

# *TOSVERT VF-AS3*

## Positioning Control Function Manual

**TOSHIBA INDUSTRIAL PRODUCTS AND SYSTEMS CORPORATION**

### **Attention**



1. Read this manual carefully before using the product. Keep this manual in a safe place for future maintenance and inspection.
2. The information in this manual is subject to change without prior notice. For the latest contents, refer to the Toshiba inverter website "<http://www.inverter.co.jp/>."



## Safety precautions

The items described in the instruction manual and on the inverter itself are very important so that you can use safely and correctly the inverter, prevent injury to yourself and other people around you as well as to prevent damage to property in the area. Thoroughly familiarize yourself with the following (display/symbols) and then continue to read the manual. Make sure that you observe all warnings given.

### Description of display




Display	Meaning
 Warning	Indicates that "mishandling may cause death or serious injury (*1) of the user."
 Caution	Indicates that "mishandling may cause injury (*2) of the user or property damage (*3)."

(\*1) Serious injury means loss of sight, burn (high temperature/low temperature), electric shock, fracture, poisoning, etc. that cause aftereffects and require hospitalization or long-term hospital visits for treatment.

(\*2) Injury means injury, burn, electric shock, etc. that do not require hospitalization or long-term hospital visits for treatment.

(\*3) Property damage means extended damage concerning the house, household goods, livestock and pets.

### Description of symbols

Display	Meaning
	Indicates prohibition (matters prohibited). The concrete contents are indicated inside or near the symbol with a picture or text.
	Indicates matters to be observed without fail. The concrete contents are indicated inside or near the symbol with a picture or text.
	Indicates a caution. The concrete contents are indicated inside or near the symbol with a picture or text.

### ■ About application limitation

## Safety precautions

- Use this function for applications that do not lead to serious accidents even if a failure or trouble occurs in this inverter or by installing a backup circuit/device as a system outside of this inverter or under conditions where a safety device works.
- When using this function, install a stop mechanism with a limit switch or mechanical stopper separately so that the movable range of the machine device should not be exceeded even if a failure or trouble occurs in this inverter.

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## **1. Introduction**

Positioning control is control to calculate the speed command to make the motor stop at the command position.

During positioning control, the motor is rotated by calculating the speed command to keep the difference between the number of command pulses and the number of feedback pulses zero.

With this inverter, multi-step point positioning control by logic input or positioning control by unit pulse train input can be performed.

Main axis orientation control to stop a rotating machine at the specified phase can be also performed by applying positioning control.

The structure of this document is as follows.

Chapter 2: Describes multi-step point positioning and a method with pulse train input as operation methods of positioning control.

Chapter 3: Describes parameters used for positioning control.

Chapter 4: Describes actual setting examples of positioning control.

Chapter 5: Describes the operation method of orientation control.

Chapter 6: Describes parameters used for orientation control.

## 2. Operation method of positioning control

This chapter describes the parameter setting necessary for positioning control and the operation procedure of the inverter.

### 2.1 Parameters to be set before positioning control

Set necessary parameters for positioning control. For how to set, see the following table.

For the parameter settings to use

- PG feedback option (VEC008Z), refer to E6582148.
- resolver option (VEC010Z), refer to E6582171.
- input terminal S4, and S5, refer to E6582183.

After making these settings, check that operation is possible with speed control.

Parameter	Function	Setting	Remarks
Pt	V/f Pattern	10: PG feedback control 11: PG feedback vector control (speed/torque) 12: PG feedback vector control (for PM) Set to any of the above.	Set to 10 when the detection accuracy of the speed is low with a small number of PG pulses or the PG not connected directly to the motor when an induction machine is driven.
F240	Start frequency	0.0	
F375	PG pulses number	Set the number of pulses for one rotation of the motor.	Set the PG pulse number when the PG is connected to the motor and the PG pulse number multiplied by the reciprocal of the reduction gear ratio when the PG is connected to the load machine.
F376	PG select	Set the type of the PG and the polarity. 0: PTI (Command) - PTI (FB) 1: PTI (Command) - Digital option (FB) 2: - 3: PTI (Command) - Resolver option (FB) 4, 5: - 6: Digital option (Command) - Non FB 7 - 9: - 10: PTI (Command) - PTI (FB inversion) 11: PTI (Command) - Digital option (FB inversion) 12: - 13: PTI (Command) - Resolver option (FB inversion) 14, 15: - 16: Digital option (Command inversion) - Non FB	Select the PG and polarity to be used. <ul style="list-style-type: none"> <li>• Set 0 or 10 to input the speed feedback signal to the S4 and S5 terminals.</li> <li>• Set 1 or 11 to use the PG feedback option (VEC008Z).</li> <li>• Set 3 or 13 to use the resolver option (VEC010Z).</li> </ul>

Parameter	Function	Setting	Remarks
F146	Terminal S4 input select	0: Digital input 1: Pulse train input 2: PG input	<ul style="list-style-type: none"> <li>Set F146 and F147=2 to input the speed feedback signal to the S4 and S5 terminals.</li> <li>Set the relevant parameter to 1 to input the position command signal to S4 or S5 terminal.</li> </ul>
F147	Terminal S5 input select	0: Digital input 1: Pulse train input 2: PG input	
F460	Speed control response 1	Set the gain of speed control.	Generally, set a value approx. between 3 Hz to 5 Hz.
ACC, DEC	Acc/Dec time 1	Set the acceleration/deceleration time at the time of normal operation.	
VL	Base frequency 1	Set the motor constant by referring to the motor nameplate.	
VLV	Base frequency voltage 1		
F405	Motor rated capacity		
F415	Motor rated current		
F417	Motor rated speed		
F400	Offline auto-tuning	2	Auto-tuning is performed immediately after operation start.

## 2.2 Positioning control by multi-step point setting

### 2.2.1 Settings of main parameters

When A510=1, input of the target position by multi-step point setting is enabled.

To switch points, use preset speed commands 1 to 3 (digital input terminal functions 10/11, 12/13, 14, 15).

The following are parameters necessary for positioning control by multi-step point setting.

- Set A510=1.
- Set A544 to A596 according to the number of steps of the positioning point.

For each multi-step point, the target position (example: A544, A545), frequency at the time of position control (example: Sr1), acceleration/deceleration time until the frequency with a position command is reached (example: A547, A548), function (example: A546) can be set with parameters. For the parameter corresponding to each point, see the table below. For how to set, refer to 2.2.1.1 and 2.2.1.2.

Multi-step point	Target position		Function setting	Speed at the time of position control	Acceleration time	Deceleration time	Preset speed input signal		
	Higher 4 digits	Lower 4 digits					1 (SS1)	2 (SS2)	3 (SS3)
1	A544	A545	A546	Sr1	A547	A548	x	-	-
2	A552	A553	A554	Sr2	A555	A556	-	x	-
3	A560	A561	A562	Sr3	A563	A564	x	x	-
4	A568	A569	A570	Sr4	A571	A572	-	-	x
5	A576	A577	A578	Sr5	A579	A580	x	-	x
6	A584	A585	A586	Sr6	A587	A588	-	x	x

Multi-step point	Target position		Function setting	Speed at the time of position control	Acceleration time	Deceleration time	Preset speed input signal		
	Higher 4 digits	Lower 4 digits					1 (SS1)	2 (SS2)	3 (SS3)
7	A592	A593	A594	Sr7	A595	A596	x	x	x

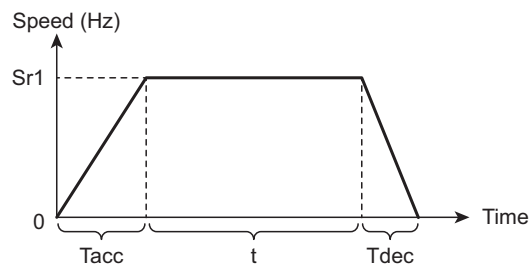
x: ON - : OFF

- Set the limits of the target position to A512 and A513 (on the positive side), and A514 and A515 (on the negative side).
- Assign the positioning preparation signal (input terminal function 178/179) to the input terminal.
- Assign the run signal (input terminal function 2/3 or 4/5) to the input terminal.
- Assign the multi-step point signal (input terminal function 10/11, 12/13, or 14/15) to the input terminal.

### 2.2.1.1 About speed and acceleration/deceleration time

Here, description is given by using the parameter for multi-step point 1. The same applies also to multi-step points 2 to 7.

The frequency at the time of positioning control is as shown in the diagram below.



- Set the steady rate at the time of positioning control to  $\pm Sr1$  (Hz).
- Set the acceleration/deceleration time until the maximum frequency (FH) is reached to A547 (A548).

The times Tacc and Tdec for acceleration/deceleration are as shown in the formulas below.

$$T_{acc} = Sr1 \times A547 / FH, \quad T_{dec} = Sr1 \times A548 / FH$$

If the position command is Pcmd, it is equivalent to the area of the trapezoid within the straight lines in the figure above.

Therefore, the time t of the steady rate is obtained as shown in the formulas below.

$$P_{cmd} = Sr1 \times \left( \frac{A547 \times Sr1}{2 \cdot FH} + t + \frac{A548 \times Sr1}{2 \cdot FH} \right)$$

$$t = \frac{P_{cmd}}{Sr1} - \frac{A547 + A548}{2 \cdot FH} \cdot Sr1$$

The time T required for positioning control is obtained as shown in the formula below.

$$T = \frac{A547 \times Sr1}{FH} + t + \frac{A548 \times Sr1}{FH} = \frac{P_{cmd}}{Sr1} + \frac{A547 + A548}{2 \cdot FH} \cdot Sr1$$



### 2.2.1.2 About functions

Here, description is given by using the parameter for multi-step point 1. The same applies also to multi-step points 2 to 7.

The function parameter (A546) is a parameter that allows you to select the method to specify the target position as shown in the table below.

Setting	Command method	Sign
0	Absolute position command	Positive
1	Absolute position command	Negative
2	Relative position command	Positive
3	Relative position command	Negative

- **When A546=0**
  - The target position (A544, A545) has a positive value.
  - The target position (A544, A545) is an absolute position.  
For example, if a target position 100000 (A544=10, A545=0) is set, the target position is the point moved for 100000 pulses from the origin in the positive direction.
- **When A546=1**
  - The target position (A544, A545) has a negative value.
  - The target position (A544, A545) is an absolute position.  
For example, if a target position 100000 (A544=10, A545=0) is set, the target position is the point moved for 100000 pulses from the origin in the negative direction.
- **When A546=2**
  - The target position (A544, A545) has a positive value.
  - The target position (A544, A545) is a relative position.  
For example, if a target position 100000 (A544=10, A545=0) is set, the target position is the point moved for 100000 pulses from the position of the previous settlement in the positive direction.
- **When A546=3**
  - The target position (A544, A545) has a negative value.
  - The target position (A544, A545) is a relative position.  
For example, if a target position 100000 (A544=10, A545=0) is set, the target position is the point moved for 100000 pulses from the position of the previous settlement in the negative direction.

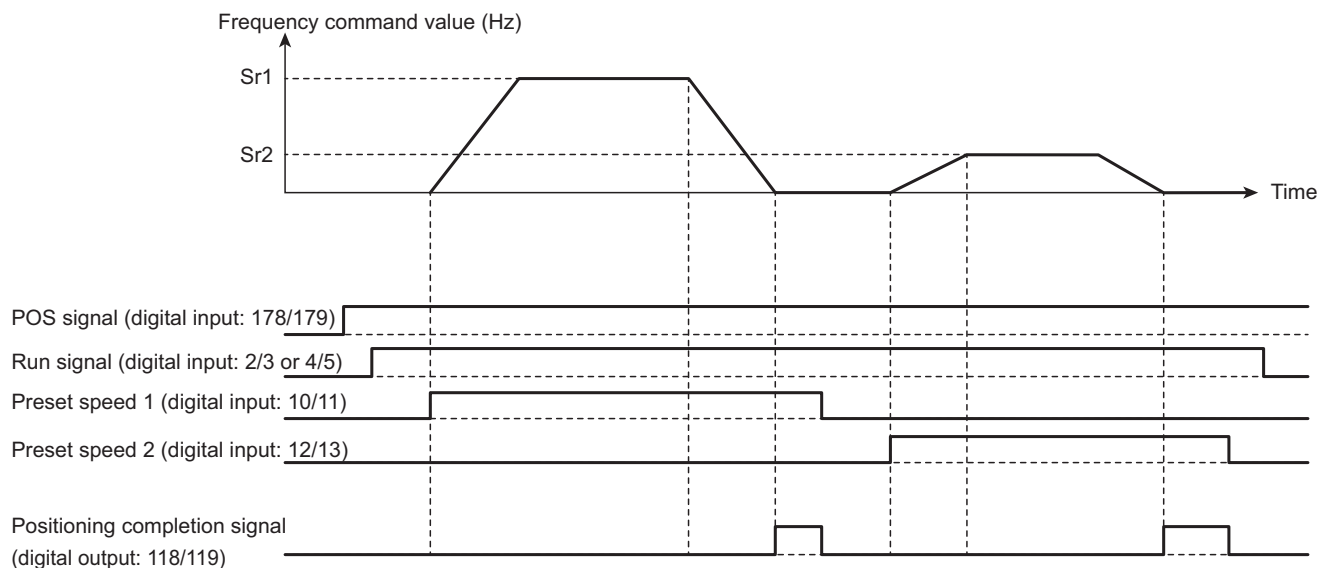
**(Caution)**

- When a relative position command is used, change the point number after positioning control settles. (Switch the preset speed command terminal).
- When the same point number is used for the relative position command, turn OFF all the preset speed signals once, then turn ON the signal corresponding to the specified point number again.

## 2.2.2 Operation style

Perform positioning control by multi-step point setting in the following procedure.

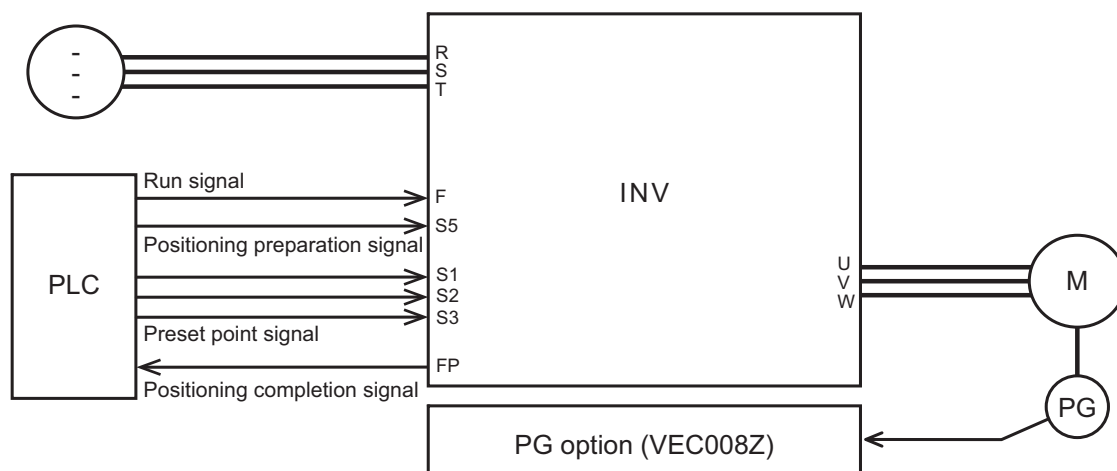
- (1) Turn ON the positioning preparation signal (digital input terminal function 178/179).
- (2) Turn ON the run signal (digital input terminal function 2/3 or 4/5).  
Then, the motor is in the servo lock status.
- (3) Turn ON the multi-step point signal (digital input terminal function 10/11, 12/13, or 14/15).  
The motor rotates so that the load machine should move to the target position specified by the multi-step point signal.
- (4) When the positioning control settles and the deviation between the target position and the current position becomes  $\pm F381$  or less, the positioning completion signal (digital output terminal function 118/119) is turned ON.



### 2.2.3 Caution

- Change the setting of A510 after turning OFF the positioning preparation signal (input terminal function 178/179) and run signal (input terminal functions 2/3, 4/5).
  - Positioning control and the PID function cannot be used at the same time.  
When A510=1, the normal PID function is disabled.
  - When the run signal is turned OFF during positioning control, positioning control is stopped, and the motor is decelerated and stopped in the deceleration time set in A511.
  - When the positioning preparation signal is turned OFF during positioning control, E-46 trip occurs.
  - To switch from positioning control to speed control, turn OFF the run signal during positioning control and turn OFF the positioning preparation signal after the inverter stops.
  - When all the multi-step point signals (input terminal functions 10/11, 12/13, 14/15) are turned OFF during positioning control, rewrite the target position to the detection position at that time. Do not turn OFF all the multi-step point signals when positioning is not completed. When it is completed, servo lock is continued in the current position.
  - If the current position becomes out of the range of - (A520, A521) to (A518, A519) during positioning control, the position limit excess signal (output terminal function 214/215) is turned ON.  
When A522=0, positioning control can be continued as it is, however, E-47 trip occurs when A522=1. Use this function to prevent the machine from exceeding the range of movement.
  - When movement in the same direction is repeated with the relative position command, clear the current position as necessary so that the current position should not be out of the range of -(A520, A521) to (A518, A519).  
For how to clear the current position, refer to 2.4.
  - This function is available with the following speed feedback detection.
    - PG feedback option (VEC008Z)
    - resolver option (VEC010Z)
    - S4, and S5 terminal (V114 or later)\*
- \* Stop position control shortly after positioning is completed.  
Do not use servo lock operation (continue to run at 0Hz).

### 2.2.4 Contact example of positioning control by multi-step point



## 2.3 Positioning control by pulse train input

### 2.3.1 Settings of main parameters

When A510=2 or 3, input of the target position by pulse train is enabled.

The target position can be specified by the number of all pulses input and the frequency at the time of positioning control by the frequency of pulse input.

The following are the parameters necessary for positioning control by pulse train input.

- Set A510=2 or 3.
- Set the limits of the target position to A512 and A513 (on the positive side), and A514 and A515 (on the negative side).
- Assign the positioning preparation signal (input terminal function 178/179) to the input terminal.
- Assign the run signal (input terminal function 2/3 or 4/5) to the input terminal.
- Connect so that the command pulse should be input in the S4 or S5 terminal.
- See the following to set the pulse input parameters.

#### 2.3.1.1 How to input pulse train when A510=2

The following are how to input a pulse train and parameter setting.

- Input a pulse train from the S4 or S5 terminal.
  - When the pulse train is input from the S4 terminal: Set F146=1 and F147=0.
  - When the pulse train is input from the S5 terminal: Set F146=0 and F147=1.
- Set the sign of the pulse train position with the pulse train positioning forward/reverse command signal (input terminal function 182/183)=OFF (forward run) or ON (reverse run).
- Set how to clear pulses in pulse train input (clear the current position and the target position) with A537.
  - When A537=0, pulses are cleared at the moment when the pulse train position command clear signal (input terminal function 184/185) is turned ON from OFF.
  - When A537=1, pulses are cleared continuously when the pulse train position command clear signal (input terminal function 184/185)=ON.

### 2.3.1.2 How to input pulse train when A510=3

The following are how to input a pulse train and parameter setting.

- Input a pulse train from the S4 and S5 terminal. Set F146=1 and F147=1.  
The number of command pulses is "number of pulses input from the S4 terminal - number of pulses input from the S5 terminal."  
Therefore, if pulses are input in S4, the motor is moved in the positive direction. If pulses are input in S5, the motor is moved in the negative direction.
- Set how to clear pulses in pulse train input with A537.
  - When A537=0, pulses are cleared at the moment when the pulse train position command clear signal (input terminal function 184/185) is turned ON from OFF.
  - When A537=1, pulses are cleared continuously when the pulse train position command clear signal (input terminal function 184/185)=ON.

#### (Caution)

- When inputting a pulse train, the excessive amount at the time of stop can be reduced by reducing the pulse train frequency at input start and input end.
- When pulses are cleared, the current position and the target position are set to 0. Clear pulses after confirming that positioning is completed.
- When A510=3, do not input a pulse train to the S4 terminal and the S5 terminal at the same time.

## 2.3.2 Operation style

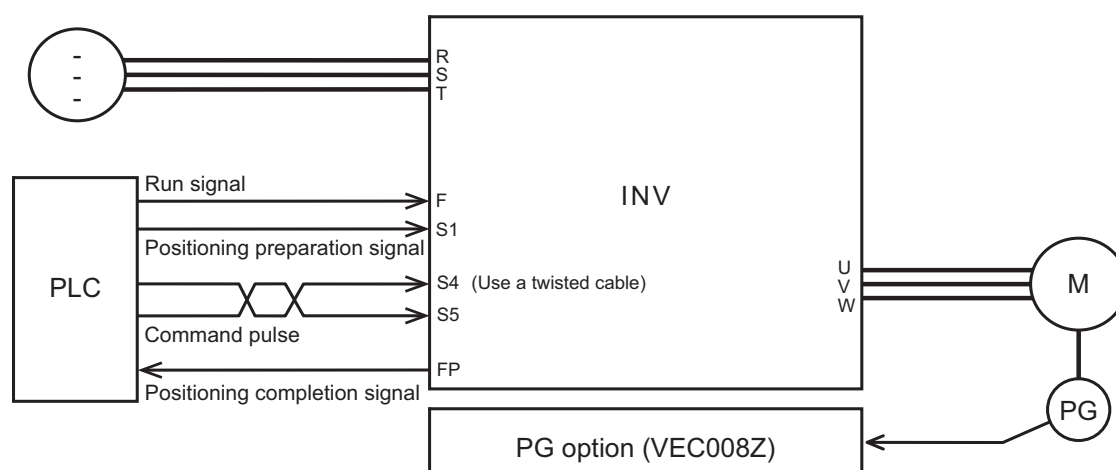
Perform positioning control by pulse train input setting in the following procedure.

- (1) Turn ON the positioning preparation signal (input terminal function 178/179).
- (2) Turn ON the run signal (input terminal function 2/3 or 4/5).  
Then, the motor is in the servo lock status.
- (3) Input the command pulse according to the desired position command.  
The motor rotates so that the load machine should move to the target position specified by the command pulse.
- (4) When the positioning control settles and the deviation between the target position and the current position becomes  $\pm F381$  or less, the positioning completion signal (output terminal function 118/119) is turned ON.

## 2.3.3 Caution

- Change the setting of A510 after turning OFF the positioning preparation signal (input terminal function 178/179) and run signal (input terminal function 2/3, 4/5).
- Positioning control and the PID function cannot be used at the same time.  
When A510=2 or 3, the normal PID function is disabled.
- When the run signal is turned OFF during positioning control, positioning control is stopped, and the motor is decelerated and stopped in the deceleration time set in A511. In the deceleration stop status, the number of command pulses and the number of detected pulses are different. Clear the current position before performing positioning control again.  
For how to clear the current position, refer to 2.4.
- When the positioning preparation signal is turned OFF during positioning control, E-46 trip occurs.
- To switch from positioning control to speed control, turn OFF the run signal during positioning control, and turn OFF the positioning preparation signal after the inverter stops.
- If the current position becomes out of the range of - (A520, A521) to (A518, A519) during positioning control, the position limit excess signal (output terminal function 214/215) is turned ON.  
When A522=0, positioning control is continued as it is, however, E-47 trip occurs when A522=1. Use this function to prevent the machine from exceeding the range of movement.
- When movement in the same direction is repeated, clear the current position as necessary so that the current position should not be out of the range of - (A520, A521) to (A518, A519).  
For how to clear the current position, refer to 2.4.
- This function is available with the following speed feedback detection.
  - PG feedback option (VEC008Z)
  - resolver option (VEC010Z)
- This function is NOT available with the speed feedback from S4, and S5 terminal.

### 2.3.4 Contact example of positioning control by pulse train input



## 2.4 Current position clearing

Clear the current position before performing positioning control.  
Perform the following current position clearing by setting A527.

A527	Type of current position clearing	Description	Remarks
0	0 point ignore (+)	Set the position when the positioning preparation signal (digital input: 178/179) is turned ON to (A528: higher four digits, A529: lower four digits).	
1	0 point signal (+)	Set the position when the origin position setting signal (digital input: 180/181) is turned OFF from ON to (A528: higher four digits, A529: lower four digits).	
2	0 point dog system (+)	Perform dog operation in the decreasing direction from a positive position, set the position when the origin position setting signal (digital input: 180/181) is turned OFF from ON to (A528: higher four digits, A529: lower four digits) and move to the origin.	Input of the Z phase signal is required. The PG option (VEC008Z) is required.
10	0 point ignore (-)	Set the position when the positioning preparation signal (digital input: 178/179) is turned ON to (-A528: higher four digits, -A529: lower four digits).	
11	0 point signal (-)	Set the position when the origin position setting signal (digital input: 180/181) is turned OFF from ON to (-A528: higher four digits, -A529: lower four digits).	
12	0 point dog system (-)	Perform dog operation in the increasing direction from a negative position, set the position when the origin position setting signal (digital input: 180/181) is turned OFF from ON to (-A528: higher four digits, -A529: lower four digits) and move to the origin.	Input of the Z phase signal is required. The PG option (VEC008Z) is required.

### 2.4.1 0 point ignore method (A527=0, 10)

- Set A527=0 or 10.
- When A527=0, the position when the positioning preparation signal (input terminal function 178/179) is turned ON is (A528, A529).
- When A527=10, the position when the positioning preparation signal (input terminal function 178/179) is turned ON is (A528, A529).
- In the case of positioning control by pulse train input (A510=2, 3), the target position is initialized to 0.

#### (Caution)

- Perform current position clearing operation (ON/OFF of the positioning preparation signal) during stop or speed control (when position control is OFF).
- In the case of positioning control by pulse train input (A510=2, 3), use with A528, A529=0.

### 2.4.2 0 point signal method (A527=1, 11)

- Set A527=1 or 11.
- When A527=1, the position when the origin position setting signal (digital input: 180/181) is turned OFF from ON is (A528, A529).
- When A527=11, the position when the origin position setting signal (digital input:180/181) is turned OFF from ON is -(A528, A529).
- In the case of positioning control by pulse train input (A510=2, 3), the target position is initialized to 0.

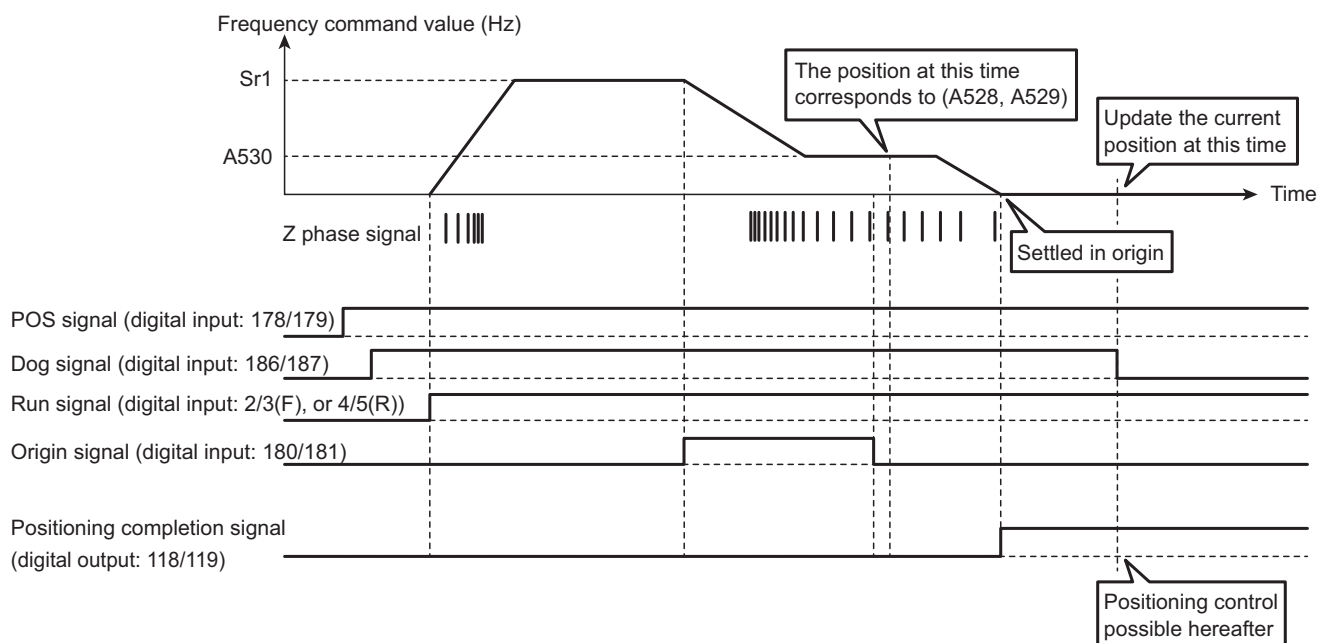
#### (Caution)

- Perform current position clearing operation (ON/OFF of the origin position setting signal) during stop or speed control (when position control is OFF).
- In the case of positioning control by pulse train input (A510=2, 3), use with A528, A529=0.

### 2.4.3 0 point dog method (A527=2, 12)

- To use this method, input of the PG option encoder Z phase signal is required.
- Set A527=2 or 12.
- When A527=2, if the near point dog signal (digital input terminal function 186/187) and the run signal (digital input terminal function 2/3 or 4/5) are turned ON with the positioning preparation signal (digital input terminal function 178/179) ON, the frequency is accelerated to -Sr1 in the acceleration time of A547 regardless of the setting of A510. (The position moves in the negative direction)
- Next, when the origin position setting signal (digital input terminal function 180/181) is turned ON, the frequency is decelerated from -Sr1 to the return to origin creep frequency (-A530) in the deceleration time A548.
- When the origin position setting signal is turned OFF in that status, the first Z phase position from that time is set to (A528, A529) and positioning control is performed at the origin (0).
- When the positioning control settles and the deviation between the target position and the current position becomes  $\pm F381$  or less, the positioning completion signal (output terminal function 118/119) is turned ON. In this status, turn OFF the near point dog signal (digital input terminal function 186/187).
- When A527=12, if the near point dog signal (digital input terminal function 186/187) and the run signal (input terminal function 2/3 or 4/5) are turned ON with the positioning preparation signal (input terminal function 178/179) ON, the frequency is accelerated to -Sr1 in the acceleration time of A547 regardless of the setting of A510. (The position moves in the positive direction)
- Next, when the origin position setting signal (digital input terminal function 180/181) is turned ON, the frequency is decelerated from -Sr1 to the return to origin creep frequency (A530) in the deceleration time A548.
- When the origin position setting signal is turned OFF in that status, the first Z phase position from that time is set to -(A528, A529) and positioning control is performed at the origin (0).
- When the positioning control settles and the deviation between the target position and the current position becomes  $\pm F381$  or less, the positioning completion signal (digital output terminal function 118/119) is turned ON. In this status, turn OFF the near point dog signal.

The following diagram shows the operation of the dog method.



**(Caution)**

- When A527=2, the position to turn ON/OFF the origin position setting signal (digital input terminal function 180/181) should be on the positive side.  
Before dog operation, move the machine in advance to a position on the positive side where the absolute value is larger than in the position where the origin position setting signal is turned ON by normal operation (speed control operation).
- When A527=12, the position to turn ON/OFF the origin position setting signal should be on the negative side.  
Before dog operation, move the machine in advance to a position on the negative side where the absolute value is larger than in the position where the origin position setting signal is turned ON by normal operation (speed control operation).
- When A527=2 or 12, the motor enters in the servo lock status directly after completion of the return to origin operation. When the near point dog signal (digital input terminal function 186/187) is turned OFF, the origin position is updated with the servo lock status kept as it is. In this status, positioning control can be performed.
- When A527=2 or 12, if the near point dog signal is turned OFF before the positioning completion signal is turned ON, E-47 trip occurs.
- In the case of positioning control by pulse train input (A510=2, 3), use with A528, A529=0.

## 2.5 Other functions

### 2.5.1 How to set gains and limits of positioning control

- There are two types of gains of positioning control. The first gains (P gain: F362, I gain: F363, D gain: F366) and the second gains (P gain: A314, I gain: A315, D gain: A318) can be switched with input terminal function 116/117.
- Set the I gain and the D gain to 0 since only P control is used for positioning control normally.  
Set approximately "500 x number of pole pairs of the motor/F375 (number of encoder pulses)" for the P gain.  
If it takes time for the position to be settled during positioning control, increase the P gain by 0.1. If vibration occurs after the position is settled, decrease the P gain by 0.1.
- By setting A526, feed forward control can be performed.  
The output is  $A526 (\%) \times \text{amount of change of position command} + \text{PID output}$ .
- The upper/lower limit can be set for the deviation. (Upper limit: A516, A517, lower limit: -A516, A517)
- In the case of positioning control by pulse train input (A510=2, 3), a limit can be set with  $\pm A538$  for the frequency target value calculated in PID control.  
(In the case of positioning control by multi-step point (A510=1), the frequency target value is limited with  $\pm UL$ .)

### 2.5.2 How to set electronic gears

If the unit of the target position at the time of multi-step point setting or the unit of the number of input pulses at the time of pulse train input is different from the unit of the feedback pulses, setting of the electronic gears (A524, A525) is required.

- Set the number of encoder feedback pulses for one rotation of the motor in A524 and the number of position command pulses for one rotation of the motor in A525. (Multiply A524 and A525 as necessary to become an integer)
- The electronic gear setting is valid for the upper/lower limit of the target position (A512 and A513, and A514 and A515).

#### (Setting example)

For example, if there is a machine that moves for 432 mm in one rotation of the motor and has an encoder with 1024 pulses for one rotation, the target position can be input by 1 mm instead of the number of encoder pulses by setting A524=1024 and A525=432.

For example, in the case of multi-step point setting, the machine can be moved 10000 mm if desired, by setting A544=1 and A545=0. In the case of pulse train input, it can be realized by inputting 10000 pulses.

When the limit of the target value should be set to  $\pm 500000$  mm, it can be realized by setting A512=50, A513=0, A514=50, and A515=0.

#### (Caution)

- The ratio of the electronic gear (A524/A525) should be in the range of 1/20 to 50.
- If the electronic gear ratio is 1, set the target position at the time of multi-step point setting or the number of input pulses at the time of pulse train input with the unit of feedback pulses.



### 3. List of positioning control parameters

#### ■ List of parameters

Title	Function	Adjustment range	Default setting value
Common to positioning control			
A510	Position control select	0: disabled 1: point to point 2: pulse train input (single phase) 3: pulse train input (2 phases)	0
A511	Position control Dec. time for quick stop	0.0 – 6000.0 (0.00 – 600.00) (s)	Depends on the capacity
A512	Position reference UL upper 4-digits (+side)	0 – 9999	9999
A513	Position reference UL lower 4-digits (+side)	0 – 9999	9999
A514	Position reference UL upper 4-digits (-side)	0 – 9999	9999
A515	Position reference UL lower 4-digits (-side)	0 – 9999	9999
A516	Position deviation UL upper 4-digits	0 – 9999	9999
A517	Position deviation UL lower 4-digits	0 – 9999	9999
A518	Present position UL upper 4-digits (+side)	0 – 9999	9999
A519	Present position UL lower 4-digits (+side)	0 – 9999	9999
A520	Present position UL upper 4-digits (-side)	0 – 9999	9999
A521	Present position UL lower 4-digits (-side)	0 – 9999	9999
A522	Position detection limit trip select	0: Disabled 1: Enabled (E-47 trip)	0
A524	Feedback pulse gain numerator	1 – 9999	1000
A525	Feedback pulse gain denominator	1 – 9999	1000
A526	Feed forward gain	0 – 100	0

Title	Function	Adjustment range	Default setting value
Current position clearing			
A527	0 point recovery select	0: 0 point ignore (+) 1: 0 point signal (+) 2: 0 point dog system (+) 10: 0 point ignore (-) 11: 0 point signal (-) 12: 0 point dog system (-)	0
A528	0 point offset upper 3-digit	0 – 999	0
A529	0 point offset lower 4-digit	0 – 9999	0
A530	0 point creep frequency	0.1 – 10.0	0.5
Positioning control by pulse train input			
F146	Terminal S4 input select	0: Digital input 1: Pulse train input 2: PG input	0
F147	Terminal S5 input select	0: Digital input 1: Pulse train input 2: PG input	0
A537	PTI position clear signal select	0: Clear at the rising edge (OFF->ON) 1: Clear during ON	1
A538	PTI position frequency UL	LL - UL (Hz)	50.0/60.0 *1
Positioning control by multi-step point			
A544	Position reference upper 4-digits 1	0 – 9999	0
A545	Position reference lower 4-digits 1	0 – 9999	0
A546	Position control function set 1	0: Absolute position command, positive direction 1: Absolute position command, negative direction 2: Relative position command, positive direction 3: Relative position command, negative direction	0
A547	Position reference increase time 1	0.00 - 600.00 (s)	1.00
A548	Position reference decrease time 1	0.00 - 600.00 (s)	1.00
A552	Position reference upper 4-digits 2	0 – 9999	0
A553	Position reference lower 4-digits 2	0 – 9999	0
A554	Position control function set 2	0: Absolute position command, positive direction 1: Absolute position command, negative direction 2: Relative position command, positive direction 3: Relative position command, negative direction	0
A555	Position reference increase time 2	0.00 - 600.00 (s)	1.00

Title	Function	Adjustment range	Default setting value
A556	Position reference decrease time 2	0.00 - 600.00 (s)	1.00
A560	Position reference upper 4-digits 3	0 – 9999	0
A561	Position reference lower 4-digits 3	0 – 9999	0
A562	Position control function set 3	0: Absolute position command, positive direction 1: Absolute position command, negative direction 2: Relative position command, positive direction 3: Relative position command, negative direction	0
A563	Position reference increase time 3	0.00 - 600.00 (s)	1.00
A564	Position reference decrease time 3	0.00 - 600.00 (s)	1.00
A568	Position reference upper 4-digits 4	0 – 9999	0
A569	Position reference lower 4-digits 4	0 – 9999	0
A570	Position control function set 4	0: Absolute position command, positive direction 1: Absolute position command, negative direction 2: Relative position command, positive direction 3: Relative position command, negative direction	0
A571	Position reference increase time 4	0.00 - 600.00 (s)	1.00
A572	Position reference decrease time 4	0.00 - 600.00 (s)	1.00
A576	Position reference upper 4-digits 5	0 – 9999	0
A577	Position reference lower 4-digits 5	0 – 9999	0
A578	Position control function set 5	0: Absolute position command, positive direction 1: Absolute position command, negative direction 2: Relative position command, positive direction 3: Relative position command, negative direction	0
A579	Position reference increase time 5	0.00 - 600.00 (s)	1.00
A580	Position reference decrease time 5	0.00 - 600.00 (s)	1.00
A584	Position reference upper 4-digits 6	0 – 9999	0
A585	Position reference lower 4-digits 6	0 – 9999	0

Title	Function	Adjustment range	Default setting value
A586	Position control function set 6	0: Absolute position command, positive direction 1: Absolute position command, negative direction 2: Relative position command, positive direction 3: Relative position command, negative direction	0
A587	Position reference increase time 6	0.00 - 600.00 (s)	1.00
A588	Position reference decrease time 6	0.00 - 600.00 (s)	1.00
A592	Position reference upper 4-digits 7	0 – 9999	0
A593	Position reference lower 4-digits 7	0 – 9999	0
A594	Position control function set 7	0: Absolute position command, positive direction 1: Absolute position command, negative direction 2: Relative position command, positive direction 3: Relative position command, negative direction	0
A595	Position reference increase time 7	0.00 - 600.00 (s)	1.00
A596	Position reference decrease time 7	0.00 - 600.00 (s)	1.00
Accuracy improvement, others			
F362	PID1 proportional gain	0.01 – 100.0	0.30
F363	PID1 integral gain	0.00 – 100.0	0.20
F366	PID1 differential gain	0.00 – 2.55	0.00
A314	PID2 proportional gain	0.01 – 100.0	0.30
A315	PID2 integral gain	0.00 – 100.0	0.20
A318	PID2 differential gain	0.00 – 2.55	0.00
F381	Simple positioning completion range	1 – 4000 (Pulse)	100

## ■ List of input/output terminals, monitors, and trips

Number	Function	Remarks
Input terminal		
178/179	Position control ready	
180/181	0 point set	
182/183	Position F/R command for PTI input	
184/185	Position command clear for PTI input	
186/187	0 point dog start	
188/189	Phase initialization	
10/11	Preset speed switching 1	
12/13	Preset speed switching 2	
14/15	Preset speed switching 3	
116/117	PID1/2 switching	
Output terminal		
118/119	Stop positioning completion	
214/215	Exceed position limit	
146/147	During position control(PID1,2 PID control)	
Monitor		
56	Position reference (upper 4 digits)	Monitoring by user-specified unit is made possible by setting the electronic gears (A524, A525).
57	Position reference (lower 4 digits)	
58	Actual position (upper 4 digits)	Monitoring by pulse of the encoder.
59	Actual position (lower 4 digits)	
Trip		
E-46	Preparation signal cut during position control	<ul style="list-style-type: none"> <li>- The preparation signal was turned OFF during position control.</li> <li>- When A527=2 or 12, the 0 point dog signal was turned OFF before completion of return to origin operation.</li> </ul>
E-47	Position detection upper limit excess	<ul style="list-style-type: none"> <li>- When A522=1, The current position exceeded the upper limit.</li> <li>- The ratio of the electronic gear (A524/A525) exceeds the limitation.</li> </ul>

## 4. Setting example of positioning control

### 4.1 Carrying goods to specified three points by carrier machine according to command

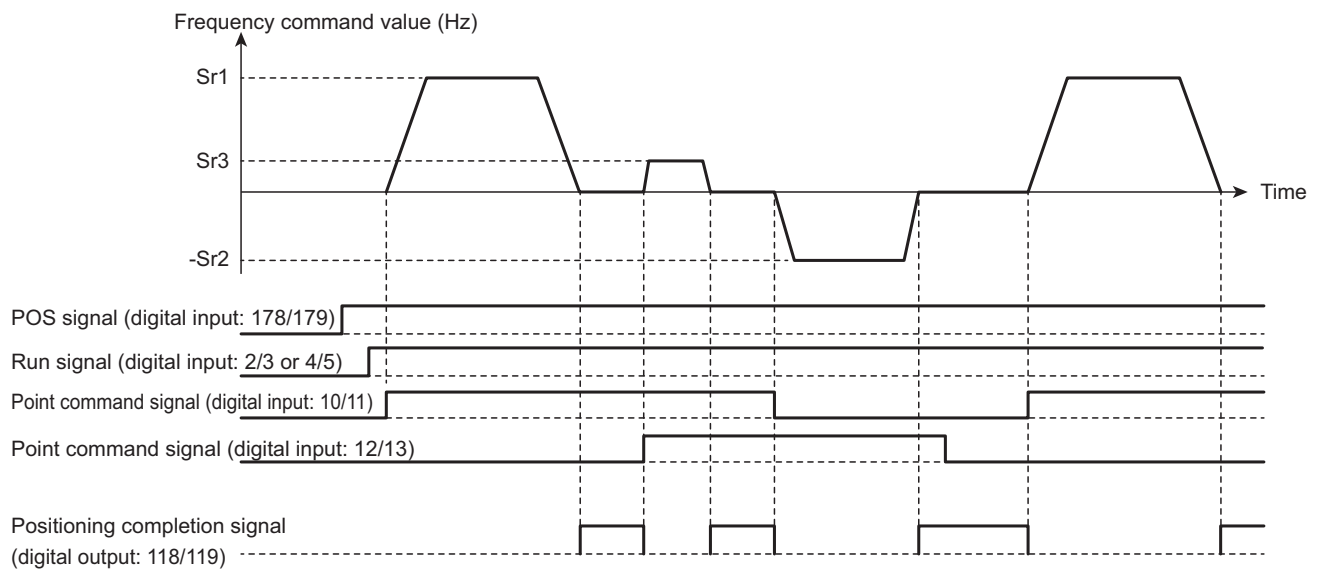
#### <System example>

Motor:	The induction machine and the PG are directly connected to the motor axis.
PG pulses number:	2000 pulses
PG feedback detector:	VEC008Z
Point 1:	50 Hz operation with 12000 pulses and acceleration/deceleration time of 1 s
Point 2:	30 Hz operation with -6000 pulses and acceleration/deceleration time of 0.5 s
Point 3:	10 Hz operation with 1000 pulses from the current position and acceleration/deceleration time of 0.1s

#### <Parameter setting>

- Set necessary parameters before performing positioning control.
  - PT=11
  - F240=0.0
  - F375=2000
  - F376=1, or 11 (depending on the encoder polarity)
  - Set F460 (the gain of speed control). (Generally, set a value approx. between 3 Hz and 5 Hz)
  - In addition, set ACC, DEC, motor constant, etc.
- Set parameters necessary to enable positioning control by multi-step point.
- A510=1 (Positioning control by multi-step point enabled)
- Set the positioning point in the first step.
  - A544=1, A545=2000, A546=0, A547, A548=1.0, Sr1=50.0
- Set the positioning point in the second step.
  - A552=0, A553=6000, A554=1, A555, A556=0.5, Sr2=30.0
- Set the positioning point in the third step.
  - A560=0, A561=1000, A562=2, A563, A564=0.1, Sr3=10.0
- Set the limits of the target position.
  - A512=1, A513=8000, A514=1, A515=0
    - F111=2 (assign the F signal to the F terminal)
    - F114=10 (assign the SS1 signal to the S1 terminal)
    - F115=12 (assign the SS2 signal to the S2 terminal)
    - F118=178 (assign the POS signal to the S5 terminal)
    - F133=118 (assign the positioning completion signal to the R1 terminal)
- Set the gain of positioning control.
  - F362=Positioning control P gain:
    - Set approximately "500 x number of pole pairs of motor/F375 (number of encoder pulses)."
    - If it takes time for the position to be settled during positioning control, increase F 362 by 0.1.
    - If vibration occurs after the position is settled, decrease the F362 by 0.1.
  - F363=0.0 (I gain=0)
  - F366=0 (D gain=0)

## &lt;Operation example&gt;



## 4.2 Moving motor for specified amount by carrier machine according to command

## &lt;System example&gt;

Motor: The induction machine and the PG are directly connected to the machine axis.

The reduction gear ratio between the motor and the machine is 1:5.

PG pulses number: 2000 pulses

PG feedback detector: VEC008Z

Move the conveyor for 200.00 mm according to the command. Acceleration/deceleration time 0.5 s, steady rate 50 Hz.

The conveyor moves 8.76 mm for one rotation of the machine.

## &lt;Parameter setting&gt;

- Set necessary parameters before positioning control.
  - PT=11
  - F240=0.0
  - F375=400 (2000/5=400 because it is the number of PG pulses for one rotation of the motor)
  - F376=1, or 11 (depending on the encoder polarity)
  - Set F460 (the gain of speed control). (Generally, set a value approx. between 3 Hz and 5 Hz)
  - In addition, set ACC, DEC, motor constant, etc.
- Set parameters necessary to enable positioning control by multi-step point.
- A510=1 (Positioning control by multi-step point enabled)
- Set the electronic gears.
 

Decide the input unit (accuracy) of the target position. Here, it is 0.01 mm.

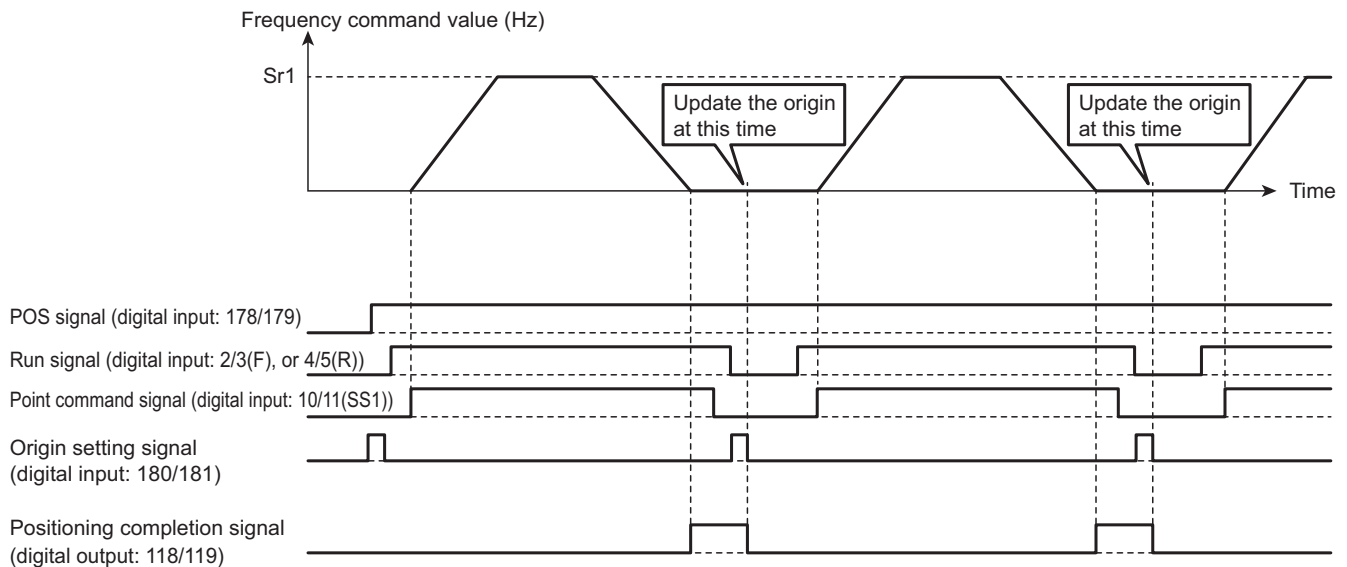
A524=2000 (Number of PG feedback pulses for one rotation of the machine)

A525=876 (If the unit is 0.01 mm for one position command pulse, the number of position command pulses for one rotation of the machine is  $(8.76/0.01=876)$ )
- Set the positioning point in the first step.
 

A544=2, A545=0 (the target position can be set by 0.01 mm by setting the electronic gears), A546=0, A547, A548=0.5, Sr1=50.0

- Set the limits of the target position.  
This parameter should be also set by 0.01 mm. For example, with a range of -10.00 mm to 210.00 mm, the setting is as follows.  
A512=2, A513=1000, A514=0, A515=1000
  - It is necessary to turn the origin position setting signal OFF -> ON -> OFF each time positioning control is performed to set the current position to the origin. Set A527=1, A528=0, and A529=0.
- F111=2 (assign the F signal to the F terminal)
- F114=10 (assign the SS1 signal to the S1 terminal)
- F118=178 (assign the POS signal to the S5 terminal)
- F117=180 (assign the origin position setting signal to the S4 terminal)
- F133=118 (assign the positioning completion signal to the R1 terminal)
- Set the gain of positioning control.
  - F362=Positioning control P gain:  
Set approximately 500 x number of pole pairs of motor/F375 (number of encoder pulses).  
If it takes time for the position to be settled during positioning control, increase P 362 by 0.1.  
If vibration occurs after the position is settled, decrease the F362 by 0.1.
  - F363=0.0 (I gain=0)
  - F366=0 (D gain=0)

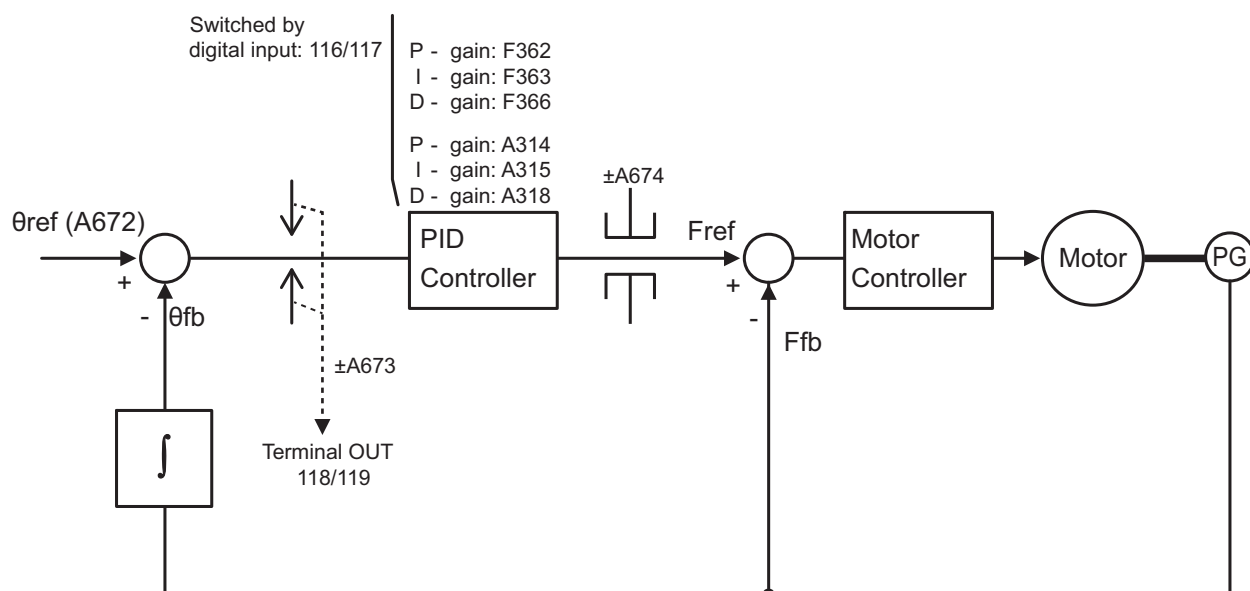
### <Operation example>





## 5. Orientation control

Orientation control is a function to stop a rotating machine at the specified phase.  
The following is a block diagram of orientation control.



### 5.1 Initialization method for phase

- Set the initialization method for the phase in A670.
  - A670=0: When the phase initialization signal (input terminal function 188/189) is turned ON from OFF, the current phase is initialized to A671.
  - A670=1: When the Z phase of the encoder option is input, the current phase is initialized to A671.

**(Caution)**

- When  $A675 > A676$  (the gear ratio of the machine is less than 1), do not use A670=1. (The current phase cannot be specified uniquely)
- When A670=1, input the encoder Z phase signal.

## 5.2 Orientation control

### 5.2.1 Settings of main parameters

Make the following settings to enable orientation control.

- Set F359=3.
- Set the number of pulses for one rotation of the motor in F375.
  - When the encoder is connected to the motor: Set the number of pulses of the encoder in F375.
  - When the encoder is connected to the load machine: Set "number of pulses of the encoder/reduction gear ratio" in F375.
    - (\*) If "number of pulses of the encoder/reduction gear ratio" is not an integer, the phase difference is large with A670=0 and orientation control cannot be performed. Use with A670=1.
    - At that time, a phase difference of "setting difference (part after the decimal point) x reduction gear ratio/actual number of PG pulses x 360 degrees" is generated.
- Set the gear ratio of the load machine to A675 and A676.
  - When the encoder is connected to the motor: Set A676/A675=Gear ratio of the load machine.
  - When the encoder is connected to the load machine: Set A675 and A676 to the same value.
- Set the phase of orientation (target phase) in A672.
- Set the orientation start signal (input terminal function 190/191) in the input terminal.

### 5.2.2 Operation style

- Turn ON the run signal and perform speed control operation.
- Turn ON the orientation start signal (input terminal function 190/191) while speed control is performed.  
Decelerate from the current speed to the orientation speed (A674) in the deceleration speed DEC and start orientation control when the orientation speed is reached.  
The upper limit frequency at the time of orientation control is  $\pm A674$ .
- When orientation control is settled and the current phase is within the orientation completion range ( $\pm A673$ ), the positioning completion signal (LO: 118/119) is output.

#### (Caution)

- Perform the normal speed control operation before turning ON the orientation start signal.
- The normal speed control operation is performed when the orientation start signal is turned OFF.

## 5.3 How to set gains of orientation control

- There are two types of gains of orientation control. The first gains (P gain: F362, I gain: F363, D gain: F366) and the second gains (P gain: A314, I gain: A315, D gain: A318) can be switched with PID1/2 switching signal (input terminal function 116/117).
- Set the I gain and the D gain to 0 since only P control is used for orientation control normally.  
Set approximately 0.4 x number of pole pairs of the motor for the P gain.
- If it takes time for the position to be settled during positioning control, increase P gain by 0.1. If vibration occurs after the position is settled, decrease the P gain by 0.1.

## 6. Orientation control

### ■ List of parameters

Title	Function	Adjustment range	Default setting value
Phase setting, orientation			
A670	Position initialization select	0: Initialize with the input terminal function 188/189 ON 1: Initialize with the Z phase of the encoder	0
A671	Initial position	0.0 – 359.9 (°)	0.0
A672	Orientation phase	0.0 – 359.9 (°)	0.0
A673	Orientation tolerance	0.1 – 20.0 (°)	1.0
A674	Orientation frequency	0.1 - 10.00 (Hz)	1.0
A675	Mechanical gear rate numerator (For orientation)	1 – 9999	1000
A676	Mechanical gear rate denominator (For orientation)	1 – 9999	1000
Accuracy improvement, others			
F362	PID1 proportional gain	0.01 – 100.0	0.30
F363	PID1 integral gain	0.00 – 100.0	0.20
F366	PID1 differential gain	0.00 – 2.55	0.00
A314	PID2 proportional gain	0.01 – 100.0	0.30
A315	PID2 integral gain	0.00 – 100.0	0.20
A318	PID2 differential gain	0.00 – 2.55	0.00

### ■ List of input/output terminals

Number	Function	Remarks
Input terminal		
178/179	Position control ready	
190/191	Orientation start	
116/117	PID1/2 switching	
Output terminal		
118/119	Stop positioning completion	
146/147	Positioning control in operation (PID1,2 PID control)	

