

## Washing machines [Commercial use]

### Features of washing machines

Commercial washing machines use inverters for drum rotation.

Operation methods are 'washing' and 'dehydration'.

-Washing: Low speed and forward/reverse operation

-Dehydration: High speed and forward operation

### Merits of inverter drives

Washing machines with inverters have the following merits:

#### - Simple switching of low/high speed

Speed control of washing machines without inverters use the following methods:

- Change of number of motor poles

- Use of pulleys or gears

Inverters can control motors at any speed, and can remove some magnet contactors for cost reduction.

#### - Simple switching of forward/reverse operation

Inverters can control forward or reverse operation simply.

Therefore, magnet contactors for forward/reverse operation aren't needed.

Besides, inverters can control motors without mechanical shock.

#### - High speed operation for tact time reduction

Inverters can control motors at frequencies higher than commercial power supply.

Therefore, washing machines with inverters can reduce the dehydration time.

### Notices regarding the use of inverter drives

#### - Maximum motor speed

The maximum motor speed depends on the motor specifications.

Please confirm the specifications of the manufacturer of your motor.

The specifications of TOSHIBA motors are as follows:

Capacity [kW]	Allowable frequency [Hz]		
	2 poles	4 poles	6 poles
0.4	60	120	120
0.75			
1.5			
2.2			
3.7			
5.5			
7.5		90	90
11			
15			
18.5			
22			
30	60	60	
37			
45			

#### - Low speed operation

Generally motors need to reduce their output torque when operating under 30Hz.

The motors are cooled by fans mounted on their shafts, so when the motor speed decreases, the cooling efficiency also decreases.

Special motors for inverter drives don't need to reduce their output torque between 6 to 60Hz.

#### - Acceleration and deceleration time

In case of high speed operation, a larger acceleration/deceleration time should be selected.

If you set a short acceleration / deceleration time, the following problems may occur:

While accelerating: Trip caused by overcurrent

While decelerating: Trip caused by overvoltage

We recommend to use the braking resistor for short time deceleration.

#### - Electromagnetic noise

The inverter is generating "electromagnetic noise".

If there are some high accuracy sensors or other sensitive equipment near the inverter drive, the inverter's noise may cause some trouble or a malfunction.

Electromagnetic noise can be avoided by installing an external noise filter or using a different wiring method.

### - Harmonics

The inverter is generating "harmonics".

These harmonics sometimes cause a malfunction in other control equipment that is connected to the same power source.

Harmonics can be avoided by installing an external "reactor".

To decrease "harmonics", we recommend to install DC reactors in all our inverter models. (NOTE: 100V input models require AC reactors.)

### Selection

When using high speed motors, the inverter capacity should be larger than the motor capacity.

When choosing inverters for washing machines, please pay attention to the following key points:

- Maximum frequency
- Minimum frequency
- Acceleration time
- Deceleration time

#### - Selection of number of motor poles

The load torque allowance of motors is decreasing at high speed.

EX:

Rated frequency: 60Hz

Operation frequency: 90Hz

Load torque allowance:  $100\% / (90\text{Hz} / 60\text{Hz}) = 66.7\%$

NOTICE:

If you operate a motor at a higher speed than its base frequency, the motor can stalled.

Please keep the following inverter selection for washing machines:

[Motor rated current] x 1.05 < [Inverter rated current]

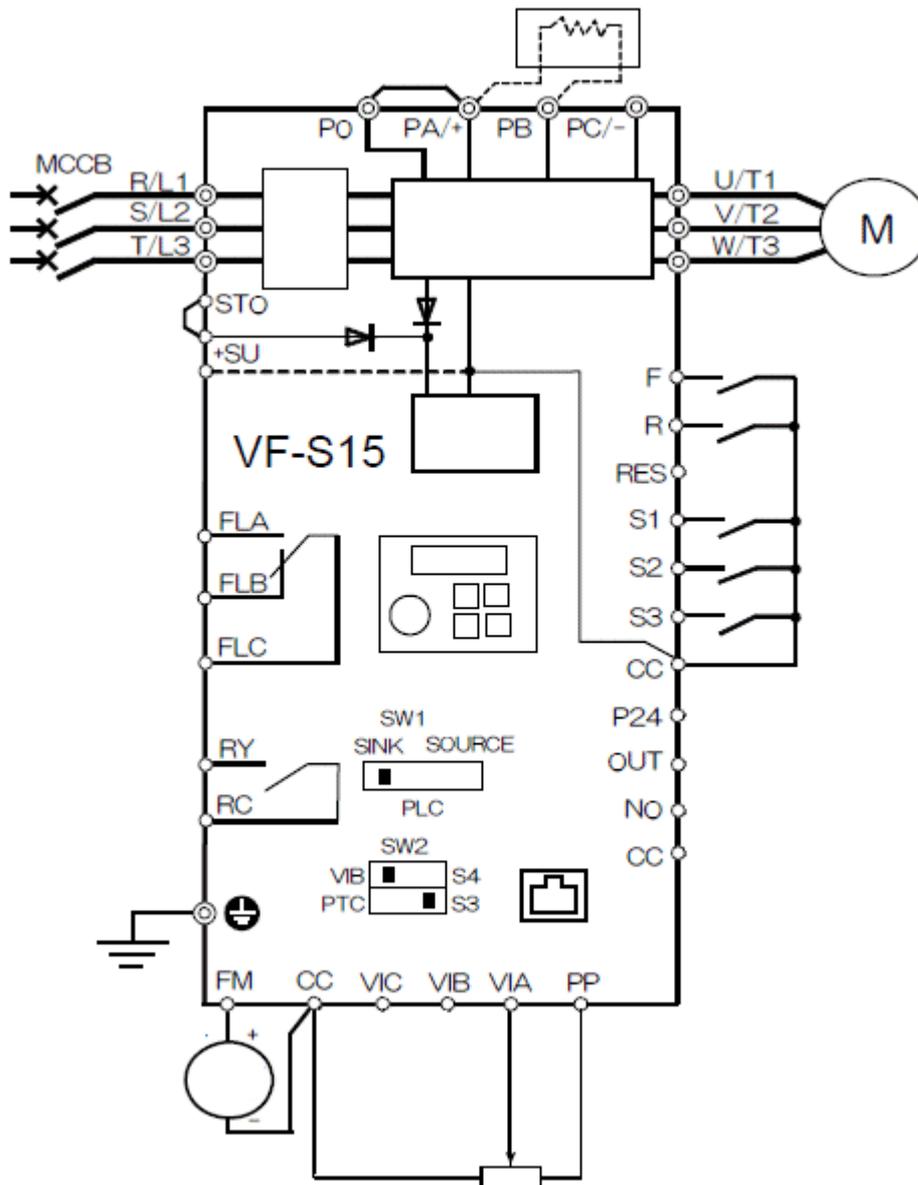
[Load torque at high speed] < [Motor allowable torque at high speed]

### Application samples

Washing machines usually use the following operating methods:

- RUN and STOP operations by remote control
- Preset speed control
  1. Low speed and forward run
  2. Low speed and reverse run
  3. High speed and forward run
- Second acceleration/deceleration time switching to avoid inverter trips at high speed.
- Emergency stop signal input
- Braking resistor installation
- Special motors for inverter drives

Connection diagram of inverters (VF-S15)



## Setting table for inverters (VF-S15)

The following table shows parameter settings for VF-S15 and a motor (60Hz: 1800min<sup>-1</sup>) manufactured by TIPM.

TIPM: Toshiba Industrial Products Manufacturing Corporation

Title	Function	Setting range	Recommended setting
<b>AU2</b>	Automatic torque boost	0 to 3	2
<b>CNOd</b>	Command mode selection	0 to 4	0
<b>FNOd</b>	Frequency setting mode selection 1	0 to 14	0 (Setting dial)
<b>ACC</b>	Acceleration time 1	0 to 3600 sec	30
<b>dCC</b>	Deceleration time 1	0 to 3600 sec	30
<b>FH</b>	Maximum frequency	30 to 500 Hz	120
<b>UL</b>	Upper limit frequency	0.0 to Maximum frequency	120
<b>OLn</b>	Electronic-thermal protection characteristic selection	0 to 7	4
<b>Sr1</b>	Preset speed frequency 1	LL to UL	6
<b>Sr2</b>	Preset speed frequency 2	LL to UL	120
<b>F116</b>	Input terminal selection 6 (S3)	0 to 203	20
<b>F304</b>	Dynamic braking selection	0: Disabled, 1: Enabled, etc.	1
<b>F405</b>	Motor rated capacity	0.01 to 22kW	Depends on the motor
<b>F415</b>	Motor rated current	0.1 to 100A	Depends on the motor
<b>F417</b>	Motor rated speed	100 to 64000 <sup>-1</sup>	Depends on the motor
<b>F500</b>	Acceleration time 2	0.1 to 3600 sec	60
<b>F501</b>	Deceleration time 2	0.1 to 3600 sec	60
<b>F505</b>	Acceleration/deceleration 1 and 2 switching frequency	0.0 to Upper limit frequency	60

### Note

After setting these parameters, please perform the following steps:

- (1) Connect the motor wiring.
- (2) Turn on the start signal.