TOSHIBA

E6581333

TOSVERT VF-AS1/PS1

Current and speed control gain adjustment method

1. Introduction

Thank you for purchasing a TOSVERT VF-AS1/PS1 industrial inverter.

This instruction manual explains the functions of the VF-AS1/PS1's parameters F458 through F466.

2. Function

2-1. Control gain adjustment function (F458 to F462)

When the inverter is operated in automatic torque boost mode or vector control mode (setting of parameter Pt: 2, 3, 4, 7 or 8), the speed response can be optimized according to the inertia of the load and vibrations can be reduced.

The settings of these parameters do not need to be changed, if no problem arises when they are at their factory defaults.

2-2. Speed control gain switching function (F463 to F466) *1

This function is used to change the speed response in low-speed and high-speed ranges when controlling speed in vector control mode.

When the inverter is used with a load whose moment of inertia changes significantly according to the operation frequency, response can be enhanced with this function.

To do so, first specify two kinds of speed control gains (proportional, stability factor and moment of inertia of load), and then switch from one to the other using the frequency switching function (F466).

*1: This function is not provided for the VF-PS1.

3. Related parameters

Title	Communication No.	Function	Adjustment range	Minimum setting unit (Panel/ Communication)	Default setting	Write during running	Vector control		V/f Constant	Note
							Speed control	Torque control		
F458	0458	Current control proportional gain	0~100	1/1	0	Disabled	●/●	●/●	-	AS1 only
F460	0460	Speed loop proportional gain	1~9999	1/1	12	Enabled	●/●	-	-	AS1/ PS1
F461	0461	Speed loop stabilization coefficient	1~9999	1/1	100	Enabled	●/●	-	-	AS1/ PS1
F462	0462	Moment of inertia of load 1	0~100	1/1	35	Enabled	●/●	-	-	AS1/ PS1
F463	0463	Second speed loop proportional gain	1~9999	1/1	12	Enabled	●/●	-	-	AS1 only
F464	0464	Second speed loop stabilization coefficient	1~9999	1/1	100	Enabled	●/●	-	-	AS1 only
F465	0465	Moment of inertia of load 2	0~100	1/1	35	Enabled	●/●	-	-	AS1 only
F466	0466	Speed PI switching frequency	0.0~FH Hz	1/1	0.0	Enabled	●/●	-	-	AS1 only

Sensorless vector/vector with sensor

●: Effective, -: Ineffective

4. Adjustment

4-1. How to adjust the speed control gain

This section explains how to adjust the speed control gain-related parameters (F458, F460, F461, F462).

By default, the response is set at approximately 5Hz based on the assumption that the inertia of the load is almost the same as the inertia of the motor (CPU versions of VF-AS1 is 124 and later). Therefore, if the inertia of the machine (inertia of the motor shaft) is reduced by means of gears, a belt, etc., the gain does not need to be adjusted in most cases.

If motor hunting occurs, or the motor hums, or gears squeak (if a gear motor is used) when the machine is operated under load or no-load conditions, then adjust this gain.

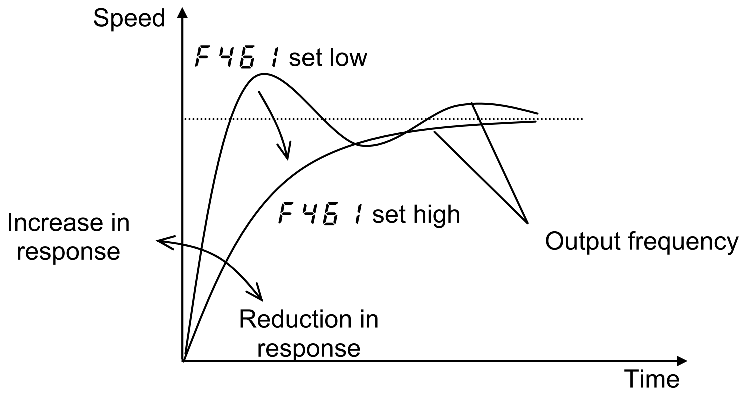
4-1-1. If the inertia of the load is unknown or there is no waveform measuring device available

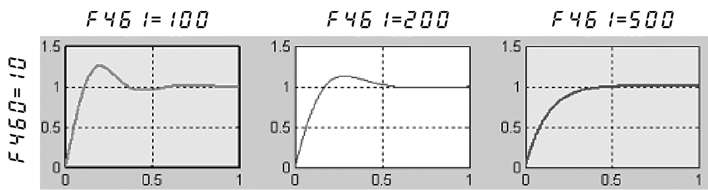
(1) Adjusting the setting of F461 (speed loop stability factor)

The figures below show the relationship between the setting of F461 and step response. Increasing the setting of F461 eliminates the occurrence of overshoots and makes operation stable. However, it reduces the response.

If you do not have a step response measuring device, follow these steps to adjust the setting of F461.

Operate the machine under no-load at low, intermediate and high speeds to determine whether motor hunting occurs, the motor hums or gears squeak (if a gear motor is used). If an unusual event has occurred, increase the set value of F461 until the unusual event disappears. Then, adjust the setting of F460.





(2) Adjusting the setting of F460 (speed loop proportional gain)

The relationship between the setting of F460 and step response is shown on the next page.

The adjustment of F461 in (1) above stabilizes the motor and allows it to run without hunting. If the response needs to be increased in such a situation, follow these steps to adjust the settings of F460 and F461.

The response can be increased by increasing the set value of F460, as described on the next page. To increase the response while keeping the motor in the state in (1) where an overshoot does not occur, parameter F461 also needs to be adjusted according to the following formulas. This adjustment makes high-speed and stable operation possible.

To increase the response in the state in (1) by a factor of K

F460= K × F460

F461= 1/K × F461

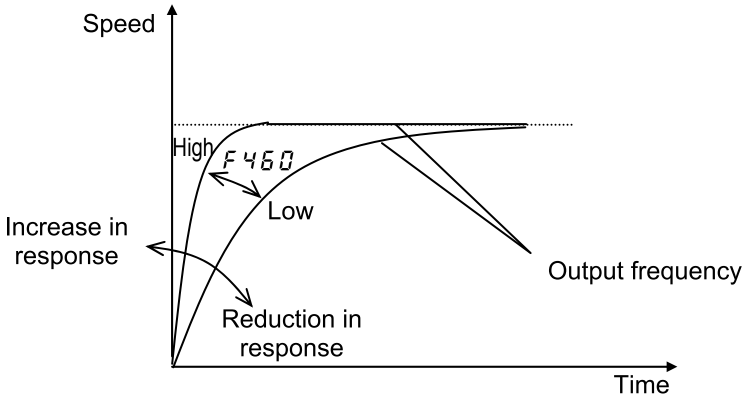
(Example of setting)

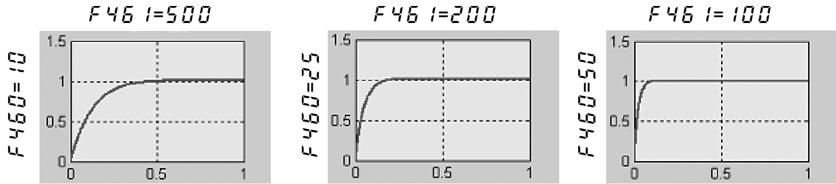
If F461 is set to 500 in (1)

To further increase the response by a factor of 2, set F461 to the following value (default value):

F460= 2 × 12 (default value)=24

F461= 1/2 × 500=250





As described earlier in this chapter, the speed response is set to approximately 5Hz by default, based on the assumption that the inertia of the load is almost the same (1 time) as the inertia of the motor. Therefore, to increase the speed of response of 5Hz by a factor of K for a machine with α inertia times as large as the inertia of the motor shaft, parameters F460 and F461 need to be set, as a guide, to the values shown below.

F460= K × α × 12 (default value)

F461= 1/K × 100 (default value)

If the problem persists despite of these adjustments, parameter F458 (current control proportional gain) also needs to be adjusted. Although parameter F458 is used to adjust the torque response, the speed response can be increased by increasing the set value of F458. *1

By default, this parameter is automatically set to:

100.0 (equivalent to a torque response of 100Hz) for inverters of 200V-15kW or less, and 400V-18.5kW or less, or

50.0 (equivalent to a torque response of 50Hz) for inverters of 200V-18.5kW or more, and 400V-22kW or more.

This parameter is effective in preventing the occurrence of a phenomenon, such as hunting, that is caused by excessively fast response, so set it as a guide to 50 or so (response of 50Hz) for small-capacity inverters, or to 25 or so (response of 25Hz) for large-capacity inverters and observe whether the phenomenon disappears.

*1: This parameter is not provided for the VF-PS1.

4-1-2. If the inertia of the load is unknown, but there is a waveform measuring device such as an oscilloscope available

(1) Connect the probes of the measuring device to the analog monitor output terminals (FM terminal-CC terminal) of your inverter. Then, change the FM terminal output setting to 6: speed feedback (real time value).
In addition, set F462 (moment of inertia of load 1) to 0 and remove the acceleration/deceleration command filter.

(2) Reduce the acceleration time to a minimum within the bounds of not causing an overcurrent stall (C blinks).

(3) Set the operation mode selection parameter (CMOd) and the speed command selection parameter (CMOd) so that they can be adjusted with the operation panel. (CMOd=“1” CMOd=“5”)

(4) Set the speed command at 10Hz or so with the △ key on the operation panel and start operation.

(5) Set the preset speed command (Sr1) to 13 to 15Hz and enter the preset speed command (turn on the S1 terminal) when constant-speed operation is performed at the frequency set in (4). Now, you can observe step response at frequencies of 10Hz and above. You can start observing the step response the moment the inverter starts, but in that case, it is difficult to observe the waveform because it is affected by motor excitation control at startup, and therefore it is recommendable to start observing step response after operation has entered the above-mentioned constant-speed region.

(6) Adjust the settings of parameters F460 and F461, observing the step response waveform (the steps to be followed to adjust these parameters are the same as those described in section 4-1-1).
First, increase the set value of F461 to eliminate overshoots. Then, increase the set value of F460 reducing the set value of F461 at the same rate, in order to increase the response to the desired level without causing an overshoot. Finally, return the setting of F462 to 35 (default setting) to finish the adjustments.

4-1-3. If both the inertia of the load and the inertia of the motor itself are known

The table below shows examples of the settings of parameters related to the inertia of a load and the inertia of a motor.
The formula in the bottom row is used to calculate the setting of F460.
If necessary, make the adjustments described in 4-1-1 or 4-1-2, using the values in this table as a guide.

Inertia of load/inertia of motor itself	Speed response (target)	Setting of F460	Setting of F461	Setting of F462
1	5Hz	12	100	35
3	5Hz	36	100	35
5	5Hz	60	100	35
α times	5Hz	12×α	100	35

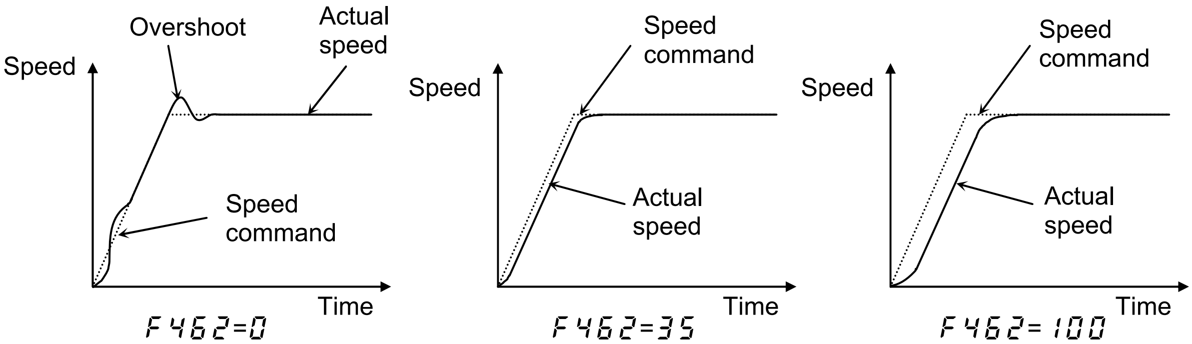
To increase the speed of response of a machine with a high-inertia load, high torque, more specifically a large electric current is required for the motor. Therefore, if you are using a machine with a high-inertia load for which high-speed responsivity is not required, you are recommended to reduce the speed of response.

4-1-4. Adjusting the moment of inertia of the load (F462)

The parameter for the adjustment of the moment of inertia of the load is effective in preventing a rapid change in acceleration during acceleration or deceleration.

When a machine with a high-inertia load is accelerated or decelerated, speed may overshoot the specified limit because of a change in acceleration, especially at acceleration and deceleration stop points.

The figures below show the relationship between the speed command during acceleration and the setting of F462.



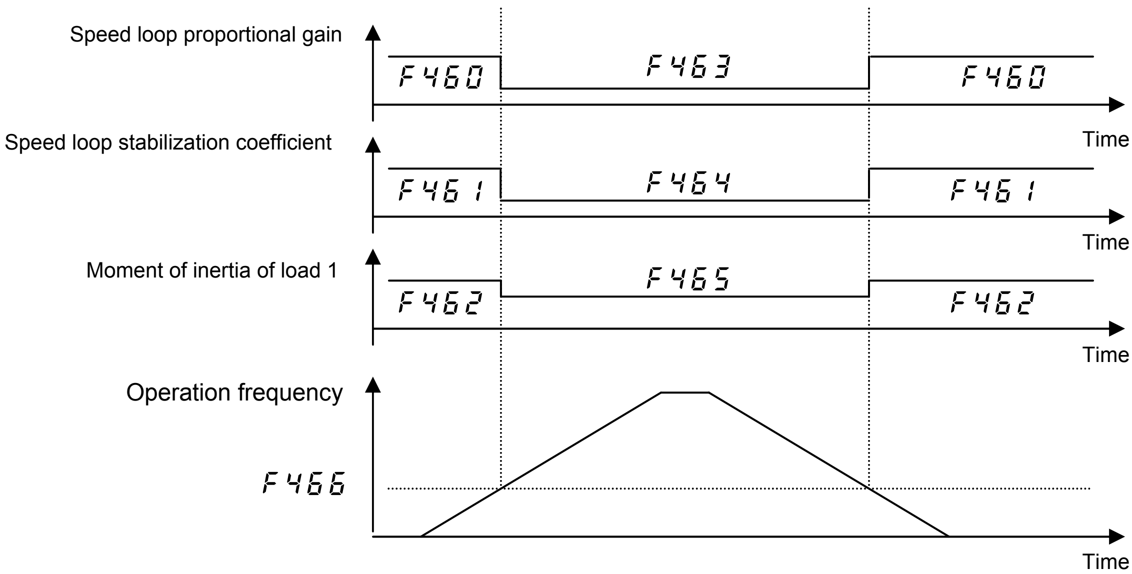
If you want to operate a machine with a low-inertia load at the highest possible acceleration/deceleration, you can increase the response by setting F462 to 0.

4-2. How to switch speed control gains *1

During high-speed or low-speed operation, speed cannot be changed in some cases without changing the speed control gain for reasons of machine characteristics. In such cases, use this gain switching function.

Gains are switched from one to the other when the frequency set with F466 is reached, as shown in the figures below.

F460 (Speed loop proportional gain) F461 (Speed loop stabilization coefficient) F462 (Moment of inertia of load 1)	Speed control gain 1
F463 (Second speed loop proportional gain) F464 (Second speed loop stabilization coefficient) F465 (Moment of inertia of load 2) F466 (Speed PI switching frequency)	Speed control gain 2



If the operation frequency is equal to or lower than the switching frequency（F466： Speed PI switching frequency):

Enable parameters F460，F461 and F462.

If the operation frequency is higher than the switching frequency (F466: Speed PI switching frequency):

Enable parameters F463, F464 and F465.

*1: This function is not provided for the VF-PS1.