56 \times (TM - TL)} \right) \]

\[ \text{Deceleration time} = \left( \frac{JM + JL}{9.56 \times (TB + TL)} \right) \]

**An example of V/F control at a base frequency of 60 Hz**

Note 1. 100% of torque refers to the amount of torque that the motor produces when it is running at a 60Hz-synchronized speed. The starting torque is smaller in this case than that required when power is supplied from a commercial power line. So, the characteristics of the motor to be operated need to be taken into consideration.

Note 2. The maximum allowable torque at 50Hz can be calculated approximately by multiplying the maximum allowable torque at a base frequency of 60Hz by 0.8.
To users of our inverters: Our inverters are designed to control the speeds of three-phase induction motors for general industry.

⚠️ Precautions

* Read the instruction manual before installing or operating the inverter unit and store it in a safe place for reference.
* When using our inverters for equipment such as nuclear power control, aviation and space flight control, traffic, and safety, and there is a risk that any failure or malfunction of the inverter could directly endanger human life or cause injury, please contact our headquarters, branch, or office printed on the front and back covers of this catalogue. Special precautions must be taken and such applications must be studied carefully.
* When using our inverters for critical equipment, even though the inverters are manufactured under strict quality control always fit your equipment with safety devices to prevent serious accident or loss should the inverter fail (such as issuing an inverter failure signal).
* Do not use our inverters for any load other than three-phase induction motors.
* None of Toshiba, its subsidiaries, affiliates or agents, shall be liable for any physical damages, including, without limitation, malfunction, anomaly, breakdown or any other problem that may occur to any apparatus in which the Toshiba inverter is incorporated or to any equipment that is used in combination with the Toshiba inverter. Nor shall Toshiba, its subsidiaries, affiliates or agents be liable for any compensatory damages resulting from such utilization, including compensation for special, indirect, incidental, consequential, punitive or exemplary damages, or for loss of profit, income or data, even if the user has been advised or apprised of the likelihood of the occurrence of such loss or damages.

For further information, please contact your nearest Toshiba Representative or International Operations-Producer Goods.

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