

## *TOSVERT VF-AS3*

### Current and Speed Control Gain Adjustment Method

**TOSHIBA INDUSTRIAL PRODUCTS AND SYSTEMS CORPORATION**

Note

1. Read this manual carefully before using the inverter. After reading, the user should keep this document at hand to use it for maintenance and inspection in the future.
2. Please be informed that the contents of this document may be changed without notice.



## 1. Introduction

To operate with the vector control of VF-AS3, this instruction manual explains speed control-related parameter adjustment and inertia auto-tuning.

## 2. Adjusting current and speed gain

### ■ Function

#### 1) Control gain adjustment function [F458] to [F462]

When the inverter is running in vector control (setting of [Pt: V/f Pattern]: "3", "4", "5", "6", "9", "10", or "11"), this function is used to optimize the speed response according to the inertia of the load and reduce vibration.

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

#### 2) Speed control gain switching function [F463] to [F466]

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

When the inverter is used with the inertia of the load which changes significantly according to the run frequency, response can be enhanced with this function.

To do so, first specify two types of speed control gains (response, stabilization coefficient, and speed reference filter coefficient), and then switch from one to the other using [F466: Speed control response switching frequency].

Speed control gains can also be switched between two types in the input terminal "68: Speed control gain switching".

### ■ Parameter setting

Title	Communication No.	Parameter name	Adjustment range	Minimum setting unit (Panel/Communication)	Default setting	Write during running *1	Vector control*2		V/f constant control
							Speed control	Torque control	
F458	0458	Current control response	0 - 150	1/1	0	N	●/●	●/●	●
F459	0459	Load inertia ratio	0.1 - 100.0	0.1/0.1	1.0	Y	●/●	-	-
F460	0460	Speed control response 1	0.0 - 25.0	0.1/0.1	0.0	Y	●/●	-	-
F461	0461	Speed control stabilization coefficient 1	0.50 - 2.50	0.01/0.01	1.00	Y	●/●	-	-
F462	0462	Speed reference filter coefficient 1	0 - 100	1/1	35	Y	●/●	-	-
F463	0463	Speed control response 2	0.0 - 25.0	0.1/0.1	0.0	Y	●/●	-	-
F464	0464	Speed control stabilization coefficient 2	0.50 - 2.50	0.01/0.01	1.00	Y	●/●	-	-
F465	0465	Speed reference filter coefficient 2	0 - 100	1/1	35	Y	●/●	-	-
F466	0466	Speed control response switching frequency	0.0 - FH (Hz)	1/1	0.0	Y	●/●	-	-

\*1: Y: Writable N: Not writable

\*2: Sensor-less vector/vector with sensor

●: Enabled, -: Disabled

## ■ Control response adjustment

This section describes how to adjust the speed control gain-related parameters ([F459], [F460], [F461], and [F462]).

The default setting values are set so that the inertia of the load including the motor (hereinafter referred to as the inertia of the load) is set to be appropriate when it is almost the same as the inertia of the motor. In most cases, for a machine where the motor shaft-converted inertia of the load is set to be small using the gear, belt, etc., adjustment is not required.

First, refer to 1) and set the speed control gain-related parameters.

Then, perform no-load and load operation. If the motor causes hunting or a roaring sound, or if the gear motor causes a noise, refer to the section 2) and adjust the speed control gain-related parameters.

### 1) How to adjust the speed control response

#### (1) Setting [F459: Load inertia ratio]

Set "Ratio of the inertia of the load to the moment of inertia of the motor" in [F459].

If the inertia of the load is unknown, set the following value according to the amount of the inertia.

- When the inertia is small: [F459] = "1.0" (default setting)
- When the inertia is large: [F459] = "5.0"
- When the amount of the inertia is unknown: [F459] = "3.0"

If the inertia of the load is known, calculate the ratio to the inertia of the motor shown in the following table and set [F459].

The following table shows the inertia based on the Toshiba standard motor.

Motor output (kW)	Standard inertia (kgm <sup>2</sup> )	Motor output (kW)	Standard inertia (kgm <sup>2</sup> )
0.75	0.00405	45	0.440
1.5	0.00593	55	0.725
2.2	0.00900	75	0.875
4.0	0.0117	90	1.00
5.5	0.0303	110	1.58
7.5	0.0401	132	1.90
11	0.0680	160	2.75
15	0.0905	200	3.25
18.5	0.165	220	3.50
22	0.200	250	3.75
30	0.248	280	4.25
37	0.380	315	4.75

#### (2) Setting [F460: Speed control response 1]

Set the speed response by the unit of 0.1 Hz in [F460].

If the target speed response is clear, specify that value.

If the target speed response is unclear, set [F460] to "0.0" (default setting). The speed response is automatically calculated according to the acceleration or deceleration time.

#### (3) Setting [F461: Speed control stabilization coefficient 1]

Set the speed control stabilization coefficient in [F461].

The speed control stabilization coefficient reduces the overshoot of speed in the excess response and vibration.

Normally, this parameter does not need to be changed from the default setting value.

#### (4) Setting [F462: Speed reference filter coefficient 1]

The speed reference filter coefficient reduces the rapid change in acceleration during acceleration or deceleration.

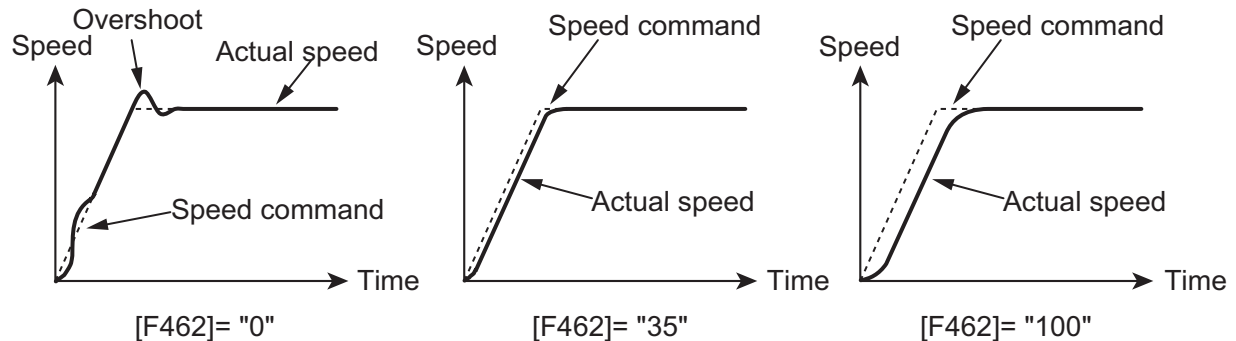
At the acceleration completion point and the deceleration stop point, in particular, when accelerating or decelerating a machine with large inertia of the load, the overshoot of speed may occur due to change in acceleration. In such a case, increase the value in [F462] to reduce the overshoot.

Meanwhile, to operate a machine with small inertia of the load in the minimum acceleration or deceleration time, decrease the value in [F462] to improve the response during acceleration or deceleration.

When [F462] = "0", the speed lamp output is used as a speed command.

Meanwhile, when [F462] = "100", a filtered value of the speed lamp output is used as a speed command. (The filter time constant depends on the speed control gain. When [F460] is set to be larger, the filter time constant becomes smaller.)

The following figures show the relationship between the speed command and the actual speed for the setting value of [F462].



## 2) Troubleshooting

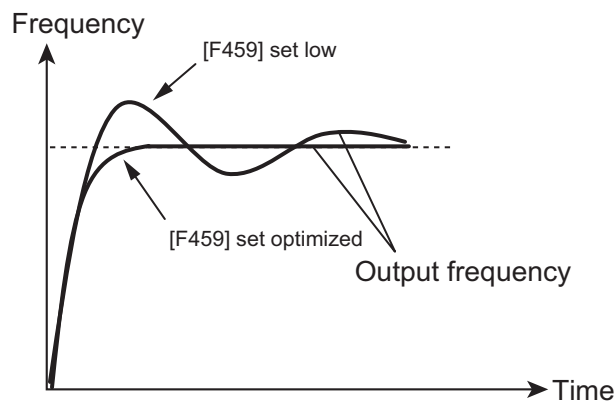
If a phenomenon, such as motor hunting or a gear noise occurs, refer to the following and adjust the speed control gain-related parameters.

### (1) Adjusting [F459: Load inertia ratio]

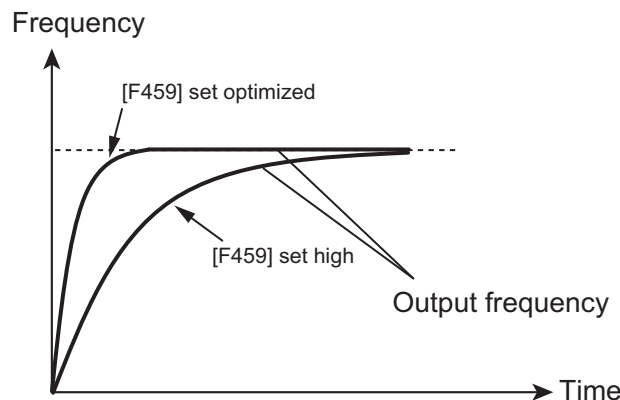
If one of the following phenomena occurs, adjust [F459].

- The motor causes great hunting.
- The motor causes hunting and overcurrent [OC] trip occurs.  
=> Decrease the value in [F459].
- The motor speed is significantly overshoot.
- Abnormal speed [E-13] trip occurs.  
=> Increase the value in [F459].

- i) The following figure shows the speed response when the actual inertia of the load is larger than the setting value of [F459].



- ii) The following figure shows the speed response when the actual inertia of the load is smaller than the setting value of [F459].

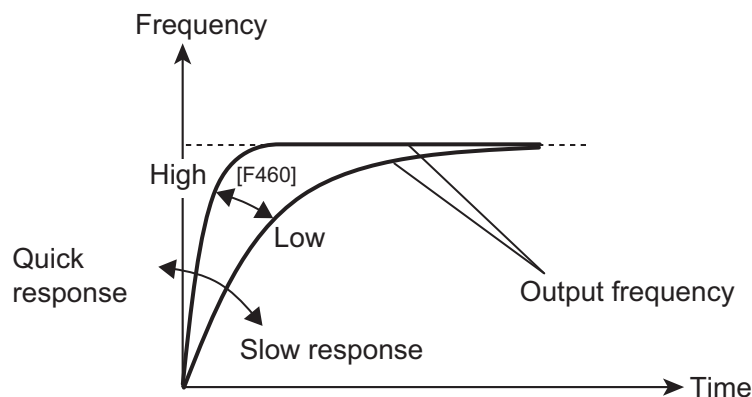


To set the optimum speed response of the load, perform auto-tuning for [F459]. For how to perform auto-tuning for [F459], refer to "■ Auto-tuning for [F459: Load inertia ratio]".

- (2) Adjusting [F460: Speed control response 1]  
 To speed up the target response, increase the value in [F460].  
 If [F460] is set to be too large, vibration may occur in the mechanical system.  
 If vibration occurs, decrease the value in [F460].  
 When [F460] is set to be too small, the speed control response becomes slow. When the acceleration or deceleration time in particular is short, delay in adjustment can be clearly seen.

Note 1) Make sure that the upper limit in [F460] is  $150/[F459]$ .

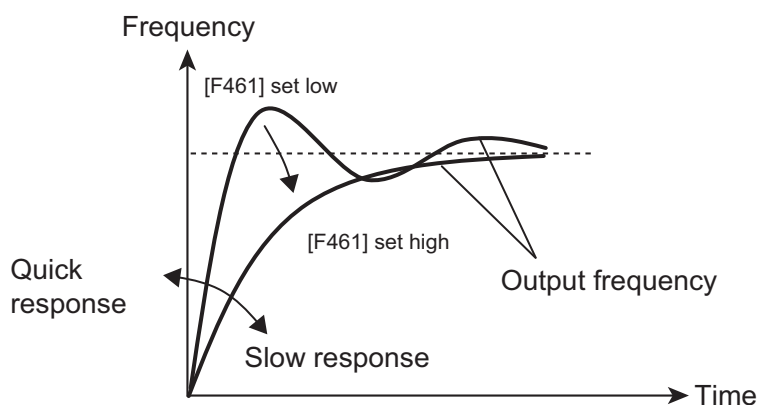
The following figure shows the relationship between the setting value of [F460] and the speed response.



Note 2) When [F460] = "0.0", the speed response is automatically calculated internally. Set [F460] = "3.0" once and check the status.

- (3) Adjusting [F461: Speed control stabilization coefficient 1]  
 To reduce the overshoot of speed or vibration in the steady-state, increase the value in [F461]. However, the response becomes slow.  
 Meanwhile, when [F461] is set to be smaller, the response becomes quicker. However, overshoot or vibration occurs more easily.

The following figure shows the relationship between [F461] and the step response.



(4) Adjusting [F458: Current control response].

If the speed control response cannot be correctly adjusted or tiny vibration cannot be reduced using the above method (1), (2), or (3), decrease the value in [F458]. However, when the value is set to be smaller, the current response or adjustment to the target value becomes slower.

\* The default setting value "0" in [F458] is equal to the 50 Hz response.

If the response is not improved even by the above method, there could be other causes. Please contact your Toshiba distributor.

### 3) How to switch speed control gains

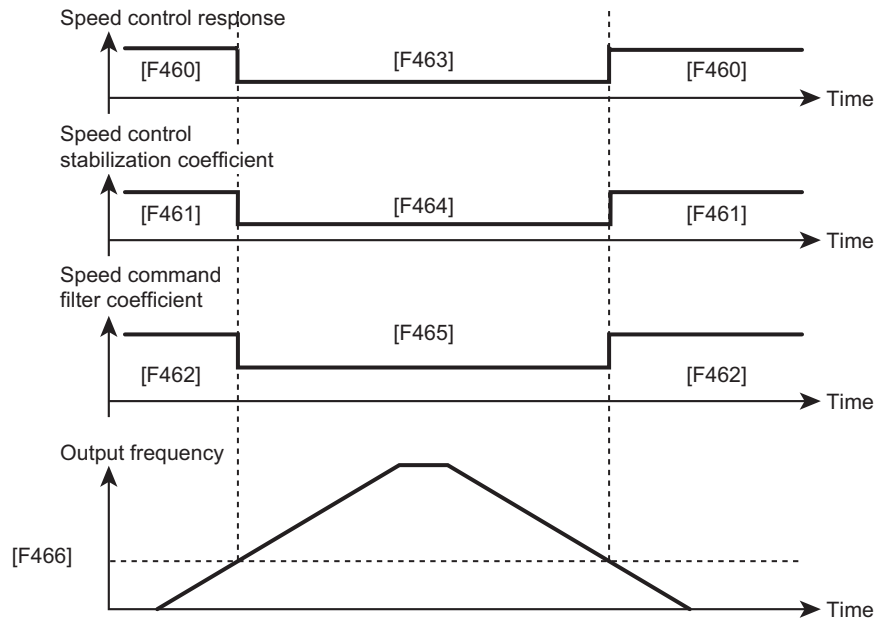
(1) To switch the gain by the parameter

During high-speed or low-speed operation, you need to change the speed control gain before adjusting it in some cases for reasons of machine characteristics. In this case, use the gain switching.

Gains are switched according to the setting frequency in [F466] as shown in the following figure.

When [F466] = "0.0", the speed control gain switching is disabled. Speed control gain 1 is enabled.

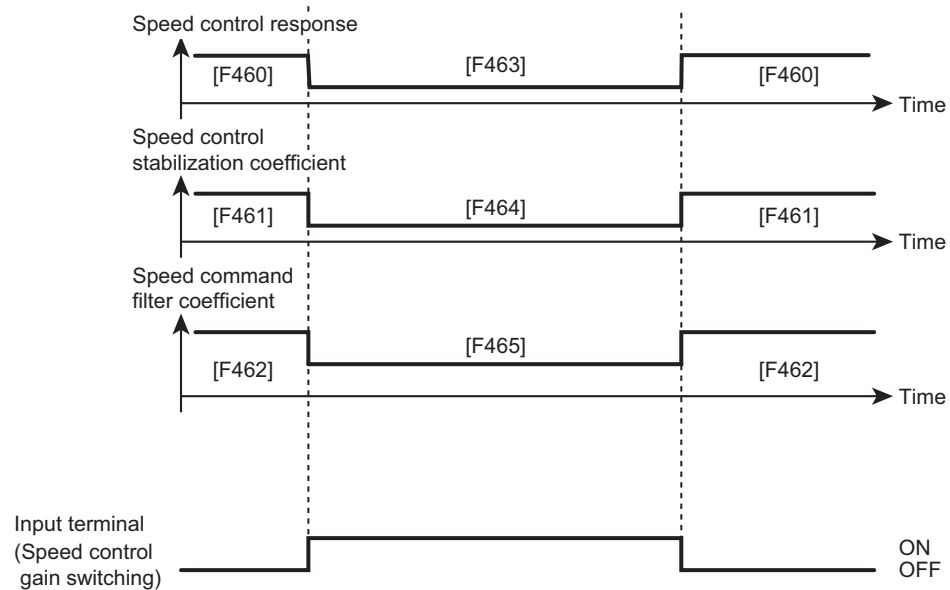
[F460: Speed control response 1]	}	Speed control gain 1
[F461: Speed control stabilization coefficient 1]		
[F462: Speed reference filter coefficient 1]		
[F463: Speed control response 2]	}	Speed control gain 2
[F464: Speed control stabilization coefficient 2]		
[F465: Speed reference filter coefficient 2]		
[F466: Speed control response switching frequency]		



In a range where the output frequency is [F466] or less, [F460], [F461], and [F462] are enabled.

In a range where the output frequency is over [F466], [F463], [F464], and [F465] are enabled.

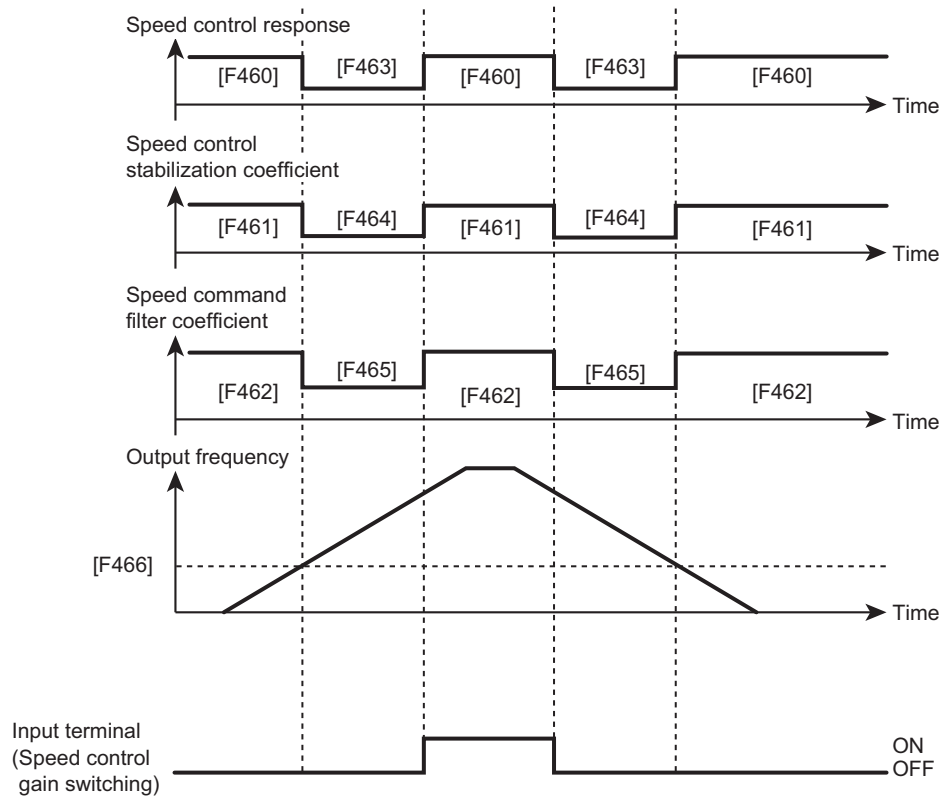
- (2) To switch gains by the input terminal  
 Use the input terminal "68: Speed control gain switching" to switch between speed control gain 1 and speed control gain 2. Gains are switched according to the input terminal signal as shown in the following figure.





By using [F466] together with the speed gain switching by the input terminal, you can switch between speed control gain 1 and speed control gain 2.

Gains are switched by the output frequency and the input terminal signal.



#### ■ Auto-tuning for [F459: Load inertia ratio]

To set the optimum speed response of the load, perform inertia auto-tuning.

##### 1) Parameter

Title	Communication No.	Parameter name	Adjustment range	Unit	Minimum setting unit Panel/Communication	Default setting
F480	0480	Inertia auto-tuning	0 - 2	-	1/1	0
F481	0481	Speed command at inertia auto-tuning	10 - 100	%	1/1	25
F482	0482	Speed variation width at inertia auto-tuning	0.1 - 25.0	%	0.1/0.1	5.0
F483	0483	Number of speed variation at inertia auto-tuning	5 - 50	Times	1/1	10

[F480: Inertia auto-tuning]

Enable or disable inertia auto-tuning.

"0: Disabled": Disabled

"1: Enabled 1": Enabled (Speed variation width automatic adjustment)

"2: Enabled 2": Enabled (Speed variation width manual adjustment)

[F481: Speed command at inertia auto-tuning]

Set the speed command at inertia auto-tuning in % of [vL: Base frequency 1].

It must be lower than the frequency (speed) used in normal operation.

[F482: Speed variation width at inertia auto-tuning]

Set the speed variation width at inertia auto-tuning in % of [vL].

When [F480] = "1", this is the initial value used when the speed variation width is automatically adjusted according to the amount of torque.

[F483: Number of speed variation at inertia auto-tuning]

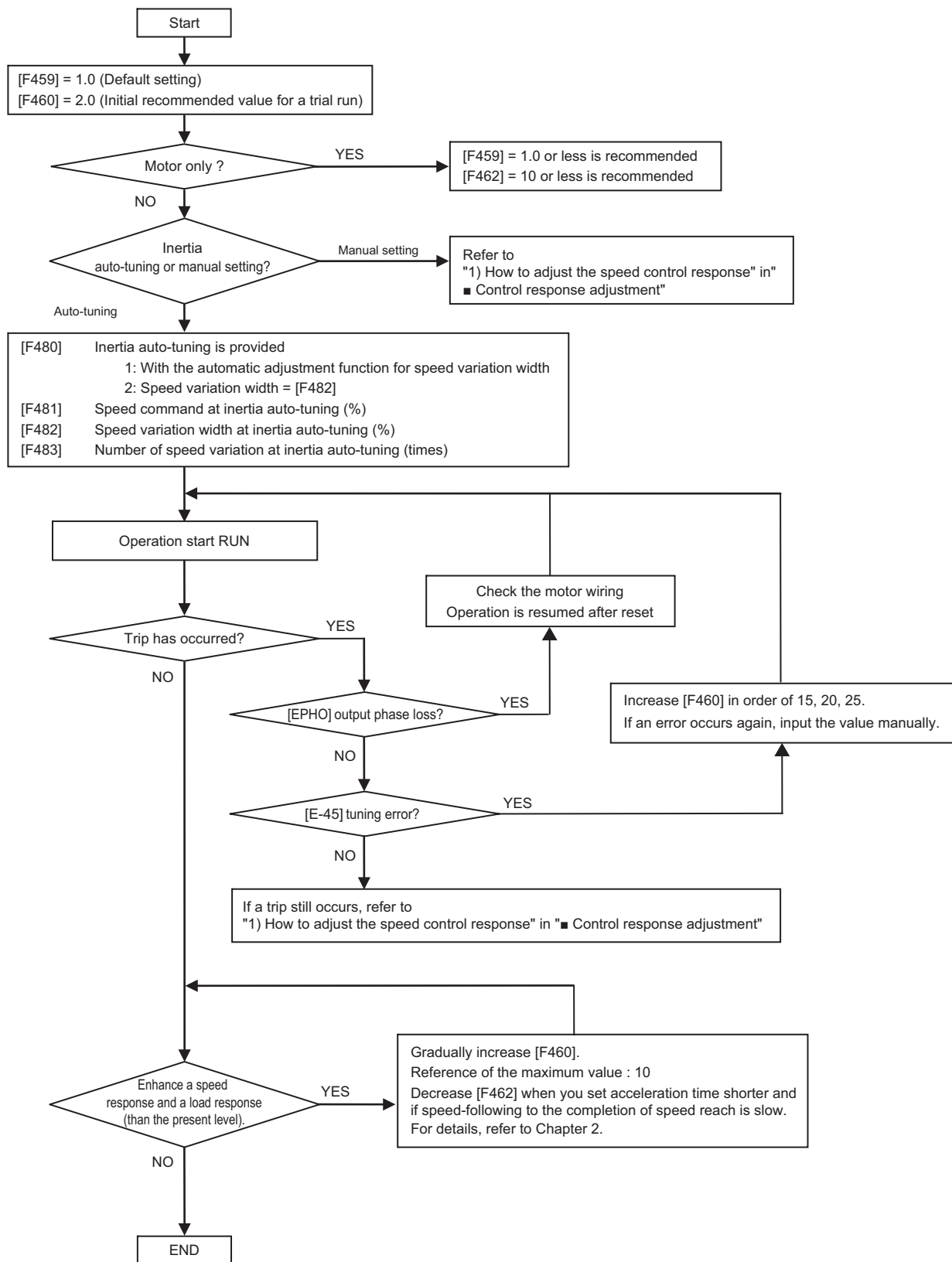
Set the number of speed variation at inertia auto-tuning.

When GD2 auto-tuning error [E-45] trip occurs, increase the value.

Cautions

- (1) After connecting the motor to the load, set the motor parameters and perform auto-tuning. Then, perform inertia auto-tuning.
- (2) If [E-45] trip occurs due to load fluctuation, manually input to [F459].
- (3) Inertia auto-tuning is disabled in the following case.  
When [Pt: V/f Pattern] is set to "0", "1", "2", "4", "5", "7", or "8".  
When [Pt] = "9" or "11" with torque control.
- (4) After inertia auto-tuning, the result is overwritten to [F459]. Record a value before auto-tuning as necessary.
- (5) The setting value "1.0" (default setting) is recommended for [F459] before inertia auto-tuning. When the inertia load is clearly large, set a value larger than "1.0" so that the adjustment accuracy may increase.
- (6) Perform inertia auto-tuning under the following conditions. If the conditions are not met, it may not be performed stably.
  - Load torque does not change suddenly during auto-tuning.
  - The inertia ratio is about 30 times or less of the inertia of a 4P standard induction motor which has the same capacity as the inverter.
  - The gear does not rattle and the belt is not loose.

## 2) Flowchart of inertia auto-tuning process



### 3) Operation example of inertia auto-tuning

When [F481] = "1"

- (1) After setting [F481] to "1", execute inertia auto-tuning with the first run command ON.
- (2) Accelerate to [F481].
- (3) For appropriate inertia auto-tuning, set the value in [F459] using [F482] as the initial value while the speed variation width is automatically adjusted.
- (4) Execute speed variation for the number of times set in [F483] and complete inertia auto-tuning. Move to normal operation.
- (5) The auto-tuning result is overwritten to [F459] and [F480] is set back to "0".

