Automate

TECHNICAL SOLUTION

Title:

ATV212 Drive with PID control-application is explained with necessary input details, wiring diagram and programming.

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Description:

This document will provide you the necessary information about the hardware and software configuration to use the ATV212 Drive with PID control – the application is explained to control the pressure of a pump with pressure feedback of 0 to 10V (corresponding to 0 to 10 bar pressure) from pressure transducer. The necessary input details, wiring diagram and programming are shown here with for reference. By following the step by step procedure provided below, you will be able to do the installation and commissioning of drive with PID control.

Hardware:

1. ATV212H075N4 drive or any of ATV212 series drive.
2. Pressure Transducer – output 0 to 10V corresponding to pressure of 0 to 10 Bar pressure.
3. Man(Open loop)/Auto(Closed loop – PID Enabled)Selector switch, Start/Stop push buttons as shown in diagram

Software:

1. Somove Lite V 1.8.5.0 (or latest version available) for drive configuration – optional

PID Definition:

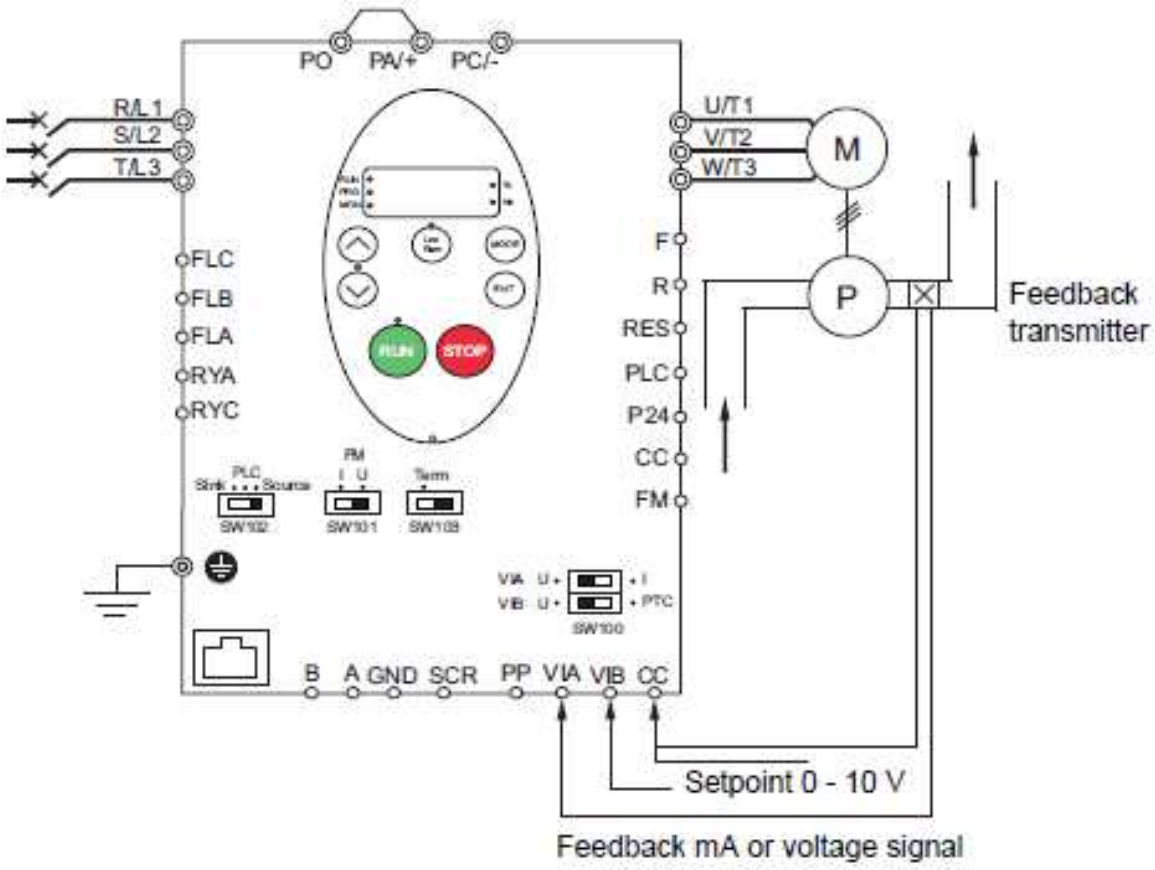
The PID algorithm is a method of Feedback control. It stands for Proportional-Integral-Derivative. The most popular method of process control involving an Analog set point and Feedback signal is the PID loop.

The proportional mode adjusts the output signal in direct proportion to the controller input: which is the error signal. The adjustable parameter to be specified is the controller gain. The larger the gain, the more the controller output will change for a given error. For instance, with a gain of 1 an error of 10% of scale will change the controller output by 10% of scale.

A proportional controller reduces error but does not eliminate it, unless the process has naturally integrating properties, i.e. an offset between the actual and desired value will normally exist. The additional integral mode, often referred to as reset gain, corrects for any offset (error) that may occur between the desired value (set point) and the process output automatically over time. The adjustable parameter to be specified is the integral of the controller.

1. Tested configuration

1. The recommended hardware wiring diagram as below.



2. Wire analog inputs (set point reference and feedback) as indicated in the above figure.
3. Set switch SW102 to source.
4. If the feedback is a milliamp signal, set switch SW100 to the I (current) position. If the feedback is a voltage signal, set switch SW100 to the V (voltage) position.

2. ATV212 PID Configuration using Somove Lite Software (or) Key Pad:

1. Program common parameters and motor name plate details of ATV212 from Quick Menu and do a auto-tuning

2. F200(**[Auto/man speed ref])** should be set to "1 -**[Disable]** "

F200	**[Auto/man speed ref]**	Auto/Manual Speed Reference Switching	0
0	[Enable]		
1	[Disable]		
	Switching between two speed reference sources by means of a logic input is enabled if parameter F200 is set to 0. To use this function, you need to assign a logic input to function 38, Auto/Man speed ref. When the assigned logic input is off, the drive will follow the speed reference source defined by parameter [Frequency mode sel] (FNOd) (see page 77). When the assigned logic input is on, the drive will follow the speed reference source defined by parameter [Remote spd ref 2] (F207) (see page 78). When parameter F200 is set to 1, the drive will follow the FNOd speed reference source when it is operating above 1 Hz. Below 1 Hz, it will follow the F207 speed reference source.		

3. FNOD **[Frequency mode sel]** parameter should be set to "2 - **[Ref source VIB]**. This parameter also can be set to any other Channel of speed references provided below, the corresponding hardware must be connected and wired with drive(for example: if "3-HMI Reference" is selected, Graphic display terminal should be connected with drive).

FNOd	**[Frequency mode sel]**	Remote Mode Primary Speed Reference Source	-	1
	The setting of parameter FNOd determines the source of the drive's speed reference when the drive is in remote mode. The drive needs to be stopped to make changes to parameter FNOd. See diagram on page 46 and description page 50 for more information on the source of the drive's speed reference.			
1	[Ref source VIA]: VIA			
2	[Ref source VIB]: VIB			
3	[HMI reference]: Graphic display option			
4	[Serial com ref.]: Serial communication			
5	[+/- Speed]: +/- Speed			

4. The parameter F113 should be set to “14 - [PID Disable]”

14	[PID disable]	OFF: PID control permitted ON: PID control prohibited PID control prohibited input terminal function is available to switch PID control and open-loop control. Also Clear PID integral value input terminal function (function 65) is available. **Note:** For software version lower than V1.7IE04, when Clear PID integral value (function 65) and PID Control Prohibited (function 14) are used, it is necessary to set [Command mode sel] (CMOd) to [Logic inputs] (0) Control terminal logic inputs.

5. The Man(PID Disable)/Auto(PID Enable) logic input from selector switch should be connected in LI RES terminal, When this input is OFF, the drive will work in closed loop PID control and if this input is ON, the drive will work in open loop without any PID correction.

F112	**[LI R selection]**	R Logic Input Function	0 to 73	6
	The setting of parameter F112 determines the control function of logic input terminal R.			
F113	**[LI RES selection]**	RES Logic Input Function	0 to 73	10
	The setting of parameter F113 determines the control function of logic input terminal RES.			

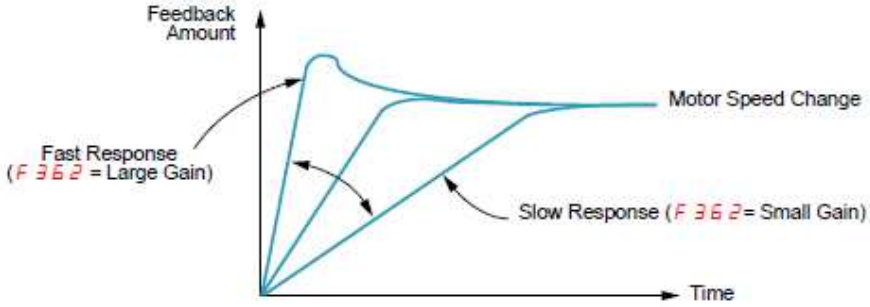
6. F360 – PID Control Enable to be set to “2- PID by VIA”

F360	**[PID control enable]**	-	0
0	[No PID]: PID disabled		
1	[PID by VIA]: Enabled (feedback source is VIA)		
2	[PID by VIB]: Enabled (feedback source is VIB)		
	Parameter F360 is used to enable PID control and define the source of the feedback signal. The PID source is defined by the setting of parameter [Frequency mode sel] (FMOd) (see page 77). Parameter [Freq band det range] (F167) can be adjusted to command a drive relay to signal when the PID setpoint and feedback are in agreement (see page 115).		

7. Program specific parameters for PID control as indicated in the following table should be fine tuned as per the process requirement.

F 3 6 2	**[PID Prop Gain]**	PID Proportionnal Gain	0.01 to 100.0%	0.30%

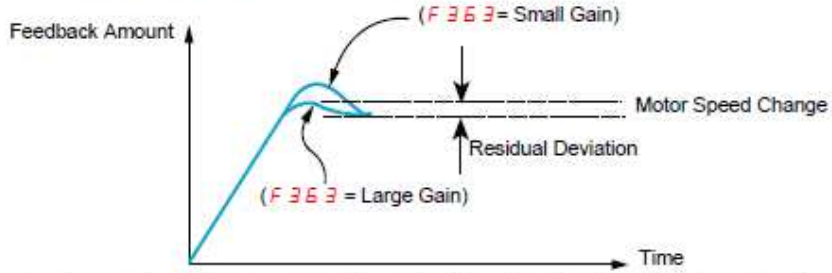
Parameter F 3 6 2 adjusts the proportional gain applied during PID control. The speed change applied to the motor is a correctional value proportional to the product of this parameter's setting and the process error (deviation between the setpoint and the feedback value).
A higher setting of F 3 6 2 provides a fast response to a process error but may also result in instability such as hunting. The diagram below illustrates the effect produced by adjusting F 3 6 2.



F 3 6 3	**[PID Integral Gain]**		0.01 to 100.0	0.20

Parameter F 3 6 3 adjusts the integral gain applied during PID control. Any residual process errors that remain after correction by the proportional gain are cleared to zero over time by the integral gain function.

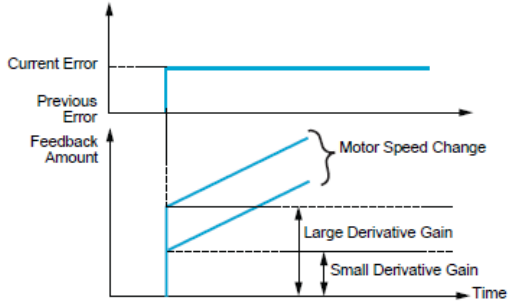
A higher setting of F 3 6 3 provides a fast response to a process error but may also result in instability such as hunting. The diagram below illustrates the effect produced by adjusting F 3 6 3.



The integral gain value can be set to zero by setting a logic input to function 65. For more information, see table on page 91 and parameters [LI F selection] (F 1 1 1), [LI R selection] (F 1 1 2), [LI RES selection] (F 1 1 3), page 90, and [VIA LI selection] (F 1 1 B), page 90.

F 3 6 6	**[PID Derivative Gain]**	0.00 to 2.55	0.00

Parameter F 3 6 6 adjusts the derivative gain applied during PID control. This gain adjusts the response time of the drive to rapid changes in the process.
Increasing the setting of F 3 6 6 more than necessary may cause great fluctuations in motor speed resulting in system instability.
The diagram below illustrates the effect produced by adjusting F 3 6 6.



F 3 5 9	**[PID ctrl wait time]**	PID Control Waiting Time	0 to 2400 s	0

If parameter F 3 5 9 is set to a value greater than 0 seconds, the drive will not immediately enter PID control upon startup. For the time set by F 3 5 9, the drive will ignore the feedback signal, accelerating the motor to the speed set by the reference input. This function can be used to help prevent the drive from entering PID control mode before the system approaches the final operating level.

F 3 8 0	**[PID reverse error]**	PI regulator reversal direction correction		0

0 [No]
1 [Yes]

This function is used to reverse the error PI for Water Pump.
If F 3 8 0 = 0 or No, PI error input = reference - feedback. The motor speed increases when the error is positive.
If F 3 8 0 = 1 or Yes, PI error input = feedback - reference. The motor speed decreases when the error is positive.

F 3 9 1	**[Stop on LL hyst]**	Stop on LL hysteresis	0.0 to [Max frequency] (F H)	0.2 Hz
F 3 9 2	**[PID wake up (thres)]**	PI wake up threshold on PI error	0.0 to [Max frequency] (F H)	0.0 Hz

⚠ DANGER

UNINTENDED EQUIPMENT OPERATION
Check that unintended restarts will not endanger personnel or equipment in any way.
Failure to follow these instructions will result in death or serious injury.

F 3 9 3	**[PID wake up, feedb]**	PI wake up threshold on PI feedback error	0.0 to [Max frequency] (F H)	0.0 Hz

⚠ DANGER

UNINTENDED EQUIPMENT OPERATION
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3. Important settings and calculations to match the Process Reference and Feedback:

1. To maintain the pressure to set value (ex: 5 Bar), it is mandatory to maintain setting of the speed reference = speed feedback
2. Let's consider the Pressure Reference – 0 to 10V through Potentiometer (or any other channel).
3. Let's consider the Pressure Feedback – 0 to 10 V from Pressure transducer corresponding to 0 to 10 bar pressure
4. Maximum Pressure to be maintained in process – 5 Bar
5. Pump estimated pressure (information from pump manufacturer) – 5 Bar pressure @ 1500 RPM
6. Maximum speed setting calculation = (1500/5) X 10(maximum feedback) = 3000 RPM = 100 HZ. So the maximum speed setting to be done at 100 HZ
7. Now, you can give start command and the speed (Pressure) reference can be adjusted through any of the channels mentioned above in "FNOD" parameter. The drive will work in closed loop PID control mode and the set pressure will be maintained.

4. Conclusion:

The PID control function is commonly used in various industries for controlling the process variable (pressure, speed, torque, tension, temperature etc...). The above document will provide the necessary hardware wiring and programming details to establish closed loop PID control function.