TOSHIBA

E6581137

TOSVERT VF-A7/P7

PID Control Function Manual

- Performs process controls for air blow rate, flow rate, pressure etc. -

Toshiba Schneider Inverter Corporation

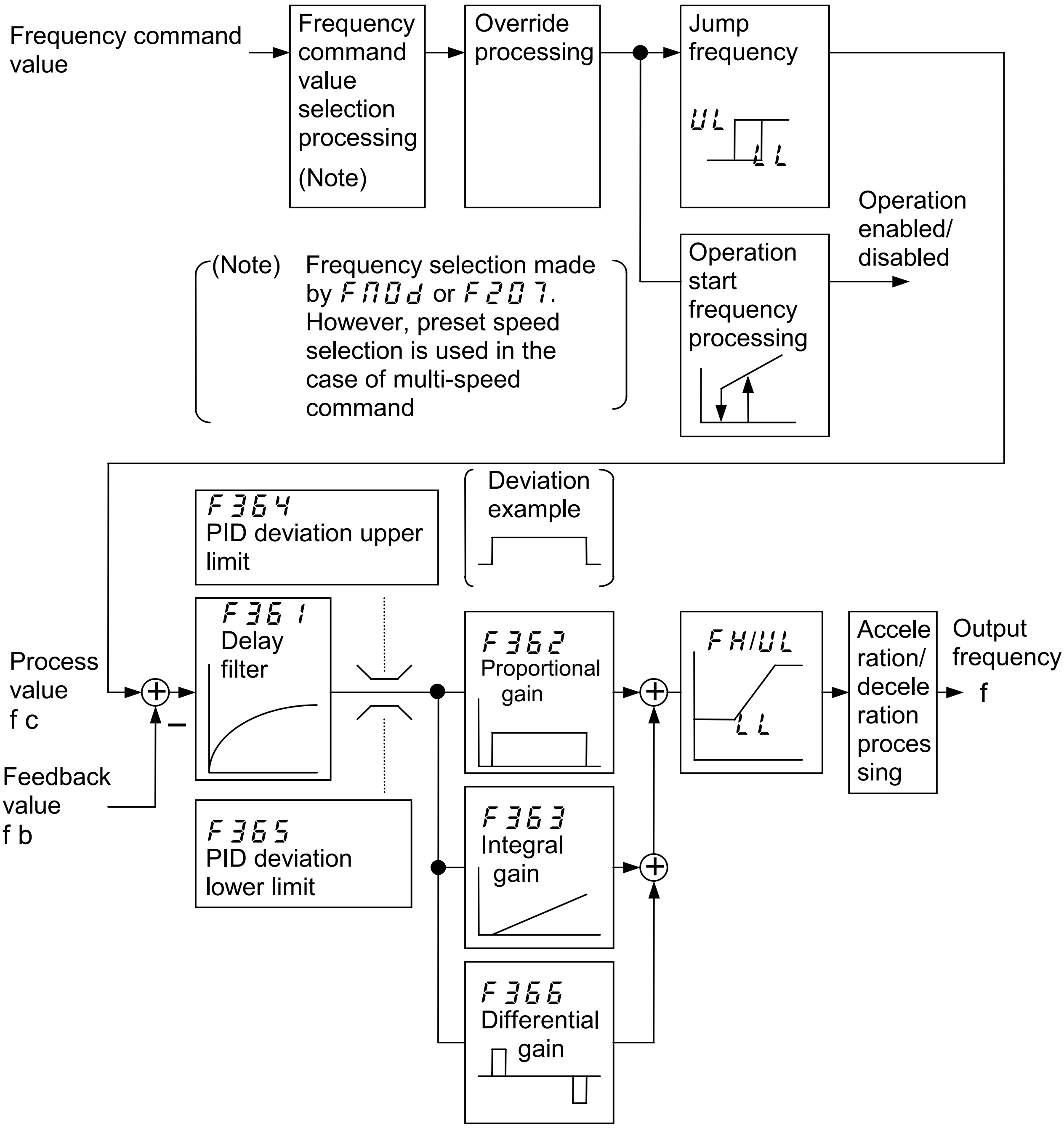
1. PID Control Function

This PID control function can be used for inverters with CPU version V200 or later.

VFA7/P7 PID control function can be used to control processes such as air blow rate, flow rate or constant pressure.

1.1. PID Control Block Diagram

The general block diagram of PID control processing is as follows:



2. PID Control Setting

- The following PID parameters are required to use PID control.

Item	Parameter	Adjustment range	Default setting
Maximum frequency	FH	30 to 400Hz	80Hz
Upper limit frequency	UL	0.0 to FH	80Hz
Signal selection of feedback	F360	0 to 4	0:No input
Signal selection of process	FMOd F207	1 to 11 1 to 11	2:RR input 1:VI input II input
Acceleration/deceleration time	ACC dEC	0.1 to 6000s 0.1 to 6000s	10s 10s
Lower limit frequency	LL	0.0 to UL	0Hz
Jump frequency	F270 to F275	F270,F272,F274 0.0 to FH F271,F273,F275 0.0 to 30Hz	0.0Hz 0.0Hz
Over-ride processing	F660 F661	0 to 11 0 to 5	0 0
Operation start frequency	F241 F242	0.0 to FH 0.0 to 30Hz	0.0Hz 0.0Hz

- In this PID control, process value and feedback value are converted into frequency signals for the purpose of processing.

  Therefore, process value and feedback value have to be converted to frequency signals.

2.1.1. Maximum Frequency

- Maximum frequency (FH) is the maximum value in the frequency range that the inverter outputs.

  To use PID control, it is recommended that you set the frequency about 10% higher than upper limit frequency (UL). (See 2.1.4.)

2.1.2. Upper Limit Frequency

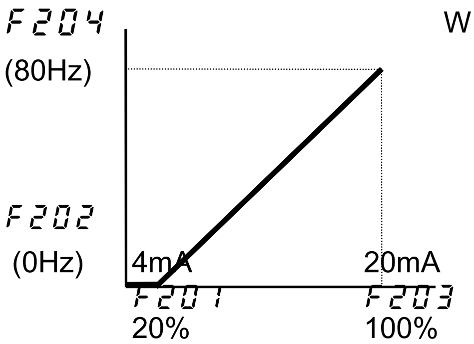
- For upper limit frequency (UL), set the upper limit frequency of the motor used.

2.1.3. Feedback Signal Setting

- Where you enter feedback input, select Signal selection of PID control (F360).
- To enter analog input, see Subsection 3.2.
- Set the zero point of feedback value to 0 Hz and set the maximum output of the feedback value to maximum frequency.

For example, in the case of 4-20mA output, set 20% to 0 Hz and 100% to maximum frequency.

Example of II terminal setting:



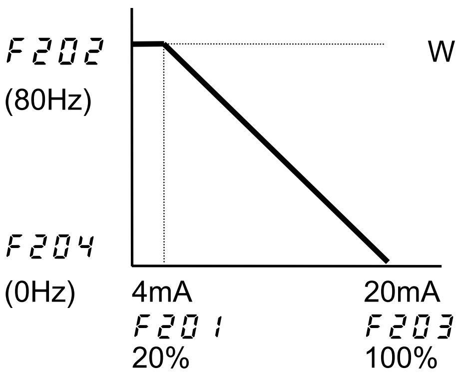
When maximum frequency is 80 Hz

Feedback value input value

Contents	Signal selection of PID control（F360）
No PID control	0
VI (voltage input)/II (current input)	1
RR (volume/voltage input)	2
RX (voltage input)	3
RX2 (voltage input (option))	4

Reverse characteristics can also be set by changing the setting.

Example of II terminal setting



When maximum frequency is 80 Hz

2.1.4. Process Signal Setting

- Process value is used as frequency command value set by speed command selection (FMOd) etc.
  To be more specific, the frequency command value is set as process value that becomes the target value of the feedback value.
- To use analog input, see Subsection 3.2.
- Process value can also be set from preset speed frequency setting.

Selection of process value input

Contents	Speed command selection (FMOd)
VI (voltage input)/II (current input)	1
RR (volume/voltage input)	2
RX (voltage input)	3
RX2 (voltage input (option))	4
Operating panel input	5
Binary/BCD input	6
Common serial communication option	7
Serial communication RS485	8
Communication add-on cassette option	9
Up-down frequency	10
Pulse input (option)	11

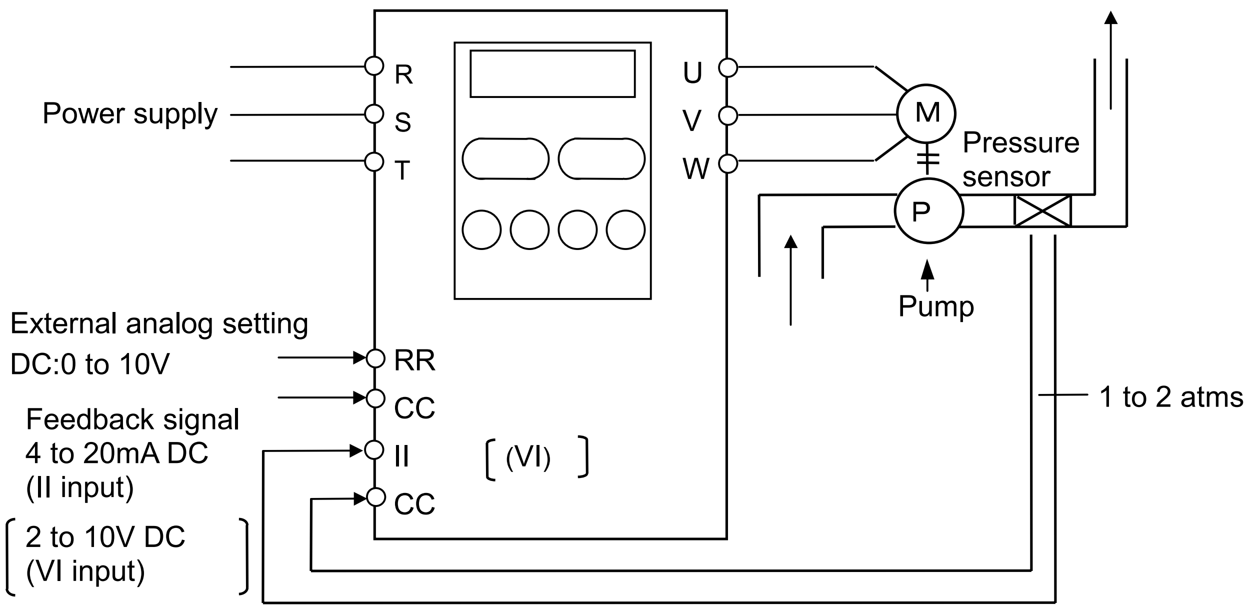
Example of process value setting

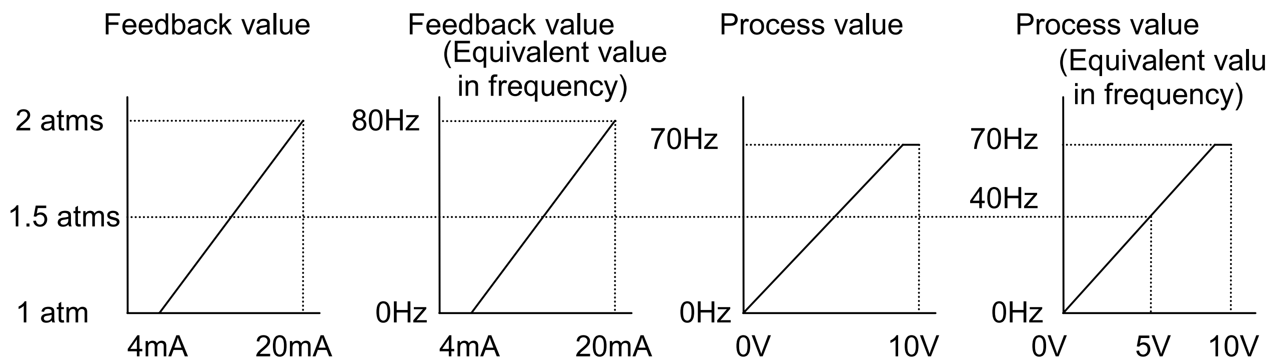
In an example of a system shown below where feedback value is 4-20mA II input (1 to 2 atms), process value is RR input and the maximum frequency is 80 Hz, suppose you want to adjust the atmospheric pressure to 1.5 atms, the process value that generates the feedback value of 1.5 atms is set here.

In the following diagram, process value of 5V corresponds to 1.5 atms and this becomes 40 Hz as frequency command value. (Actual output does not necessarily become 40 Hz.)

Example of a system

Parameter setting: FMOD=2 (RR input) F360=1 (VI/II input)
FH =80.0 UL =70.0





Feedback value (4 to 20mA)	Process value (0 to 10V)	Frequency command value (Hz)
4	0	0
8	2.5	20
12	5.0	40
16	7.5	60
20	10	80

* The actual motor frequency is output as a result of PID control and the frequency does not become as shown above.

(Notes)
Suppose process value is 10V – 80 Hz, when feedback value is 20mA - 80 Hz, deviation becomes zero.
Here, even if the actual output goes high, the feedback value is limited and does not become more than 20mA – 80 Hz and thus the output frequency is fixed to 80 Hz.
Therefore, setting the upper frequency to about 70 Hz prevents the output from becoming fixed at maximum frequency as described in 2.1.2,"Upper Limit Frequency."
Therefore, set the setting range of process value lower than the maximum frequency.

2.1.5. Acceleration/Deceleration Time

- Set the acceleration/deceleration time (ACC/dEC) short while observing the inverter does not trip.
  A longer acceleration/deceleration time results in poor response.
  A shorter acceleration/deceleration time may cause an inverter trip.

2.1.6. Lower Limit Frequency, Jump Frequency

- Lower limit frequency (LL) and upper limit frequency (UL) are both valid for process value and output frequency.
  When lower limit frequency is set, process value is also limited at lower limit frequency.
  Therefore, set the lower limit frequency so that the command of process value stays above the lower limit frequency.
- Jump frequency (F270 to F275) is valid for process value.
  A disabling band can be provided for the process value to be set.

2.1.7. Override Processing

- Override processing (F660,F661) is valid for process value.
  This is used to perform fine adjustment for process value.

2.1.8. Operation Start Frequency

- Operation start frequency (F241,F242) is valid for process value.
  This is the function to start the operation when the setting of the process value becomes higher than the setting of the operation start frequency (F241+F242) and stops when it becomes lower than the operation start frequency (F241-F242).

2.1.9. Switching to Open Loop Control Operation

- To start the open loop control operation (manual operation) from PID operation (automatic operation), either use PID control OFF selection (input terminal function 36/37) or set "0" in the PID feedback selection (F360).
  Here, be careful because the acceleration/deceleration time is faster now.
  (Set the second acceleration/deceleration time etc. if necessary.)

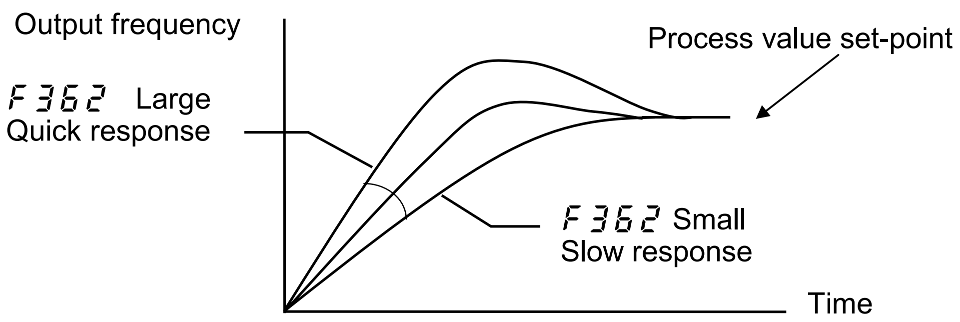
3. Adjusting PID Control

- Adjust the PID control gain in accordance with process value, feedback input signal and the controlled system.
  The adjustment parameters for PID control are as follows:

Item	Parameter	Adjustment range	Default setting
Delay filter	F361	0 to 255	1
Proportional (P) gain	F362	0.01 to 100	0.1
Integral (I) gain	F363	0.01 to 100	0.1
PID deviation upper limit	F364	0 to 50(%)	50
PID deviation lower limit	F365	0 to 50(%)	50
Differential (D) gain	F366	0 to 2.55	0

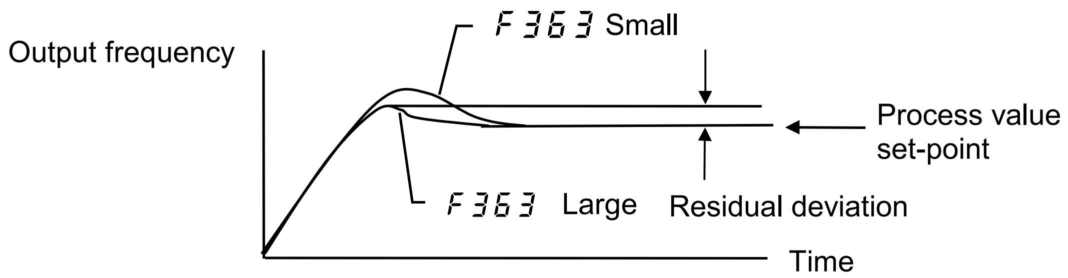
3.1.1. Adjusting the Proportional (P) Gain

- Proportional (P) gain (F362) is the proportional gain used for PID control.
  This is a coefficient to multiply the deviation (difference between the process value and the feedback value) to obtain the correction value for control proportional to the deviation. If you increase this value, control response increases but if you increase the value unnecessarily, it may cause unstable conditions such as hunting.



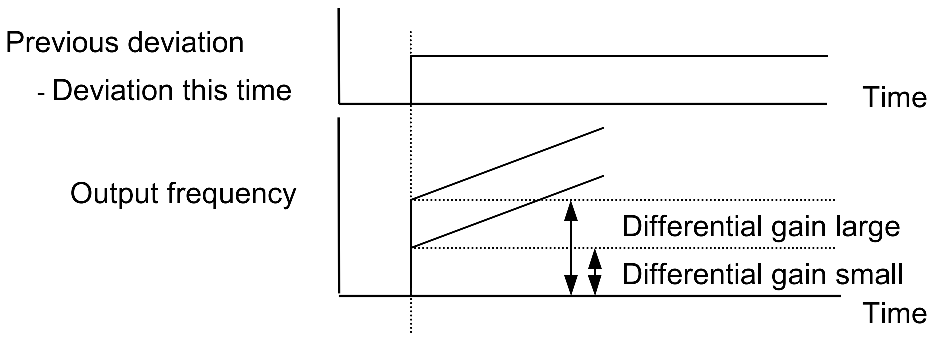
3.1.2. Adjusting the Integral (I) Gain

- Integral (I) gain (F363) is the integral gain used for PID control.
  This is used to set the deviation that remains after the proportional action (residual deviation offset) to 0.
  If you increase this value, residual deviation becomes small but if you increase the value unnecessarily, it may cause unstable conditions such as hunting.



3.1.3. Adjusting the Differential (D) Gain

- Differential (D) gain (F366) is the differential gain used for PID control.
  This is used to improve the response when a deviation that changes quickly occurs.
  However, if you increase this value unnecessarily, unstable condition of output frequency fluctuation occurs.



3.1.4. Adjusting the Delay Filter

- Delay filter (F361) works to moderate a deviation that changes quickly (first-order lag processing).
  Normally, you need not change this setting. If you decrease this value, processing becomes faster and if you increase the value, the processing becomes slower.

3.1.5. Adjusting the PID Deviation Upper Limit

- PID deviation upper limit (F364) is the upper limit for deviation increase (+).
  This is used to limit the deviation that occurs momentarily. Normally you need not change this setting.

3.1.6. Adjusting the PID Deviation Lower Limit

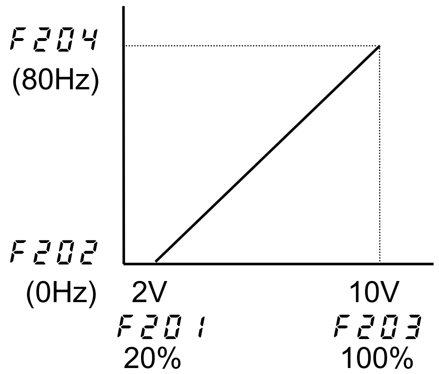
- PID deviation lower limit (F365) is the lower limit for deviation decrease (–).
  This is used to limit the deviation that occurs momentarily. Normally you need not change this setting.

3.2. Adjusting the Analog Input Signal

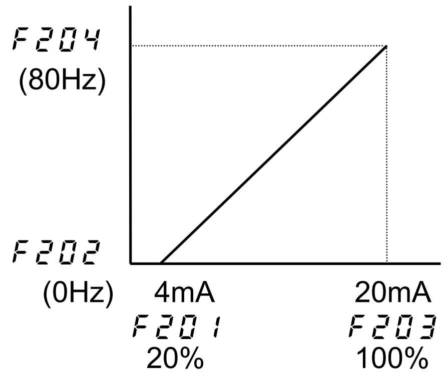
The reference that can be set as feedback inputs such as voltage input (VI input)/current input (II input), volume/voltage input (RR input), voltage input (RX input) and voltage input (RX2 input [option]) should be adjusted with voltage scaling, if necessary.

If feedback input is small, for example, this can be used as gain adjustment.

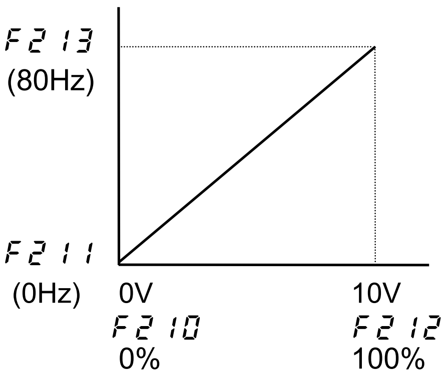
Example of VI terminal setting
(default setting)



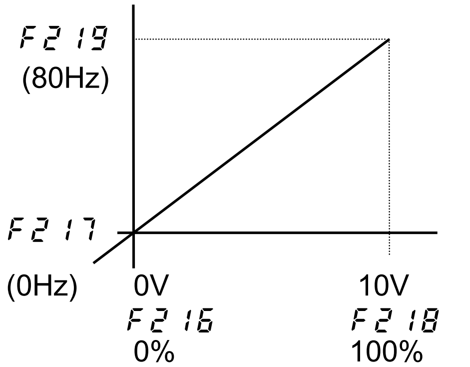
Example of II terminal setting
(default setting)



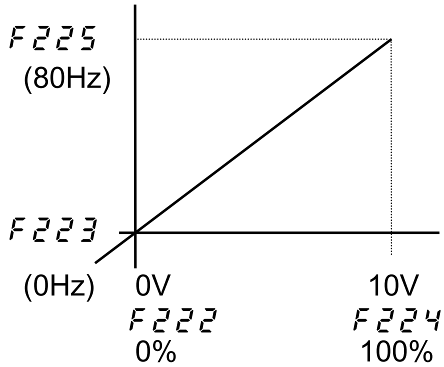
Example of RR terminal setting (default setting)



Example of RX terminal setting
(default setting)



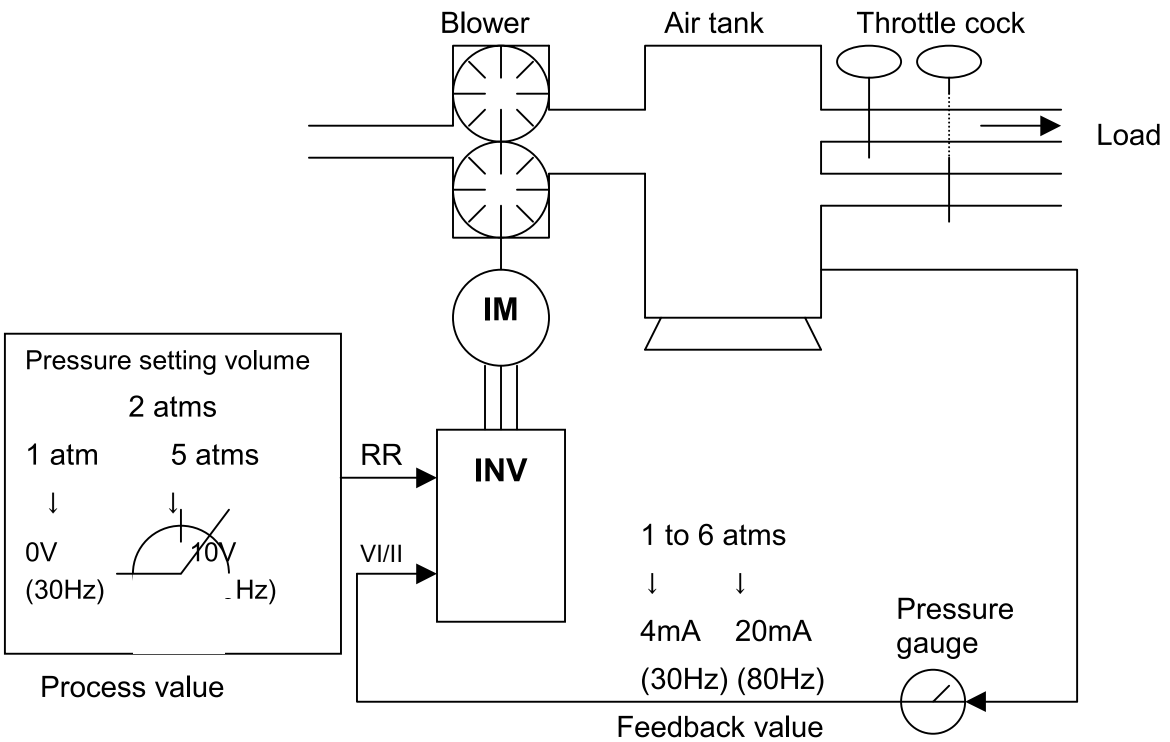
Example of RX2 terminal setting
(default setting)[Option]



4. PID Application Example

In this example, process value and feedback value are set in a compressor system with the configuration shown below where the lower limit frequency setting is required.

(Frequency settings for pressure setting and feedback value are the settings required to perform PID control and not for the actual output frequency.)



Compressor operating condition

- Process value should be set in the range from 1 to 5 atms.
- Mechanical specification
  The compressor runs in the range from 30 Hz to 70 Hz. (A mechanical damage occurs if operated below 30 Hz.)
- Feedback (sensor) is 4mA to 20mA corresponding to 1 to 6 atms.

- Setting procedure

1) Set the lower limit frequency (LL) to 30 Hz (mechanical specification). LL = 30Hz

2) Set the upper limit frequency (UL) to 70 Hz (mechanical specification). UL = 70Hz

3) Set the maximum frequency (FH) a little higher than the upper limit frequency (UL).

FH = 80Hz

** With the settings above, the motor will be controlled within 30 Hz to 70 Hz.

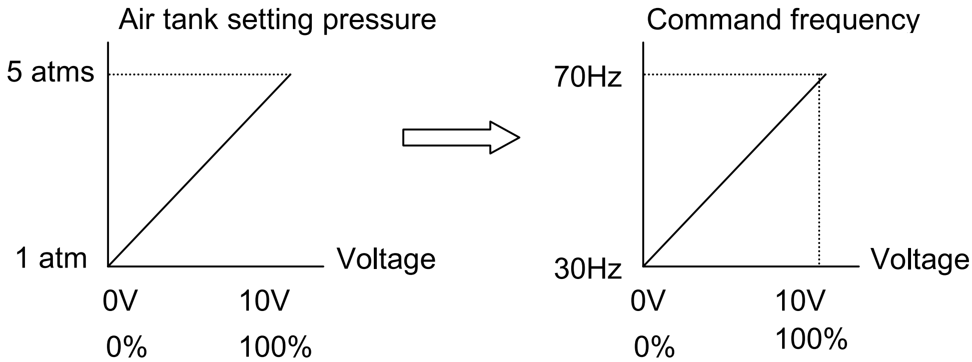
4) Process signal (FMOd) settings

Setting 1: Set 1 atm to 30 Hz.

1 atm –0V —30 Hz (F210 = 0, F211 = 30 Hz)

Setting 2: Set 5 atms to 70Hz.

5 atms –10V —70 Hz (F212 = 100, F213 = 70 Hz)



** With the settings above, process value 0 - 10V corresponds to 1 - 5 atms.

5) Feedback signal (F360) settings

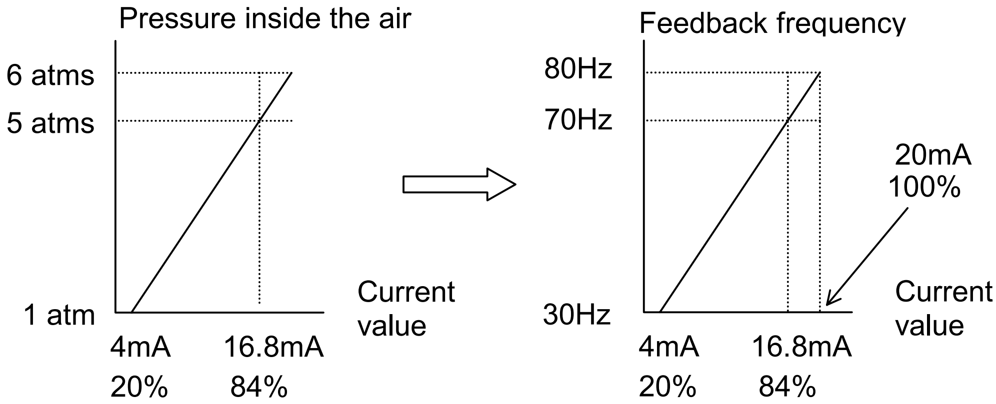
Setting 1: Set 1 atm – 4mA to 1 atm – 30 Hz in the same way as process value.

1 atm – 4mA – 30 Hz (F201 = 20, F202 = 30 Hz)

Setting 2: Set 5 atms – 16.8mA to 5 atms – 70 Hz in the same way as process value.

5 atms – 16.8mA – 70 Hz (F203 = 84, F204 = 70 Hz)

Or, you can set 6 atms – 20mA – 80 Hz (F203 = 100, F204 = 80 Hz).



** With the settings above, feedback value 4 – 20mA corresponds to 1 - 6 atms.

(Notes)

Make sure to set the feedback value higher than the upper limit value of the process value.
If the feedback value and the process value are both set to the same 20mA – 70 Hz, even if the actual pressure goes high, the feedback value does not go higher than 20mA – 70 Hz and thus the output frequency becomes fixed to 70 Hz.

Therefore, in an example above, settings are made so that the feedback value is 6 atms (20mA) against 5 atms of the process value.

Setting parameters

Parameter	Function	Setting	Remarks
FMOd	Speed setting mode selection	2	Default value (RR terminal)
FH	Maximum frequency	80	
UL	Upper limit frequency	70	
LL	Lower limit frequency	30	
F201	VI/II reference point #1	20	Feedback value
F202	VI/II reference point #1 frequency	30	With 4mA input, 30 Hz (1 atm)
F203	VI/II reference point #2	100	Feedback value
F204	VI/II reference point #2 frequency	80	With 20mA input, 80 Hz (6 atms)
F210	RR reference point #1	0	Process value
F211	RR reference point #1 frequency	30	With 0V input, 30 Hz (1 atm)
F212	RR reference point #2	100	Process value
F213	RR reference point #2 frequency	70	With 10V input, 70 Hz (5 atms)
F360	Signal selection of PID control	1	Input from VI/II terminal