Q1 How can I use the inverter immediately?
A1 Just connect the power supply and the motor, and you can use the VF-S9 series inverter immediately.

You can use the RUN and STOP keys and the frequency setting potentiometer to easily operate the inverter. You can also make adjustments easily using the automatic setting functions.

- Automatic acceleration/deceleration: Automatically adjusts the acceleration or deceleration time according to the load.
- Automatic torque increase: Automatically improves the motor torque according to the load.
- Automatic environment setting: Automatically makes all the settings related to the inverter environment protection at one time.
- Automatic function setting: Selects the inverter operation method.

Q2 What can I do if I forget what I have programmed?
A2 You can use the change setting retrieval function. You can also use the following operation to restore all the parameters to the default values immediately.

1) Change setting retrieval (G-r;): Automatically retrieves and displays only the parameters differing from the default setting.
   You can confirm the changed parameters.

2) Standard setting mode selection (3-M): Restores all the parameters to the default values.

Q3 How can I change the frequency by contact input in combination with a PC (programmable controller)?
A3 Incorporating a standard 15-step speed function, the VF-S9 series allows you to change the frequency by setting parameters and using contact input.

Multi-step contact input signal samples
- ON — OFF (Speed command other than a preset-speed becomes effective when all contacts are OFF.)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>0</td>
</tr>
<tr>
<td>S2</td>
<td>0</td>
</tr>
<tr>
<td>S3</td>
<td>0</td>
</tr>
<tr>
<td>S4</td>
<td>0</td>
</tr>
<tr>
<td>S5</td>
<td>0</td>
</tr>
<tr>
<td>S6</td>
<td>0</td>
</tr>
<tr>
<td>S7</td>
<td>0</td>
</tr>
<tr>
<td>S8</td>
<td>0</td>
</tr>
<tr>
<td>S9</td>
<td>0</td>
</tr>
<tr>
<td>S10</td>
<td>0</td>
</tr>
<tr>
<td>S11</td>
<td>0</td>
</tr>
<tr>
<td>S12</td>
<td>0</td>
</tr>
<tr>
<td>S13</td>
<td>0</td>
</tr>
<tr>
<td>S14</td>
<td>0</td>
</tr>
<tr>
<td>S15</td>
<td>0</td>
</tr>
</tbody>
</table>

You can change the frequency using contact input.

Q4 What is the input/output programmable terminal block?
A4 The VF-S9 series allows you to set the terminal functions as you wish from a broad menu selection.

<table>
<thead>
<tr>
<th>Input terminal selection</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(F)</td>
<td>Acceleration/deceleration 1</td>
</tr>
<tr>
<td>2(R)</td>
<td>Reverse run command</td>
</tr>
<tr>
<td>3(RST)</td>
<td>Jog run command</td>
</tr>
<tr>
<td>4(S1)</td>
<td>Forward-run command</td>
</tr>
<tr>
<td>5(S2)</td>
<td>Brake command</td>
</tr>
<tr>
<td>6(S3)</td>
<td>Stop command</td>
</tr>
</tbody>
</table>

Q5 How can I get a large torque?
A5 The VF-S9 series ensures a torque of 150% or more from low speeds by utilizing Toshiba’s sensorless vector control.

Enable the sensorless vector control for a load that requires high starting or low speed torque.

To use sensorless vector control
1) When automatic torque increase RLU2 — if is set, all the sensorless vector controls and motor constants are set at one time.
2) Set V/F control mode selection Pr5-3 (sensorless vector control).
3) The same capacity as the inverter with a 4P Toshiba standard motor, it is not necessary to set the motor constants.

(1) The motor constants can be set individually.
(2) Motor constant can be set using the automatic tuning function and can be set individually.
(3) The motor constants can be set individually.

Note) When the default setting is entered, the system enters the setup parameter mode.
A6 To allow start/stop of the motor by external contacts, and to control the frequency by a current signal of 4-20 mA (or a voltage signal of 0-10 Vdc.)

Parameters to be changed

<table>
<thead>
<tr>
<th>Parameter</th>
<th>CNAd (Command mode selection)</th>
<th>FNa (Frequency setting mode selection)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setting</td>
<td>0 (Terminal board)</td>
<td>0 (Terminal board)</td>
</tr>
</tbody>
</table>

Q7 Why do other devices malfunction due to noise?

Using PWM control, the VF-S9 series generates noise that may affect nearby instrumentation and electronic equipment.

Noise is classified by propagation route into transmission noise, and radiation noise. Take the following counter measures for noise which affects other equipment:

- Separate the signal cables from the power cables with sufficient distance.
- Install noise filters.
- Use twisted-pair shielding cables for weak electric circuits and signal circuits, and be sure to ground one end of the shielding.
- Install the inverters separately from other equipment.
- Cover the inverters and their cables with metal conduit tubes and metal control panels, and ground these covers.
- EMC plate is attached for measures of radiation noise.

Q6 How do I start/stop a motor by external contacts, and control the frequency by a current signal of 4-20 mA (or a voltage signal of 0-10 Vdc.)

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

Installing a molded-case circuit breaker (MCCB)

Command mode selection

<table>
<thead>
<tr>
<th>Command mode selection</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (Terminal board)</td>
<td></td>
</tr>
</tbody>
</table>

Installing a magnetic contactor (MCCB)

(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 primary circuit of the MCCB equipped with a voltage tripping device for opening the primary circuit when the inverter protective circuit is activated.

(2) Avoid turning the magnetic contactor on and off frequently to turn on/off 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.

Installing a magnetic contactor (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 and failure.

(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 current. Mount a surge suppressor on the excitation coil of the relay.

(2) When using the control circuit, use shielded wires or twisted pair cables.

(3) Because all of the control terminals except FLA, FUB, and FLC are connected to electronic circuits, insulate these terminals to prevent them from coming into contact with the main circuit.

Installing an overload relay

(1) The VF-S9 inverter has a built-in overload protection function by means of a thermal-relay. 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 active different from that of the equivalent.

(b) When driving several motors simultaneously.

(c) When you want to use a constant torque Toshiba VF motor together with the VF-S9 inverter, change the inverter's electronic thermal protection characteristics to match those 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 a embedded thermal relay.
To users of our inverters

Selection

5) Measures by means of wiring and grounding
(1) Use a grounding wire as long as possible.
(2) Separate the inverter’s grounding wire from that of other systems or install the grounding wire of each system separately to the grounding point.
(3) Ground (shield) the main circuit wires with metallic conduits.
(4) The PWM output frequency should not be decreased by 2.0kHz or less in the motor service mode.

Leakage current

The PF-S9 series of inverters uses high-speed switching devices for PWM control. When a relatively long wiring is used for power supply to an inverter, current may leak from the cable or from the motor because of its capacitance, adversely affecting peripheral equipment. The intensity of such a leakage current depends on the PWM carrier frequency, the lengths of the input and output cables, etc., of the inverter. To prevent current leakage, it is recommended to take the following measures:

Effects of leakage current

Leakage current which increases when an inverter is used may pass through the following routes:

(1) Leakage due to the capacitance between the ground and the noise filter
(2) Leakage due to the capacitance between the grounding point and the motor
(3) Leakage due to the capacitance between ground and the cable connecting the inverter and the motor
(4) Leakage due to the capacitance of the cable connecting the motor and an inverter in another power distribution line
(5) Leakage due to the capacitance between ground and the noise filter

The leakage current which passes through the above routes may cause the following troubles:

- Malfunction of a leakage circuit breaker in the same or another power distribution line
- Malfunction of a ground-relay installed in the same or another power distribution line
- Leakage of an insulating transformer introduced by the inverter and the motor, at a current below the rate current

Measures against effects of leakage current

The measures against the effects of leakage current are as follows:

1) Measures to prevent the malfunction of leakage circuit breakers

(1) Decrease the PWM carrier frequency of the inverter. In the case of the PF-S9, the frequency can be decreased to 2.0kHz.
(2) Install leakage circuit breakers (LSCB) with a high-frequency protective function (e.g., Toshiba 12 type of relays) in both the same and the other power distribution lines. This makes it possible to operate the PF-S9 with its PWM carrier frequency set high.

2) Measures against malfunction of ground fault relay

(1) Decrease the PWM carrier frequency of the inverter. In the case of the PF-S9, the frequency can be decreased to 2.0kHz.
(2) Install ground fault relays with a high-frequency protective function (e.g., Toshiba CQR2 type of relays) in both the same and other lines. This makes it possible to operate the PF-S9 with its PWM carrier frequency set high.

3) Measures against noise produced by other electric and electronic systems

(1) Separate the grounding line of the inverter from that of the affected electric and electronic systems.
(2) Decrease the PWM carrier frequency of the inverter. In the case of the PF-S9, the frequency can be decreased to 2.0kHz.

4) Measures against malfunction of external thermal relays

(1) Remove the external thermal relay and use the electronic thermal relay of the inverter. Install the electronic thermal relay on the inverter when a single inverter is used to drive more than one motor. Refer to the instruction manual for measures to be taken when thermal relays cannot be removed.
(2) Decrease the PWM carrier frequency of the inverter. In the case of the PF-S9, the frequency can be decreased to 2.0kHz.

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 a VF-S9 inverter under the following conditions:

(1) When the power source capacity is 200kVA or more, and when it is 10 times or more greater than the inverter capacity.
(2) When the inverter is connected to the same power distribution system as a thyristor-committed control equipment.
(3) When the inverter is connected to the power distribution system as that of damped wave producing systems, such as arc furnaces and large capacity inverters.

Ground fault

Before beginning operation, thoroughly check the wiring between the motor and the inverter for incorrect wiring or short circuits. Do not ground the neutral point of any star-connected motor.

Interference

Radio interference

(Noise produced by inverters)

Since the PF-S9 series of inverters performs PWM control, it produces noise and sometimes affects nearby instrumental devices, electrical and electronic systems, etc. The effects of noise greatly vary with the noise resistance of each individual device, its wiring condition, the distance between it and the inverter, etc.

(3) When the inverter is connected to the same power distribution system as that

\[ \text{Interference } = \text{Noise resistance} \times \text{Noise induced by the inverter} \]

For example, the noise resistance of electronic circuits is very low, so the interference is easily expressed. The interference is greatly affected by the noise resistance of the devices, the distribution of wires, the distance between it and the inverter, etc.

Starting characteristics

When a motor is driven by an inverter, its operation is restricted by the inverter’s overload current rating, so the starting characteristics are different from those obtained from commercial power supply operation. Although the starting torque inverter is smaller than the motor than with the commercial power supply, a high starting torque can be produced at low speeds by adjusting the \( V/f \) pattern torques boost amount or by employing vector control. (2000 in serieose control mode, though the noise resistance with the motor characteristics.)

Screwed to a larger starting torque is necessary, select an inverter with a larger capacity and examine the possibility of increasing the motor capacity.

Rate of acceleration and deceleration

The actual acceleration and deceleration times of a motor driven by an inverter are determined by the torque and moment of inertia.

\[ \text{Deceleration time} = \frac{\text{Moment of inertia} \times \text{changing speed}}{\text{Torque}} \]

Replace the inverter with a new one

Replaced with a new one (upon examination)

Decided upon examination

Selection of the capacity (model) of the inverter

Refer to the applicable motor capactes rated in the standard specifications.

Rated output current

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.

\[ \text{Deceleration time} = \frac{\text{Moment of inertia} \times \text{changing speed}}{\text{Torque}} \]

The replacement intervals do not indicate the service life of each component, but the number of years beyond which the failure rate of a component used without being replaced increases sharply because of deterioration and wear.

Standard replacement intervals of main parts

The table below lists standard component replacement intervals under normal operating conditions (i.e., average year round ambient temperature of 30°C, load ratio of 80% or less, average operation time of 12 hours/day). The replacement intervals do not indicate the service life of each component, but the number of years beyond which the failure rate of a component used without being replaced increases sharply because of deterioration and wear.

<table>
<thead>
<tr>
<th>Component name</th>
<th>Standard replacement intervals</th>
<th>Replacement method, etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling fan</td>
<td>5 years</td>
<td>Replaced with a new one</td>
</tr>
<tr>
<td>Circuit breaker relay</td>
<td></td>
<td>Decided upon examination</td>
</tr>
<tr>
<td>Timer</td>
<td></td>
<td>Replace the timer with a new one (upon examination)</td>
</tr>
<tr>
<td>Capacitors on the printed circuit board</td>
<td>5 years</td>
<td>Replaced with a new one</td>
</tr>
</tbody>
</table>

Component name: The service life of each component greatly varies with its usage environment.

Rate of acceleration

What is the acceleration time of a motor driven by an inverter is classified into transmission noise, induction noise and radiation noise.

Noise due to motor operation is classified into four types:

- Transmission noise: Noise produced by the inverter when it is operating
- Induction noise: Noise produced by the inverter when it is operating
- Radiation noise: Noise produced by the inverter when it is operating
- Noise due to the capacitance between the ground and the noise filter: Noise produced by the inverter when it is operating

Measures against noises

To prevent the noise from inverter, the following measures are recommended:

1) Separate the power line from other lines, such as weak-current lines and signal lines, and install them apart from each other.
2) Install a noise filter in each inverter. It is effective for noise prevention to install noise filters in other devices and systems, as well.
3) Shield cables and wires with grounded metallic conduits, and cover electronic systems with grounded metallic cases.
4) Separate the power distribution line of the inverter from that of other devices and systems.
5) Install the input and output cables of the inverter apart from each other.
6) Use shielded twisted pair wires for wiring of the weak-current and signal circuits, and always ground one side of each pair of wire.
7) Ground the inverter with grounding wires as large and short as possible, separately from other devices and systems.
8) All models have built-in noise filters which significantly reduce noise.

Power factor improvement capacitors

These capacitors are used to improve the power factor and suppress high harmonic currents and surges. Add an input AC reactor when using a VF-S9 inverter under the following conditions:

(1) When the power source capacity is 200kVA or more, and when it is 10 times or more greater than the inverter capacity.
(2) When the inverter is connected to the same power distribution system as a thyristor-committed control equipment.
(3) When the inverter is connected to the power distribution system as that of damped wave producing systems, such as arc furnaces and large capacity inverters.

Note: The service life of each component greatly varies with its usage environment.