TOSHIBA

E6581329①

TOSVERT VF-AS1/VF-PS1

PID control Instruction Manual

Toshiba Schneider Inverter Corporation

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— Contents —

1. Introduction

VF-AS1 and VF-PS1 have PID control function.
You can select the PID control type for your applications.

Process PID control: For temperature or pressure control of fan and pump, which is performed gently in response to change the speed.
Speed PID control : For speed control of a winder, which is performed at high speed in response to change the speed.
Dancer control : For dancer positioning control of winder system
Stop holding P control: Stop position control function by servo lock. <VF-AS1 only>

Note) See the manual E6581319 for detail of “Stop holding P control”.
E6581319: PG feedback board instruction manual

This manual constructs the following.

Chapter 2: Explanation abou three PID control types for VF-AS1 and VF-PS1.
Chapter 3: Difference in parameters of three PID control types.
Chapter 4: Explanation about the parameters you need to set for PID control.
Chapter 5: Explanation about the parameters for adjustment.
Chapter 6: Setting about analog input characteristics.
You need to convert the process value and the feedvack value into the frequency for PID control.
Chapter 7: Paramerter list of PID control.

First, check your PID control type in chapter 2.
And see chapter 3 to 6 for your setting and adjustment.
See chapter 7 for adjustment range of each parameter.

2. PID control function

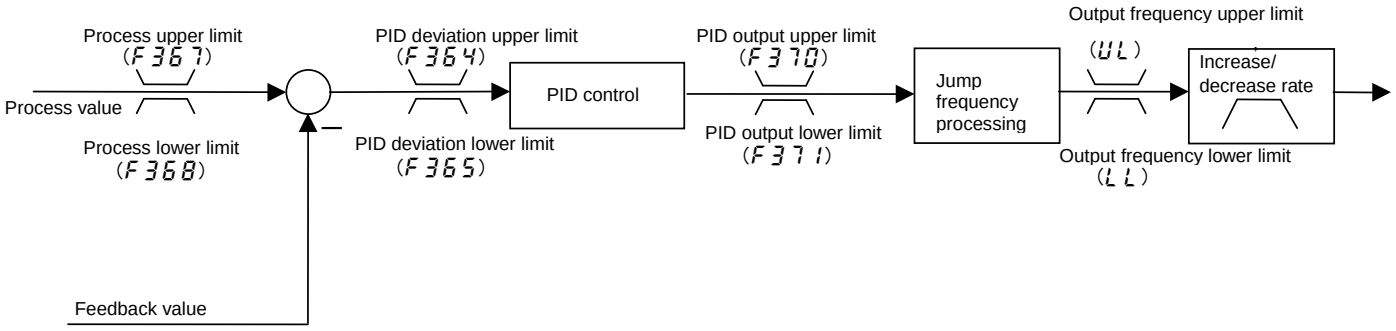
VF-AS1 and VF-PS1 have three types of PID control functions.
You can select the type of PID control for applications by setting parameter.

2.1. Process PID control

Process PID control is selected for temperature or pressure control of fan and pump, which is performed gently in response to change the speed.

[Process PID control (F359= 1)]

[Diagram]



[Parameter setting]

See the chapter 4 and 5 for detail of parameter setting.

1) Select the PID control type.

Title	Function	Setting
F359	PID control switching	1(process PID control)

2) Select the input of process value and feedback value.
You need to convert temperature or pressure into frequency for setting.

Item	Title	Function
Process value	FMOd	Frequency setting mode selection 1
	F207	Frequency setting mode selection 2
Feedback value	F360	PID control feedback control signal selection

Frequency free unit covertion function enables to set process value and feedback value easily
See the chapter 7 for detail.

3) Set the following parameters to suit the motor if necessary.

Title	Function
FH	Maximum frequency
UL	Upper limit frequency
LL	Lower limit frequency
F270~F275	Jump frequency 1 to 3
F240	Operation starting frequency
F241	Operation starting frequency hysteresis
F243	Stop frequency setting

4) Set the following parameter to suit the system.

a) Set the acceleration time and deceleration time to small for quick response.
But too small setting cause inverter trip.

Title	Function
ACC	Acceleration time 1
dEC	Deceleration time 1

.

b) Set the following parameters if necessary.

Item	Title	Function
Limit the input level of process value.	F367	Process upper limit
	F368	Process lower limit
Limit the PID output.	F370	PID output upper limit
	F371	PID output lower limit
Switc the PID forward /reverse characteristic.	Input terminal function: 54/55: PID forward/reverse switching	
Output of agreement signal between process value and feedback value. <VF-PS1 only>	F374	Frequency command agreement detection range
	Output terminal function: 144 to 149: Frequency command agreement signal (RR/S4, VI,RX)	

5) Adjust the PID control gain.

a) Fundamental adjustment

Item	Title	Function
PID control gain	F362	Proportional (P) gain
	F363	Integral (I) gain
	F366	Differential (D) gain

b) Adjust the following parameters if necessary.

Deviation means difference between process value and feedback value.

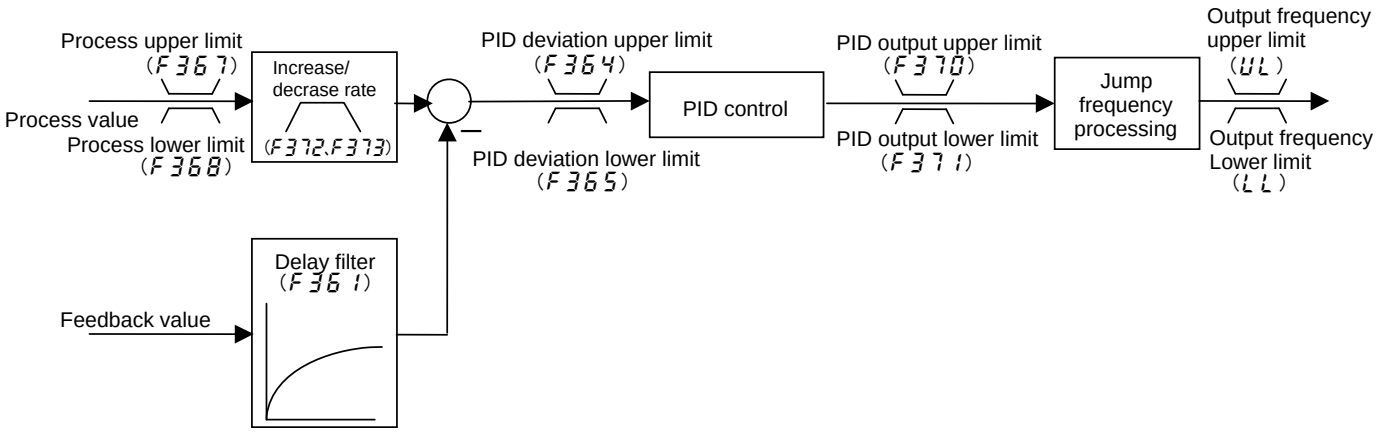
Item	Title	Function
Steady the PID control. (Limit the PID deviation)	F364	PID deviation upper limit
	F365	PID deviation lower limit
Start the PID control after the system become stable.	F369	PID control waiting time

2.2. Speed PID control

Speed PID control is selected for speed control of a winder, which is performed at high speed in response to change the speed.

[Speed PID control (F359=2)]

[Diagram]



[Parameter setting]

See the chapter 4 and 5 for detail of parameter setting.

1) Select the PID control type.

Title	Function	Setting
F359	PID control switching	2(speed PID control)

2) Select the input of process value and feedback value.
You need to convert tension level into frequency for setting.

Item	Title	Function
Process value	FNOd	Frequency setting mode selection 1
	F207	Frequency setting mode selection 2
Feedback value	F360	PID control feedback control signal selection

a) Frequency free unit covertion function enables to set process value and feedback value easily
See the chapter 7 for detail.

b) You can select the feedback signal by PG feedback.
*You need PG feedback option.

c) You can add or multiply for process value by override function.

Item	Title	Function
Addition	F660	Override addition input selection
Multiplication	F661	Override multiplication input selection

3) Set the following parameters to suit the motor if necessary.

Title	Function
FH	Maximum frequency
UL	Upper limit frequency
LL	Lower limit frequency

F270~F275	Jump frequency 1 to 3
F240	Operation starting frequency
F241	Operation starting frequency hysteresis
F243	Stop frequency setting

4) Set the following parameters to suit the system.
Speed PID control set the acceleration time and the deceleration time to the smallest automatically in spite of parameter(ACC,dEC) setting.
The quick response is enabled by process increase and decrease rate separated from acceleration time and declereation time.

Set the following parameters if necessary.

Item	Title	Function
Limit the input level of process value.	F367	Process upper limit
	F368	Process lower limit
Limit the PID output.	F370	PID output upper limit
	F371	PID output lower limit
Switc the PID forward /reverse characteristic.	Input terminal function: 54/55: PID forward/reverse switching	
Output of agreement signal between process value and feedback value. <VF-PS1 only>	F374	Frequency command agreement detection range
	Output terminal function: 144 to 149: Frequency command agreement signal	

5) Adjust the PID control gain.

See the section 5 for detail.

a) Fundamental adjustment

And adjust for stability and quick response.

Deviation means difference between process value and feedback value.

Item	Title	Function
PID control gain	F362	Proportional (P) gain
	F363	Integral (I) gain
	F366	Differential (D) gain
Steady the PID control (Feedback filter)	F361	Delay filter
Steady the PID control. (Limit the PID deviation)	F364	PID deviation upper limit
	F365	PID deviation lower limit
Adjust for quick responce	F372	Process increasing rate (speed type PID control)
	F373	Process decreasing rate (speed type PID control)

b) Adjust the following parameters if necessary.

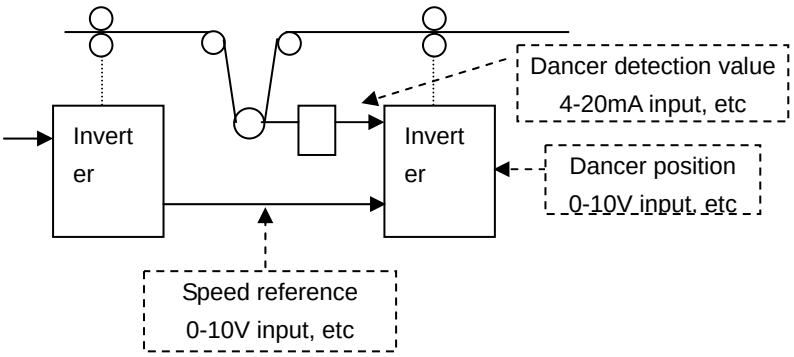
Item	Title	Function
Start the PID control after the system become stable.	F369	PID control waiting time

2.3. Dancer control

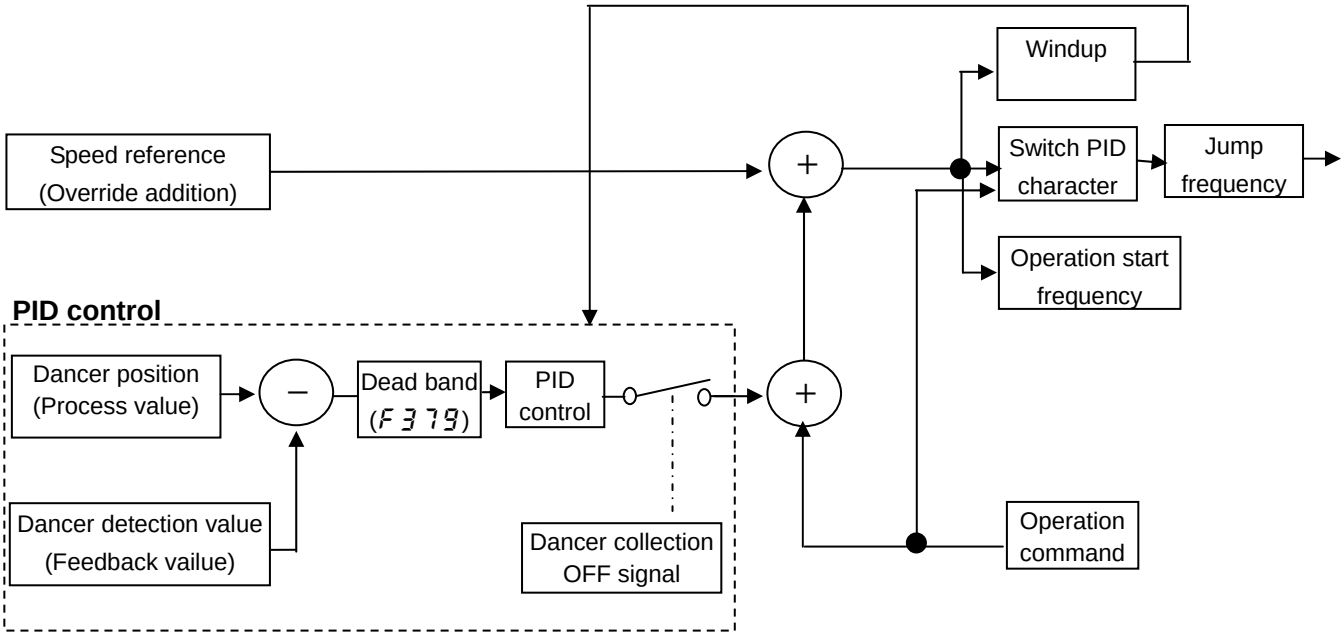
Dancer control is selected for dancer positioning control of winder system.

[Dancer control (F359=4)]

[System image]



[Diagram]



[Dancer control operation]

1) Inverter operates by speed reference.
*Dancer control use override addition function for speed reference.

2) PID control: Process value; dancer position
Feedback value; dancer detection value
Correct speed reference by deviation of PID control for dancer.
Set the dead band (F379) for the deviation if necessary.

3) Set the dancer correction OFF signal to input terminal if necessary.
In case the input terminal ON, the PID output is zero. The speed reference is override addition value.

Windup: If the value after override addition become following, inverter control stop the integration.
(1) Upper limit (UL) or more
Maximum frequency (FH) or more
(2) Lower limit (LL) or less
Clear the windup process by deviation value of PID control.

[Parameter setting]

See the chapter 4 and 5 for detail of parameter setting.

1) Select the PID control type.

Title	Function	Setting
F359	PID control switching	4(dancer control)

2) Set the speed reference as override addition.

Item	Title	Function
Addition	F660	Override addition input selection

*You can set override multiplication (F661) instead of F660, but it is difficult to set.
Use F660 please.

3) Select the input of process value (dancer position) and feedback value (dancer detection value).
Set each level converted into frequency for the setting.
Set the dead band for deviation of PID control if necessary.

Item	Title	Function
Process value	FMOd	Frequency setting mode selection 1
	F207	Frequency setting mode selection 2
Feedback value	F360	PID control feedback control signal selection
PID output dead band	F379	PID output dead band

*Frequency free unit covertion function enables to set process value and feedback value easily
See the chapter 7 for detail

4) Set the following parameters to suit the winder system if necessary.

Item	Title	Function
Operation by speed reference only (Dncer correction OFF)	Input terminal function: 94/95: Dancer correction OFF	
Prohibit the reverse-run	F311	Reverse- run prohibition selection

5) Set the following parameters to suit the motor if necessary.

Title	Function
FH	Maximum frequency
UL	Upper limit frequency
LL	Lower limit frequency
F270~F275	Jump frequency 1 to 3
F240	Operation starting frequency

F241	Operation starting frequency hysteresis
F243	Stop frequency setting

6) Set the following parameters to suit the system.

a) Set the acceleration time and the deceleration time to small for quick response.
But too small setting cause inverter trip.

Title	Function
ACC	Acceleration time 1
dEC	Deceleration time 1

b) Set the following parameters if necessary.

Item	Title	Function
Limit the input level of process value.	F367	Process upper limit
	F368	Process lower limit
Limit the PID output.	F370	PID output upper limit
	F371	PID output lower limit
Switc the PID forward /reverse characteristic.	Input terminal function: 54/55: PID forward/reverse switching	
Output of agreement signal between process value and feedback value. <VF-PS1 only>	F374	Frequency command agreement detection range
	Output terminal function: 144 to 149: Frequency command agreement signal	

7) Adjust the PID control gain.

a) Fundamental adjustment

Item	Title	Function
PID control gain	F362	Proportional (P) gain
	F363	Integral (I) gain
	F366	Differential (D) gain

b) Adjust the following parameters if necessary.

Deviation means difference between process value and feedback value.

Item	Title	Function
Steady the PID control. (Limit the PID deviation)	F364	PID deviation upper limit
	F365	PID deviation lower limit
Start the PID control after the system become stable.	F369	PID control waiting time

3. PID control type and parameters

The following is parameters for PID control.

Valid parameters are different from each PID control types, Process PID control, Speed PID control and Dancer control.

* Override function of dancer control is different from the others.

Title	Function	PID control type ○: valid ×: invalid △ : *1		
		Process type	Speed type	Dancer control
FMOd	Frequency setting mode selection 1	○	○	○
FH	Maximum frequency	○	○	○
UL	Upper limit frequency	○	○	○
LL	Lower limit frequency	○	○	○
ACC	**Acceleration time 1**	○	×	○
dEC	**Deceleration time 1**	○	×	○
F207	Frequency setting mode selection 2	○	○	○
F240	Operation starting frequency	○	○	○
F241	Operation starting frequency hysteresis			
F243	Stop frequency setting	○	○	○
F270	Jump frequency 1	○	○	○
F271	Jump step 1	○	○	○
F272	Jump frequency 2	○	○	○
F273	Jump step 2	○	○	○
F274	Jump frequency 3	○	○	○
F275	Jump step 3	○	○	○
F311	Reverse- run prohibition selection	○	○	○
F359	PID control switching	○	○	○
F360	PID control feedback control signal selection	○	○	○
F361	**Delay filter**	×	○	×
F362	Proportional (P) gain	○	○	○
F363	Integral (I) gain	○	○	○
F364	PID deviation upper limit	○	○	○
F365	PID deviation lower limit	○	○	○
F366	Differential (D) gain	○	○	○
F367	Process upper limit	○	○	○
F368	Process lower limit	○	○	○
F369	PID control waiting time	○	○	○
F370	PID output upper limit	○	○	○
F371	PID output lower limit	○	○	○
F372	**Process increasing rate (speed type PID control)**	×	○	×
F373	**Process decreasing rate (speed type PID control)**	×	○	×
F374	Frequency command agreement detection range <VF-PS1 only>	○	○	○
F379	**PID output dead band**	×	×	○
F660	**Override addition input selection**	△	**○ (Valid for process value)**	**○ (Speed reference)**
F661	**Override multiplication input selection**	△		△

F702	Frequency free unit display magnification	○	○	○
F703	Frequency free unit conversion selection	○	○	○
F729	Operation panel override multiplication gain <VF-AS1 only>	○	○	△

[Input/output terminal function]

Terminal	Function	PID control type ○: valid ×: invalid △ : *1		
		Process type	Speed type	Dancer control
Input terminal	PID control OFF selection	○	○	○
	PID differentiation/integration reset	○	○	○
	PID forward/reverse switching	○	△	△
	Dancer correction OFF	×	×	**○**
Output terminal	PID deviation limit	○	○	○
	Frequency command agreement signal (RR/S4) *2	○	○	○
	Frequency command agreement signal (VI) *2	○	○	○
	Frequency command agreement signal (RX) *2	○	○	○

[FM/AM pulse output and monitor output function]

Function		PID control type ○: valid ×: invalid △ : *1		
FM/AM/pulse output	Monitor output	Process type	Speed type	Dancer control
Frequency command value		○	○	○
Speed feedback (real time value)		○	○	○
Speed feedback (1-second filter)		○	○	○
PID feedback value		○	○	○
—	PID result frequency	○	○	○
—	**Synchronous speed frequency command**	×	×	**○**

*1: The functions are valid, but it is not used actually.

*2: VF-PS1 only

4. Setting for PID control

First, set the process value and feed back value. : 4.1
Then, set other parameters to suit the motor and the system if necessary. : 4.2, 4.3
Note) It is necessary to convert the process value and feedback value into frequency for setting.
Actual output frequency is different from setting frequency of PID control.

4.1. Fundamental setting

You need to set process value and feedback value.
In case of process type PID control and dancer control, you need to set the acceleration time and the decceleration time to small for quick response.

4.1.1. Feedback value

Input the signal from detecter as feedback signal.

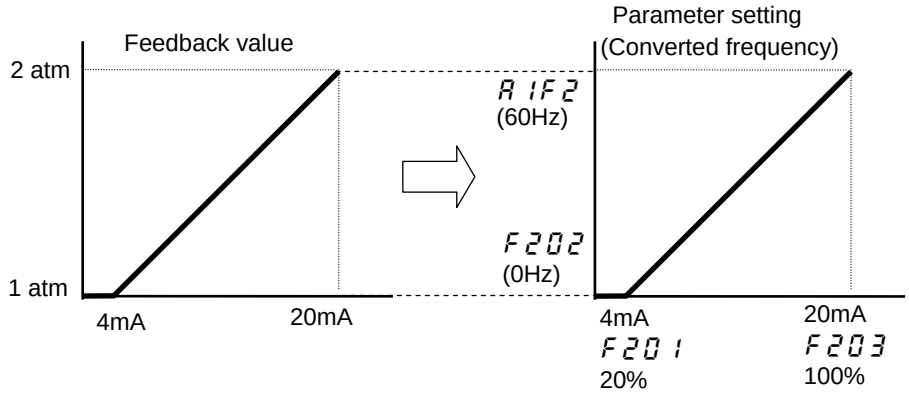
1. Select the feedback input from F360.

Description	PID control feedback control signal selection (F360)
Deviation input (no feedback input)	0
VI/II (voltage/current input)	1
RR/R4 (potentiometer/voltage input)	2
RX (voltage input)	3
Option AI1 (differential current input)	4
Option AI2 (voltage/current input)	5
PG feedback option	6

2. Convert the feedback input level into frequnency, and set it.

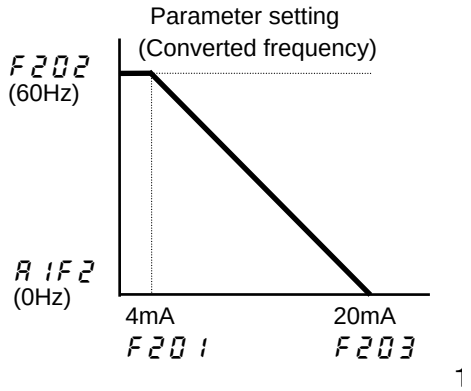
1) Analog input
See the chapter 6 for detail of analog input characteristic setting.

[Example of feedback setting]
Condition: Pressure control as PID control
Input the feedback signal of 1 to 2 atm into VI/II terminal by 4 to 20mA signal.

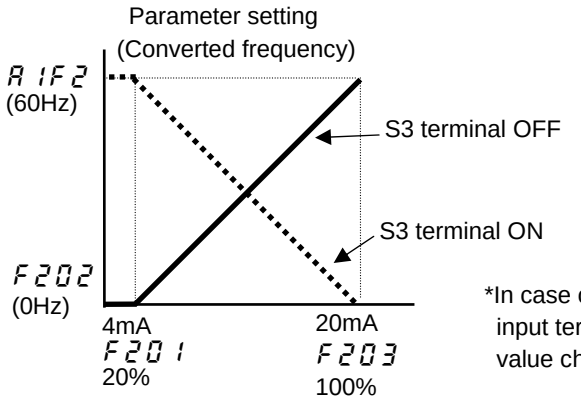


You can set the reverse characteristic or switch the characteristic.

a) Example of reverse characteristic setting



b) Example of switching characteristic by S3 input terminal (positive logic)



*In case of switching characteristic by input terminal, characteristic of process value change too.

Title	Function	Example of setting
AIF2	VI/II input point 2 frequency	60(Hz)
F117	Input terminal function selection 7 (S3)	54: PID forward/reverse switching
F201	VI/II input point 1 setting	20(%)
F202	VI/II input point 1 frequency	0(Hz)
F203	VI/II input point 2 setting	100(%)

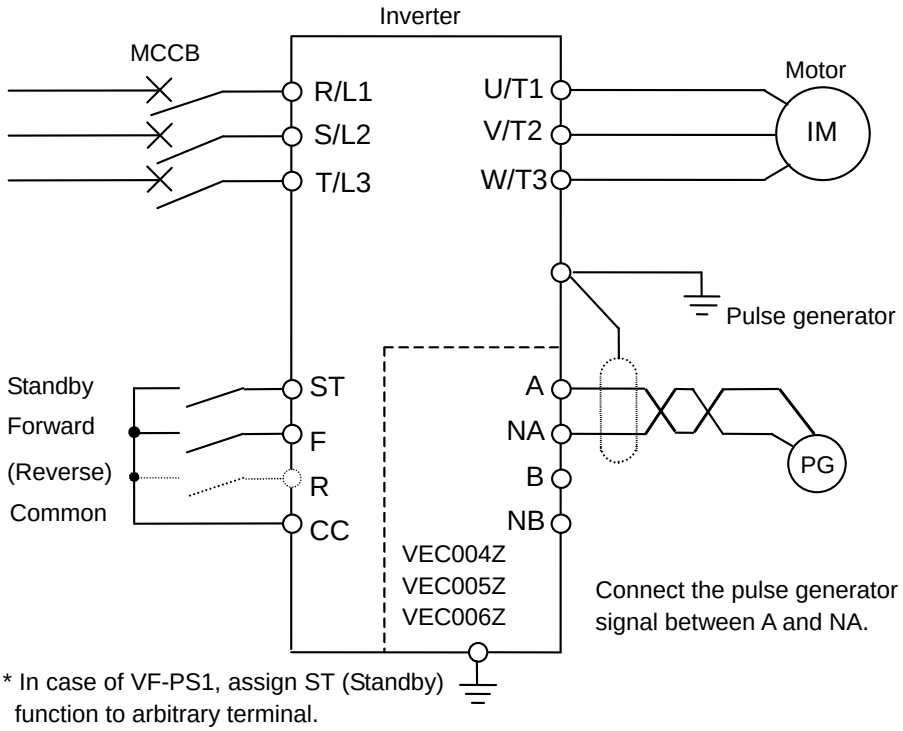
2) Optional terminal input
You can input the signal into optional terminals as same as anarog input.
See the section 6 for detail of input characteristic setting.
AI1: differential current input
AI2: voltage / current input

3) PG feedback input
It is used in speed PID control mainly.
Input by single-phase pulse in case of PG feedback for PID control.
Set Pt (V/f control mode selection) except 7: PG feedback control and 8: PG feedback vector control<VF-AS1 only>.
See the manual E6581319 for detail of PG feedback option.
E6581319: PG feedback board instruction manual

[Example of PG feedback input]

a) Connection example

Connect single-phase pulse signal to A-NA terminals of PG feedback bord option.

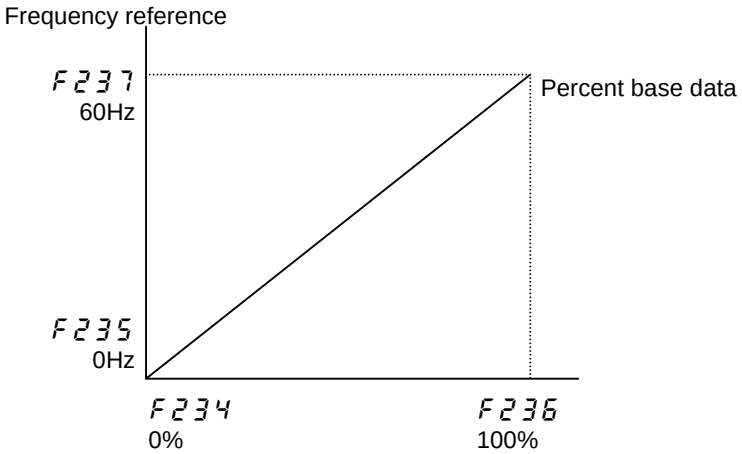


* In case of VF-PS1, assign ST (Standby) function to arbitrary terminal.

b) Parameter setting

Calculate the input pulse frequency to persent base data by the following.
Set the parameters of 2 input points.

$$\text{Percent base data} = \frac{\text{Input pulse frequency}}{\text{PG input pulse} \times \text{Maximum frequency}} \times 100(\%)$$



Title	Function	Adjustment range	Setting (Example)
FH	Maximum frequency	30.0～500.0	60.0（Hz）
F234	RP/hign speed pulse input point 1 setting	0 ~ 100	0(%)
F235	RP/hign speed pulse input point 1 frequency	0.0 ~ FH	0.0(Hz)
F236	RP/hign speed pulse input point 2 setting	0 ~ 100	100 (%)
F237	RP/hign speed pulse input point 2 frequency	0.0 ~ FH	60.0(Hz)
F375	Number of PG input pulses	12 ~ 9999	500
F376	Selection of number of PG input phase	1: Single-phase input 2: Two-phase input 3: Two-phase input (Inversion of polarity)	1
F377	PG disconnection detection	1: Disabled 2: Enabled (with filter) 3: Enabled (Detection of momentary power failure)	1

Note) In case of using shaft built-in type PG, set the RP/hign speed pulse input point 2 to a multiple number of “1/ (a half number of motor poles)”.
For example, set F236 =50(%) in case of using shaft built-in type PG with 4-poles motor.

c) Previous check

You can check frequency reference from pulse input by monitor function previously.

Set the monitor selection to 1: frequency command.

See the section 8 of inverter instruction manual for the detail of monitor function.

4.1.2. Process value

Input the target value against the feedback value as process value.

1. Select the process value input from parameter F110 or F207.

Description	Frequency setting mode selection 1 (F110) Frequency setting mode selection 2 (F207)
VI/II (voltage/current input)	1
RR/S4 (potentiometer/voltage input)	2
RX (voltage input)	3
Operation panel input enabled (including LED/LCD panel option input)	4
Operation panel RS485 (2-wire) communication input	5
Internal RS485 (4-wire) communication input	6
Communications option input	7
Optional AI1 (differential current input)	8
Optional AI2 (voltage/current input)	9
UP/DOWN frequency	10
Optional RP pulse input	11
Optional High-speed pulse input	12
-	13

Speed type
You can add or multiply for process value by override function.
Note) Dancer control use override addition function for speed reference.

2. Convert the feedback input level into frequnency, and set it.

<Note>
You need to input the process value less than maximum of feedback value.
If the process value is setted maximum of feedvack value or more, the feedback value reaches maximum and the deviation becomes zero. The output frequency is fixed because the feedback value does not become high level anymore.
You can set upper limit of process value input by parameter F367: Process upper limit.

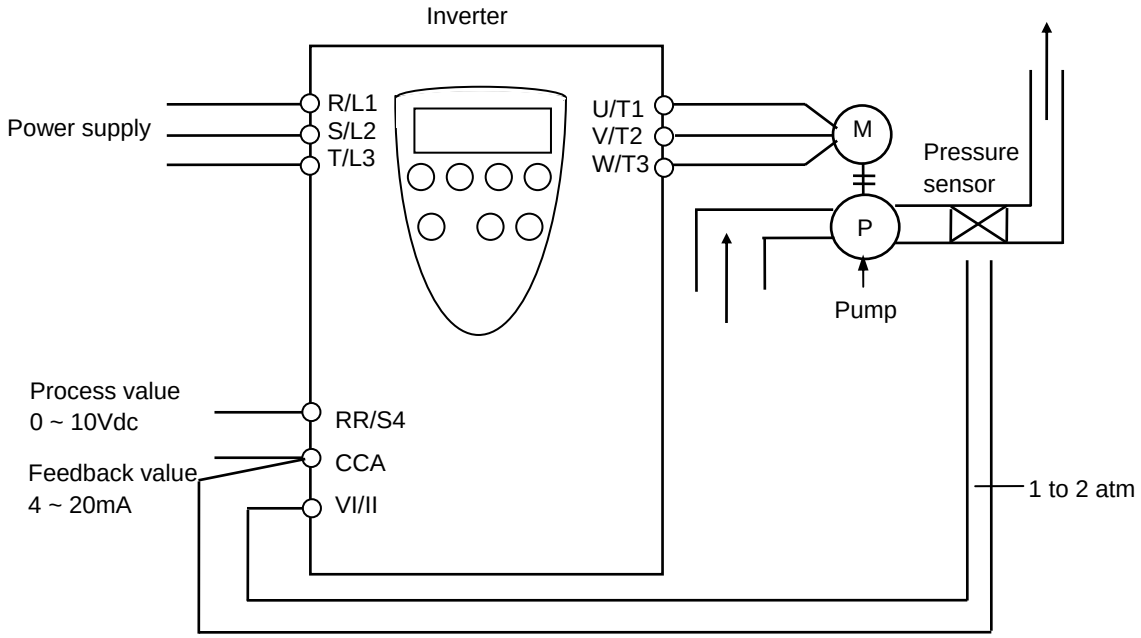
1) Analog input
See the chapter 6 for detail of analog input characteristic setting.

[Example of process value setting]

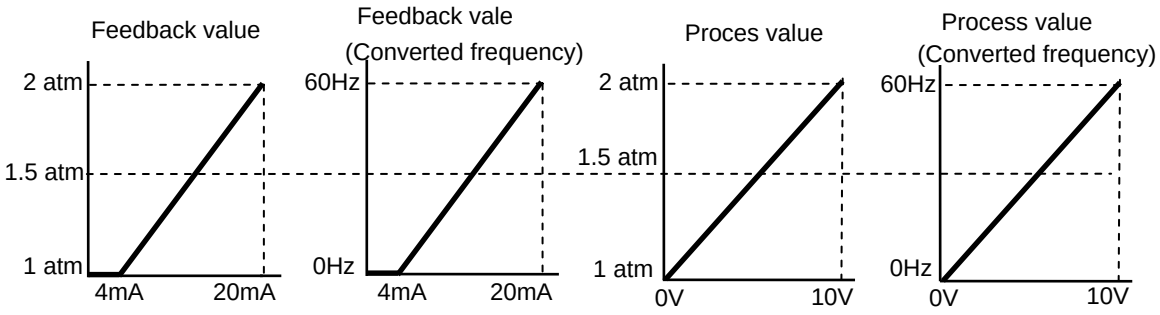
Condition: Pressure control as PID control

Input the feedback signal of 1 to 2 atm into VI/II terminal by 4 to 20mA signal.
Input the process value into RR/S4 terminal by 0 to 10V signal.

a) Example of system



b) Parameter setting



Pressure (atm)	Feedback value (4~20mA)	Process value (0~10V)	Converted frequency (Hz)
1	4	0	0
1.25	8	2.5	15
1.5	12	5.0	30
1.75	16	7.5	45
2	20	10	60

Convert the feedback value and process value to frequency, and set each level.

Actual output frequency is different from these setting frequencies.

Note)

You need to input the process value less than maximum of feedback value.

For example, if you input the process value as 2 atm=10V(60Hz), the feedback value reaches 2 atm=20mA(60Hz) and deviation becomes zero. The feedback value can not exceed 20mA(60Hz) even if the output becomes high level. Then output frequency is fixed.

.

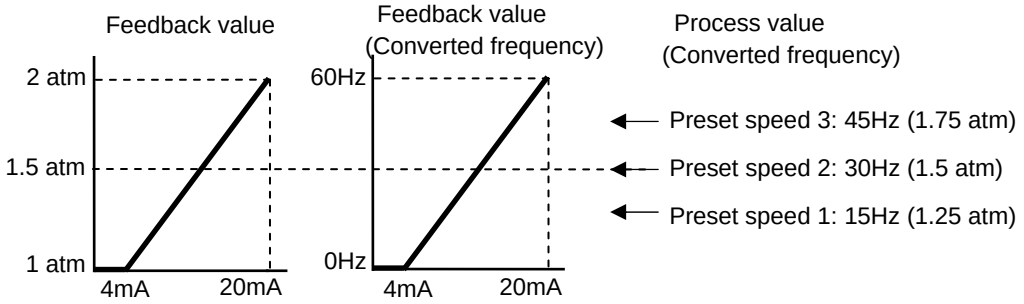
Title	Function	Setting (Example)
AuF2	RR/S4 input point 2 frequency	60(Hz)
AIF2	VI/II input point 2 frequency	60(Hz)
F108	Analog iVI/II voltage/current switching	1:
F201	VI/II input point 1 setting	20(%)
F202	VI/II input point 1 frequency	0(Hz)
F203	VI/II input point 2 setting	100(%)
F210	RR/S4 input point 1 setting	0(%)
F211	RR/S4 input point 1 frequency	0(Hz)
F212	RR/S4 input point 2 setting	100(%)

2) Preset speed

[Example of process value setting]

Condition: Pressure control as PID control

Input the feedback signal of 1 to 2 atm into VI/II terminal by 4 to 20mA signal.
Input the process value into S1 and S2 terminals by preset speed (3 preset speeds) setting.



Pressure (atm)	Feedback value (4~20mA)	Process value			Converted frequency (Hz)
		Preset speed 1 to 3	S1 terminal	S2 terminal	
1	4	-	-	-	0
1.25	8	1	ON	OFF	15
1.5	12	2	OFF	ON	30
1.75	16	3	ON	ON	45
2	20	-	-	-	60

Title	Function	Setting (Example)
AIF2	VI/II input point 2 frequency	60(Hz)
Sr1	Preset speed operation frequency 1	15(Hz)
Sr2	Preset speed operation frequency 2	30(Hz)
Sr3	Preset speed operation frequency 3	45(Hz)
F108	Analog iVI/II voltage/current switching	1: Current input
F115	Input terminal function selection 5 (S1)	10: Preset speed 1
F116	Input terminal function selection 6 (S2)	12: Preset speed 2
F201	VI/II input point 1 setting	20(%)
F202	VI/II input point 1 frequency	0(Hz)
F203	VI/II input point 2 setting	100(%)

Note) You need to input the process value less than maximum of feedback value.

4.1.3. Override function

Speed type

You can add or multiply for process value by override function (F660, F661).

<VF-AS1 only>

Multiplication gain is able to set by parameter F729.

See the inverter instruction manual for the detail of the setting.

* The functions are valid for process type PID control, but it is not used actually.

Dancer control

Dancer control uses override addition function (F660) for speed reference.

4.1.4. Acceleration and decleration time

Process type Dancer control

Set the acceleration time (ACC) and the deceleration time (dEC) to small for quick response.

But too small setting cause inverter trip.

Speed type

Speed PID control set the acceleration time and the deceleration time to the smallest automatically in spite of parameter(ACC,dEC) setting.

*Adjust each gain in case of inverter trip. If you need to set the acceleration time and the deceleration time larger, change the process type PID control.

4.2. Set to suit the motor

Set the following parameters to suit the motor if necessary.

These parameters are valid for actual output frequency (result of PID control).

Title	Function	Discription
FH	Maximum frequency	1) Set the maximum frequency of output frequency. 2) It is base of the acceleration time (ACC) and the deceleration time (dEC). Acceleration time (ACC) is from 0Hz to FH. Deceleration time (dEC) is from FH to 0Hz.
UL	Upper limit frequency	It is upper limit of output frequency.
LL	Lower limit frequency	It is lower limit of output frequency.
F270~ F275	Jump frequency 1 to 3	Set the jump frequency to avoid (jump) resonance frequency of machinery if necessary.
F240	Starting frequency setting	1) Inverter output the frequency setted by F240 immediately. 2) It is useful for quick response of starting torque.
F241	Operation start frequency	Inverter operates RUN and STOP by F241 setting frequency
F243	Stop frequency setting	The output frequency is dropped to 0Hz at the frequency setted by F243.

4.3. Set to suit the system

4.3.1. Set if necessary

Set the following parameters if necessary.

Title	Function	Discription
F367	Process upper limit	1) It is upper limit of process value. 2) It is necessary to input the process value less than maximum of feedback value. If the process value is setted maximum of feedvack value or more, the feedback value reaches maximum and the deviation becomes zero. The output frequency is fixed because the feedback value does not become high level anymore. Set the upper limit of process value input by this parameter if necesary.
F368	Process lower limit	It is lower limit of process value.
F370	PID output upper limit	It is upper limit of output frequency by PID control.
F371	PID output lower limit	It is lower limit of output frequency by PID control.

4.3.2. Switch PID characteristic

It is used in process PID control mainly.

You can switch the PID forward / reverse characteristic,for example cooler and heater.

[Input terminal function]

Positive logic	Negative logic	Function	Discription (Positiv logic)
54	55	PID forward/reverse switching	Switch the PID forward / reverse characteristic of process value and feedback value.

4.3.3. Agreement between process and feedback value

<VF-PS1 only>

Inverter can output agreement signal between the process value and the feedback value.

Select the output terminal function number for each input terminal (RR/S4,VI/II,RX) of feedback value.

Title	Function	Discription
F374	Frequency command agreement detection range	Set the PID frequency command agreement detection. range :0.0～FH(Hz).

.[Output teiminal function]

Positive logic	Negative logic	Function	Discription (Positiv logic)
144	145	Frequency command agreement signal (RR/S4)	Frequency command agreement between FNOd (or F207) and RR/S4 input.
146	147	Frequency command agreement signal (VI)	Frequency command agreement between FNOd (or F207) and VI input.
148	149	Frequency command agreement signal (RX)	Frequency command agreement between FNOd (or F207) and RX input.

4.3.4. Switch to frequency command operation

Process type | Speed type

You can switch from PID control to frequency command operation (not PID control) by input terminal signal.

a) Inverter operates with frequnency reference setted by process value.

b) The acceleration time and the deceleration time are setted small for quick response in case of process PID control.

You can set second acceleration time and deceleration time if necessary for frequency command operation.

[Input terminal function]

Positive logic	Negative logic	Function	Discription (Positiv logic)
36	37	PID control OFF selection	Switch to frequnency command operation after PID control OFF

5. PID control adjustment

5.1. Outline of adjustment

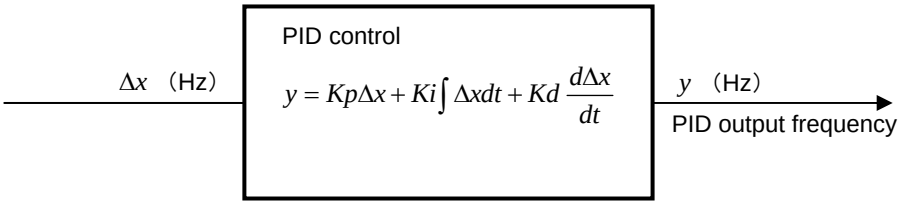
If you have an aim of PID control gain, set each gain and check the working of your system. Adjust the gain only if necessary.

If you don't have an aim of PID control gain, adjust in order of the following.

1) First, operate in default setting and check the working of your system.
2) Adjust the fundamental adjustment.
   a) Adjust the proportional (P) gain first if the response speed delay.
   b) Adjust the integral (I) gain if the unstable situation continues.
   c) Adjust the differential (D) gain if the unstable situation continues after adjustment of PI gains or the load fluctuates large continuously.
3) Adjust the applied adjustment for stability if necessary.
   *Set the delay filter for stability of the speed PID control.

5.2. Fundamental adjustment (common)

Adjust the PID control fundamental gain.

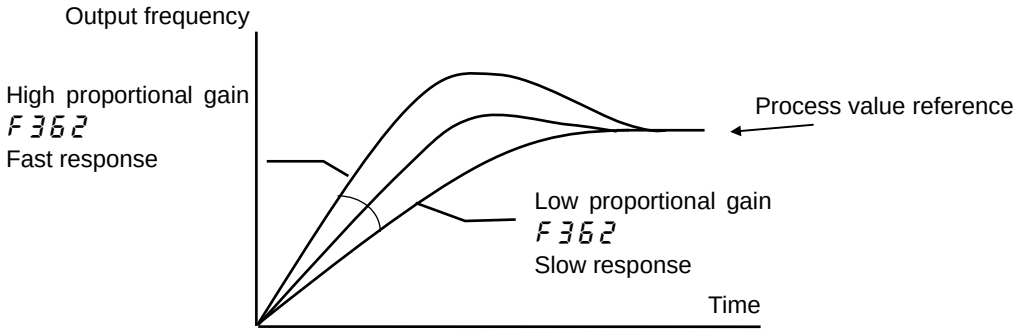


Symbol	Title	Function	Setting value
Kp	F362	Proportional (P) gain	F362=1.0: *Kp* =1.0
Ki	F363	Integral(I) gain	F363=1.0: *Ki* =1.0（1/s）
Kd	F366	Differential (D) gain	F366=1.0: *Kd* =1.0（s）

5.2.1. Proportional (P) gain

Set the proportional (P) gain of PID control by F362.

The proportional (P) gain, a factor by which the deviation (difference between the process value and the feedback value) is multiplied, is used to perform control in such a way as to make a correction in proportion to the deviation. Although setting this gain high is effective in increasing the response speed, setting it excessively high may cause an unstable operation, such as vibration.

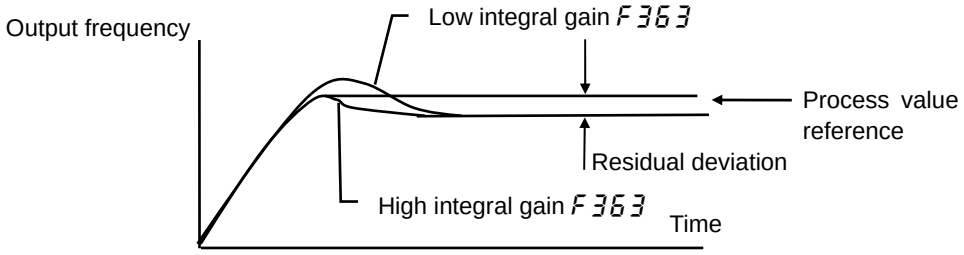


5.2.2. Integral (I) gain

Set the integral (I) gain of PID control by F363.

The integral gain reduces the deviation remaining after proportional control to zero (offsetting of residual deviation).

Although setting this gain high is effective in reducing the residual deviation, setting it excessively high may cause an unstable operation, such as vibration.

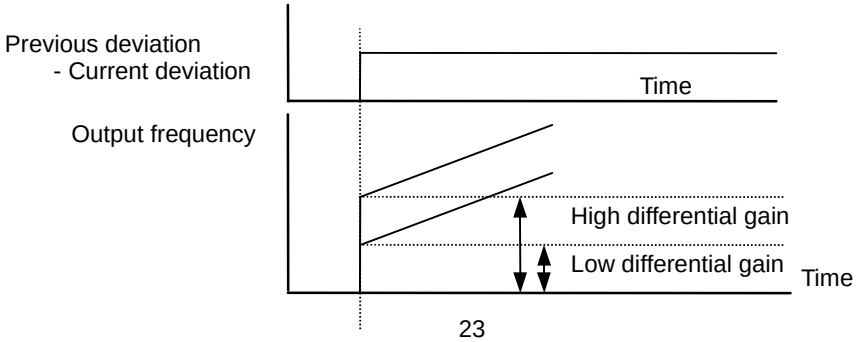


5.2.3. Differential (D) gain

Set the differential (D) gain of PID control by F366.

The differential gain increases the speed of response to rapid changes in deviation.

If this gain is set excessively high, a phenomenon in which the output frequency greatly fluctuates may occur.



5.3. Applied adjustment (Common)

Adjust the following for stability if necessary.

5.3.1. PID deviation upper limit and lower limit

Limit the PID deviation momentarily for stability. (It is not necessary to change under normal conditions.)
Inverter can output the signal in case of the deviation level within the limit setting.

Title	Function	Discription
F364	PID deviation upper limit	It is upper limit of deviation increase (+).
F365	PID deviation lower limit	It is lower limit of deviation decrease (-).

[Output terminal function]

Positive logic	Negative logic	Function	Discription (Positiv logic)
38	39	PID deviation limit	In case of the PID deviation level between F364 and F365.

5.3.2. PID differentiation / integration reset

You can reset the PID differentiation value and integration value by input terminal signal.
[Input terminal function]

Positive logic	Negative logic	Function	Discription (Positiv logic)
52	53	PID differentiation/ integration reset	Reset the PID differentiation value and integration value.

5.3.3. PID control waiting time

You can set the waiting time before PID control start.
It is useful in case the system is not steady at start, etc.

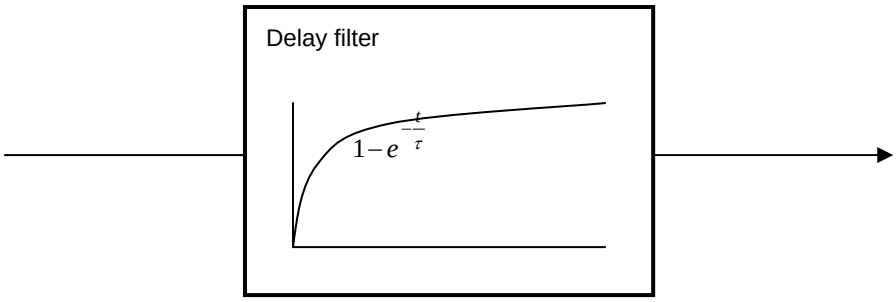
Title	Function	Discription
F369	PID control waiting time	Inverter operates with frequnency reference setted by process value within F369 setting time. After F369 setting time, switch the PID control mode.

5.4. Applied adjustment (for speed PID control)

Adjust the following for stability of speed PID control if necessary.

5.4.1. Delay filter

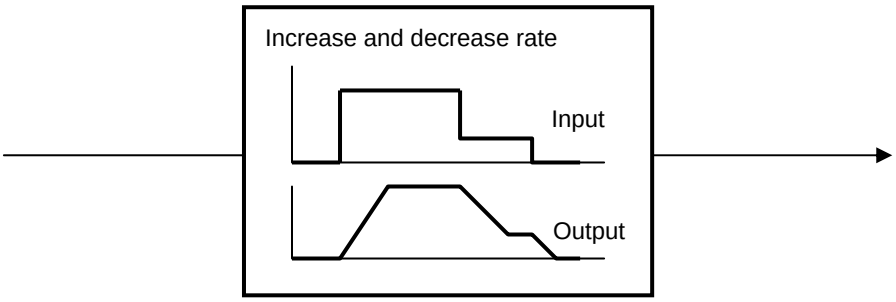
The delay filter set with F361 moderates changes in deviation (primary delay control).
Large setting cause processing speed delay for stability of the control.
(It is not necessary to change under normal conditions.)



Symbol	Title	Function	Setting value
τ	F361	Delay filter	F361=1.0: τ=1.0（s）

5.4.2. Process increasing rate/ decreasing rate

Set the F372 and F373 to small for quick response if necessary.
It is effective for response of feedback value.



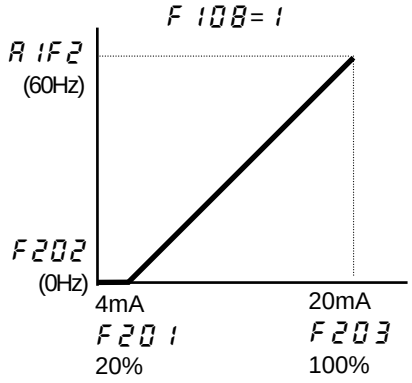
Symbol	Title	Setting value
F372	Process increasing rate (speed type PID control)	F372=1.0 : Increase reference from 0Hz to FH (Maximum frequency) in 1.0 sec
F373	Process decreasing rate (speed type PID control)	F373=1.0 : Decrease reference from FH (Maximum frequency) to 0Hz in 1.0 sec

6. Analog input characteristics

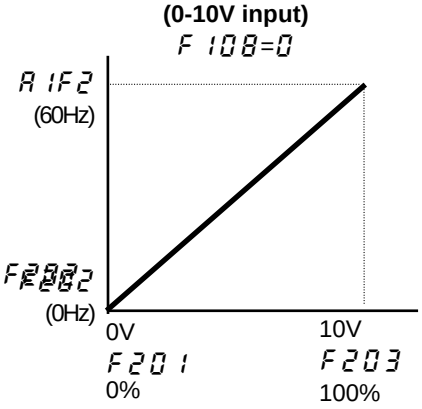
Set the analog input characteristics in case the feedback value and the process value input by the analog input terminals.

*The following examples are setting from 0 to 60Hz

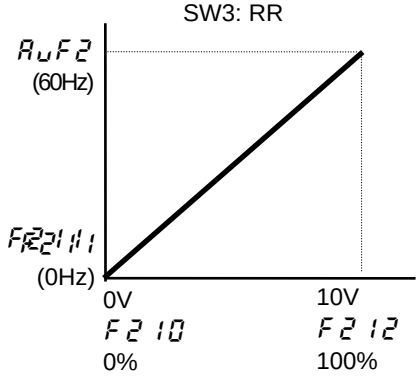
VI/II terminal
(4-20mA input)



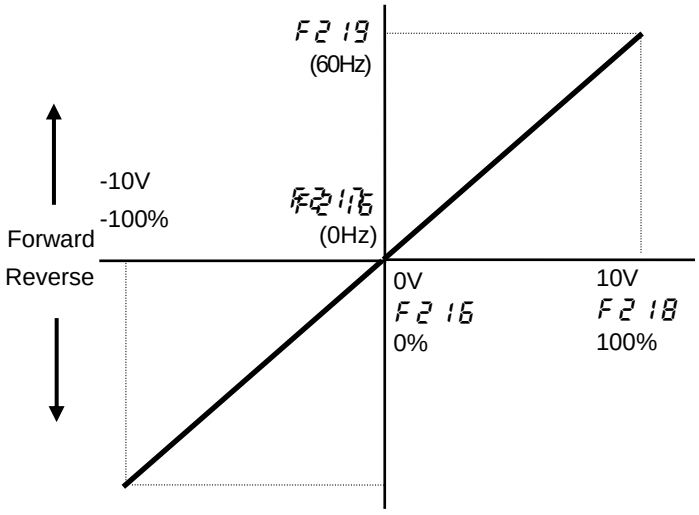
VI/II terminal
(0-10V input)



RR/S4 terminal
(0-10V input)
SW3: RR

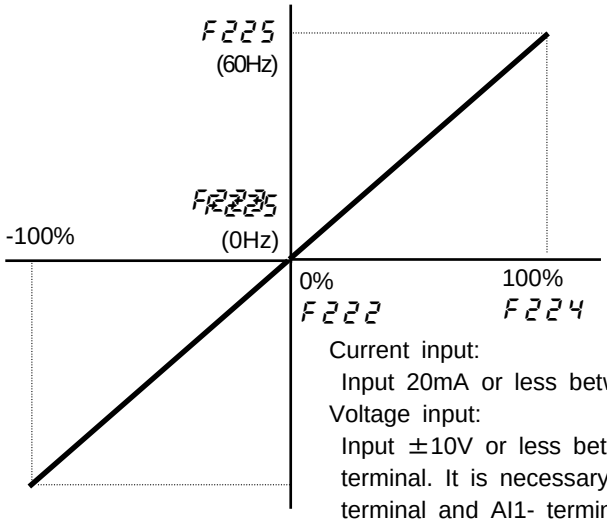


RX terminal
(-10 to 10V input)



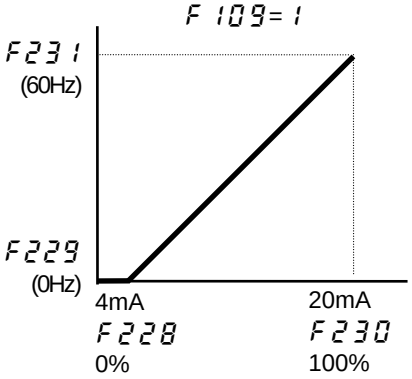
AI1 terminal <Option>
(-100 to 100% input)

<VF-AS1 only>

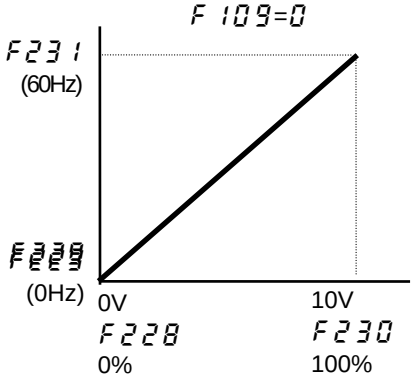


Current input:
Input 20mA or less between AI1+ terminal and AI1- terminal.
Voltage input:
Input ±10V or less between AI1+(or AI1-) terminal and CCA terminal. It is necessary to input 5V or less between AI1+ terminal and AI1- terminal.

AI2 terminal <option>
(4-20mA input)



AI2 terminal <option>
(0-10V input)



7. Parameter list of PID control

Title	Function	Adjustment range	Default setting
FNOd	Frequency setting mode selection 1	1: VI/II (voltage/current input) 2: RR/S4 (potentiometer/voltage input) 3: RX (voltage input) 4: Operation panel input enabled (including LED/LCD panel option input) 5: Operation panel RS485 (2-wire) communications input 6: Internal RS485 (4-wire) communications input 7: Communications option input 8: Optional AI1 (differential current input) 9: Optional AI2 (voltage/current input) 10: UP/DOWN frequency 11: Optional RP pulse input 12: Optional High-speed pulse input 13: -	2
FH	Maximum frequency	30.0~500.0 (Hz)	80.0
UL	Upper limit frequency	0.0~FH (Hz)	60.0
LL	Lower limit frequency	0.0~UL (Hz)	0.0
ACC	Acceleration time 1	0.1~6000 (sec.)	Depends on the capacity
dEC	Deceleration time 1	0.1~6000 (sec.)	
F207	Frequency setting mode selection 2	Same as FNOd (1~13)	1
F240	Starting frequency setting	0.0~10.0 (Hz)	0.1
F241	Operation start frequency	0.0~FH (Hz)	0.0
F243	Stop frequency setting	0.0~30.0 (Hz)	0.0
F270	Jump frequency 1	0.0~FH (Hz)	0.0
F271	Jump step 1	0.0~30.0 (Hz)	0.0
F272	Jump frequency 2	0.0~FH (Hz)	0.0
F273	Jump step 2	0.0~30.0 (Hz)	0.0
F274	Jump frequency 3	0.0~FH (Hz)	0.0
F275	Jump step 3	0.0~30.0 (Hz)	0.0
F311	Reverse-run prohibition selection	0: Permit all 1: Prohibition reverse-run 2:Prohibition forward-run	0
F359	PID control switching	0: No PID 1: Process PID control (temperature, pressure, etc.) 2: Speed PID control (potentials etc.) 3: Stop holding P control 4: Dancer control	0
F360	PID control feedback control signal selection	0: Deviation input (no feedback input) 1: VI/II (voltage/current input) 2: RR/S4 (potentiometer/voltage input) 3: RX (voltage input) 4: Optional AI1 (differential current input) 5: Optional AI2 (voltage/current input) 6: PG feedback option	0
F361	Delay filter	0.0~25.0 (sec.)	0.1
F362	Proportional (P) gain	0.01~100.0	0.10
F363	Integral (I) gain	0.01~100.0 (1/sec.)	0.10
F364	PID deviation upper limit	LL~UL (Hz)	60 / 50
F365	PID deviation lower limit	LL~UL (Hz)	60 / 50
F366	Differential (D) gain	0.00~2.55	0.00

F367	Process upper limit	LL~UL (Hz)	60 / 50
F368	Process lower limit	LL~UL (Hz)	0.0
F369	PID control waiting time	0~2400 (sec.)	0
F370	PID output upper limit	LL~UL (Hz)	60 / 50
F371	PID output lower limit	LL~UL (Hz)	0.0
F372	Process increasing rate (speed type PID control)	0.1~600.0(s)	10.0
F373	Process decreasing rate (speed type PID control)	0.1~600.0(s)	10.0
F374	Frequency command agreement detection range <VF-PS1 only>	0.0~FH (Hz)	2.5
F379	PID output dead band	0.0~100(%)	0
F660	Override addition input selection	0: Deselect 1: VI/II (voltage/current input) 2: RR/S4 (potentiometer/voltage input) 3: RX (voltage input) 4: Operation panel input enabled (including LED/LCD panel option input) 5: Operation panel RS485 (2-wire) communications input 6: Internal RS485 (4-wire) communication input 7:Communications option input 8:Optional AI1 (differential current input) 9:Optional AI2 (voltage/current input) 10:UP/DOWN frequency 11:Optional RP pulse input 12:Optional High-speed pulse input 13:-	0
F661	Override multiplication input selection	0:Deselect 1:VI/II 2:RR/S4 3:RX 4: F729 <VF-AS1 only> 5:AI1	0
F702	Frequency free unit display magnification	0.00:OFF, 0.01~200.0	0.00
F703	Frequency free unit conversion selection	0: All frequencies display free unit selection 1: PID frequencies free unit selection	0
F729	Operation panel override multiplication gain <VF-AS1 only>	-100~100 (%)	0

*1 : See the manual E6581319 for detail of “Stop holding P control”.
E6581319: PG feedback board instruction manual

[Input/output terminal function]

	Positive logic	Negative logic	Function
Input terminal	36	37	PID control OFF selection
	52	53	PID differentiation/integration reset
	54	55	PID forward/reverse switching
	94	95	Dancer correction OFF
Output terminal	38	39	PID deviation limit
	144	145	Frequency command agreement signal (RR/S4) *2
	146	147	Frequency command agreement signal (VI) *2
	148	149	Frequency command agreement signal (RX) *2

*2: VF-PS1 only

[FM/AM pulse output and monitor output function]

FM/AM pulse output		Monitor output		Function
Option No.	Communication No.	Option No.	Communication No.	
1	FD02	1	FE02	Frequency command value
6	FD16	6	FE16	Speed feedback (real time value)
7	FD17	7	FE17	Speed feedback (1-second filter)
13	FD22	13	FE22	PID feedback value
-	-	79	FD52	PID result frequency
-	-	80	FE84	Synchronous speed frequency command

You need to convert the process value and the feedback value into frequency for the PID control.
F702 (free unit selection) and F703 (conversion item selection) enable to set process value and feedback value easily. It is possible to convert frequency display to temperature or pressure level by caluclation.

Value displayed
= Frequency displayed on the monitor or specified with a parameter × F702

F703 = 0

Frequency on the monitor or specified with paramerter display the value multiplied by F702.

Note) This setting does not change automaticalily if it is switched from PID control to frequency command operation. Output frequency displays the value by F702.

F703 = 1

The following frequency with the parameters and the monitor display the value multiplied by F702.

[Parameters]

Title	Function
F364	PID deviation upper limit
F365	PID deviation lower limit
F367	Process upper limit
F368	Process lower limit

[FM/AM pulse output and monitor display]

FM/AM pulse output		Monitor output		Function
Option No.	Communication No.	Option No.	Communication No.	
1	FD02	1	FE02	Operation frequency command value
13	FD22	13	FE22	PID feedback value