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# S7-200 SMART PID Configuration & PID Tune Control

# S7 - 200 SMART/ Version 2.3

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# 1 Introduction

### 1.1 Overview

PID Auto-Tune capability has been incorporated into the S7-200 smart PLC and STEP-7 Micro/WIN has added a PID Tuning Control Panel. Together, these two features greatly enhance the utility and ease of use of the PID function.

Auto-tune can be initiated by the user program from an operator panel or by the PID Tuning Control Panel. PID loops can be auto-tuned one at a time or all eight loops can be auto-tuned at the same time if necessary. The PID Auto-Tune computes suggested (near optimum) values for the gain, integral time (reset) and derivative time (rate) tuning values. It also allows you to select tuning for fast, medium, slow or very slow response of your loop.

With the PID Tuning Control Panel you can initiate the auto-tuning process, abort the auto-tuning process and monitor the results in a graphical form. The control panel displays any error conditions or warnings that might be generated. It also allows you to apply the gain, reset and rate values computed by auto-tune.

### 1.2 Mode of Operation

#### a. Proportional Control

A proportional controller will have the effect of reducing the rise time and will reduce, but never eliminate the steady state error.

#### b. Integral Control

An integral control will have the effect of eliminating the steady state error, but it may make the transient response worse.

#### c. Proportional & Integral (P-I) Control

A PI controller could improve relative stability and eliminate steady state error at the same time, but the settling time is increased.

#### d. Proportional & Derivative (P-D) Control

A PD controller could add damping to a system, but the steady-state response is not affected.(steady state error is not eliminated).

#### e. Proportional , Integral & Derivative (P-I-D) Control

A PID controller removes steady-state error and decreases system settling times while maintaining a reasonable transient response.

### 1.3 Components used

This application example has been created with the following components:

| Table 1-1                     |        |                     |      |
|-------------------------------|--------|---------------------|------|
| Component                     | Number | Article number      | Note |
| CPU ST60                      | 1      | 6ES7 288-1ST60-0AA0 |      |
| STEP 7-MicroWIN<br>SMART V2.4 | 1      | 6ES7 288-SW01-0AA0  |      |
| TIA PORTAL V15.1              | 1      | 6ES7 822-1AA05-0YA7 |      |
| Basic HMI KTP900 PN           | 1      | 6AV2 123-2JB03-0AX0 |      |

This application example consists of the following components:

### Table 1-2

| Component | File name | Note |
|-----------|-----------|------|
|           |           |      |
|           |           |      |

# 2 Engineering

### 2.1 Description of interface

| LAD / FBD                    | STL           | Description  |
|------------------------------|---------------|--|
| PID<br>EN ENO<br>TBL<br>LOOP | PID TBL, LOOP | The PID loop instruction (PID)<br>executes a PID loop<br>calculation on the<br>referenced LOOP based<br>upon the input and<br>configuration information in<br>Table (TBL). |

The PID loop instruction (Proportional, Integral, and Derivative Loop) is provided to perform the PID calculation. The top of the logic stack (TOS) must be ON (power flow) to enable the PID calculation. The instruction has two operands: a table address which is the starting address of the loop table and a LOOP number which is a constant from 0 to 7. Eight PID instructions can be used in a program. If two or more PID instructions are used with the same loop number (even if they have different table addresses), the PID calculations will interfere with one another and the output will be unpredictable. The loop table stores nine parameters used for controlling and monitoring the loop operation and includes the current and previous value of the process variable, the set point, output, gain, sample time, integral time (reset), derivative time (rate), and the integral sum (bias). STEP 7-Micro/WIN SMART offers the PID wizard to guide you in defining a PID algorithm for a closed-loop control process. Select the "Instruction wizard" command from the "Tools" menu and then select "PID" from the "Instruction wizard" window.

# 2.2 Project integration

| LAD/FBD   | STL   | Description  |
|---|---|--|
| PID0_CTRL<br>– EN<br>– PV_I Output –<br>- Setpoint_R<br>– Auto_Manual<br>– ManualOutput | PID0_CTRL<br>PID_Scale,<br>Setpoint, Auto<br>Manual, Manual<br>Output_ Value, PID<br>_Out | The PIDx_CTRL instruction executes<br>the PID function based on the inputs<br>and outputs you enter in the PID<br>Wizard. It is called every scan.<br>Note: The inputs and outputs for the<br>PIDx_CTRL instruction depend on<br>the choices you make in the wizard.<br>For example, if you select to Enable<br>Low Alarm (PV) on the Loop Alarm |
|   |   | Options screen of the wizard, then<br>the Low Alarm output displays in the<br>instruction.   |
|   |   | In automatic mode, calculations will<br>be performed using the built-in PID<br>algorithm to drive the "Output" of the<br>PIDx_CTRL box. In manual mode,<br>the "Output" is controlled by the<br>"Manual Output" input.   |
|   |   | If the checkbox in the wizard on the<br>next-to-last screen is checked to<br>"Add Manual Control of the PID",<br>then the PIDx_CTRL instruction will<br>contain the input parameters "Auto   |

| _Manual" and "Ma<br>Otherwise, these two<br>appear on the<br>instruction, and autor<br>enabled.   | nual Output".<br>inputs will not<br>PIDx_CTRL<br>natic mode is   |
|---|--|
| When used, the "A<br>Boolean input must be<br>mode control, and o<br>mode control. When<br>manual mode, the "C<br>PIDx_CTRL instruction<br>by writing a normaliz<br>(0.00 - 1.00) to the "N<br>input, driving the "Out<br>the range values as<br>wizard for the "Output"<br>if in the wizard you se<br>range to be from 2000<br>when the "Manual Out<br>0.00, the "Output" shot<br>Similarly, when the "N<br>input is at 1.00, the "<br>be at 26000. When<br>Output" input is at 0.5<br>should be halfway thre<br>or in this case, (26<br>2000 = 14000. | uto _Manual"<br>> ON for auto-<br>if for manual-<br>the PID is in<br>output" (of the<br>i) is controlled<br>ed real value<br>Manual Output"<br>tiput" between<br>signed in the<br>. For example,<br>>t the "Output"<br>to 26000, then<br>put" input is at<br>uld be at 2000.<br>Manual Output"<br>Output" should<br>the "Manual<br>0, the "Output"<br>ough its range,<br>000-2000)/2 + |

### PIDx\_CTRL subroutine parameters

| Inputs/Outputs  | Operands   | Data types |
|---|--|------------|
| PV_I  | VW, IW, QW, MW, SW, SMW, LW,<br>T, C, AIW, AC, *VD, *LD, *AC             | INT        |
| Set point _R  | ID, QD, MD, SD, SMD, VD, LD, AC,<br>Constant, *VD, *LD, *AC              | REAL       |
| Auto _Manual  | I, Q, M, SM, T, C, V, S, L   | BOOL       |
| Manual Output   | ID, QD, MD, SD, SMD, VD, LD, AC,<br>Constant, *VD, *LD, *AC              | REAL       |
| Output (Analog)   | IW, QW, MW, SW, SMW, T, C, VW,<br>LW, AIW, AC, Constant, *VD,<br>*LD,*AC | INT        |
| Output (Digital), High<br>Alarm, Low Alarm,<br>Module Err | I, Q, M, SM, T, C, V, S, L   | BOOL       |

## 2.3 Operation

### 2.3.1 PID Wizard Programming Steps

Use one of the following methods to open the PID Wizard:

• Select the PID Wizard from the Tools menu in Micro/WIN SMART :



Figure 1. Select the PID Wizard

• Open the "Wizard" folder in the project tree and double-click "PID" or select "PID" and press the Enter key.



Figure 2. Select PID Wizards

#### Step 1: Define the PID loop number

To be configured in this dialog box, select the loop to be configured. Up to 8 loops can be configured. When you select a loop on this dialog, the tree view on the left side of the PID wizard is updated with all the nodes required to configure the loop.

| PID Loop Wizard  |  | X |
|--|--|---|
| Loops  | Introduction   |   |
| Loop 0     Parameters     Input     Output     Alarms     Code     Components     Input     Output     Alarms     Output     Alarms     Output     Alarms     Output     Alarms     Code     Memory Allocation     Components     Code     Memory Allocation     Components     Code     Memory Allocation     Components     Completion | <ul> <li>This wizard generates a PID (Proportional, Integral, Derivative) loop instruction (one for each loop) based on your input. You then place these instructions in your program to control and monitor a PID loop.</li> <li>A separate control panel is available to assist you in tuning and monitoring your loops.</li> <li>Number of Loops</li> <li>Select Loops to configure.</li> <li>✓ Loop 0</li> <li>✓ Loop 1</li> <li>Loop 2</li> <li>Loop 3</li> <li>Loop 4</li> <li>Loop 6</li> <li>Loop 7</li> </ul> |   |
|  | < Previous Next > Generate Cancel  |   |

Figure 3. Select the loop you need to configure

#### Step 2: Name the loop configuration

We can configure a custom name for the loop. The default name for this section is "loop x", where "x" is equal to the loop number.

| PID Loop Wizard  |   | X      |
|--|---|--------|
| Loops  Coop 0  Parameters  Output  Alarms  Code Memory Allocation Components  Components  Code Memory Allocation Components  Code Memory Allocation Components  Code Memory Allocation Components  Code Components  Components  Components  Components  Components  Completion | Loop 0         What should this Loop be named?         Loop 0                  Previous         Next >         Generate | Cancel |

Figure 4. Name the PID loop

| PID Loop Wizard   | ×   |
|---|---|
| PID Loop Wizard   | Parameters<br>Gain<br>1.0<br>Sample Time<br>1.0<br>second(s)<br>b.            |
| Memory Allocation<br>Components<br>Components<br>Parameters<br>Input<br>Output<br>Alarms<br>Code<br>Memory Allocation<br>Components<br>Completion | Integral Time<br>10.0 • minute(s)<br>Derivative Time<br>0.0 • minute(s)<br>C. |
|   | < Previous Next > Generate Cancel   |

Step 3: Set the PID loop parameters

Figure 5. Set the PID parameters

The PID loop parameters are defined in Fig. 5 and should be real number.

- a. **Gain** : The proportional constant, default = 1.00.
- b. **Integration time** : If you do not want the integral action, you can set the value very large (such as 10000.0), the default value = 10.00.
- c. **Derivative time** : If you do not want a differential loop, you can set the derivative time to 0 and the default value = 0.00.
- d. **Sampling time**: It is the time interval between the PID control loop sampling and recalculating the output value. The default value is 1.00. After the wizard is completed, if you want to modify this number, you must return to the wizard to modify it, and you cannot modify it in the program or in the status table.

| PID Loop Wizard  | X  |
|--|--|
| Loops<br>Loop 0<br>Parameters<br>Input<br>Output<br>Alarms<br>Code<br>Memory Allocation<br>Components              | Specify how the loop Process Variable (PV) should be scaled. The Loop PV is a parameter you specify for the subroutine generated by the wizard.  Type  Process Variable Scaling Unipolar  a. |
| Coop 1     Parameters     Input     Output     Alarms     Code     Memory Allocation     Components     Completion | Scaling<br>Process Variable<br>Low: 0000 **<br>High: 27648 **<br>D.O **<br>100.0 **<br>D.O **  |
|  | < Previous Next > Generate Cancel  |

Step 4: Set the loop process variable

Figure 6. Set the PID input process variable

- a. Specifies how the loop process variable (PV) is calibrated. You can choose from the following options:
- **Unipolar:** the input signal is positive, such as 0-10V or 0-20mA.
- **Bipolar:** The input signal varies from negative to positive. If the input signal is ±10V, ±5V, etc.
- Select 20% offset: If the input is 4-20mA, select the single polarity and this item, 4mA is 20% of the 0-20mA signal, so choose 20% offset, that is, 4mA corresponds to 5530, 20mA corresponds to 27648.
- b. Feedback input value range:
- When a. is set to unipolar, the default value is 0 27648, corresponding to the input range 0 10V or 0 20mA, etc., the input signal is positive.
- When a. is set to bipolar, the default value is -27648 +27648, and the corresponding input range can be ±10V, ±5V, etc. depending on the range.
- When a. Select 20% offset, the value range is 5530 27648, which cannot be changed.
- c. In the "Scaling" parameter, specify how the loop setpoint (SP) is scaled. The default is a real number between 0.0 and 100.0.

| PID Loop Wizard   | X   |
|---|---|
| Loops Loop 0 Parameters Loop 0 Parameters Unput Code Code Components Compone | Specify how the loop Output should be scaled. The Loop Output is a parameter you specify for the subroutine generated by the wizard.  Type Type Analog Scaling Unipolar |
| Completion  | Range<br>Low: 0000  |
|   | < Previous Next > Generate Cancel   |

Step 5: Set the input loop output options

Figure 7. Set the PID output options.

a. Output Type:

You can select either an analog output or a digital output. The analog output is used to control some equipment that requires analog quantity, such as proportional valve, frequency converter, etc.; digital output is actually the on/off state of the control output point according to a certain duty cycle change, which can control the solid state relay (Heating rod, etc.).

- b. To select the analog quantity, you need to set the range of the loop output variable value. You can choose:
- **Unipolar** : unipolar output, can be 0-10V or 0-20mA, etc.
- **Bipolar** : bipolar output, can be positive or negative 10V or positive and negative 5V, etc.
- Unipolar 20% offset : If the 20% offset is selected, the output is 4 20mA.
- c. Ranges:
- When c is unipolar, the default is 0 to 27648.
- When c is bipolar, the value is -27648 to 27648.
- When c is 20% offset, the value is 5530 27648, which cannot be changed.

| PID Loop Wizard   |   |                                    |                     | 2      |
|---|---|------------------------------------|---------------------|--------|
| Loop 0  Loop 0  Parameters  Duput  Alarms  Code  Memory Allocation  | The wizard can provide outputs for variou condition is met.                 | s loop conditions. The outpu<br>a. | ts are set when the | alarm  |
| Components  Coop 1  C | High<br>✓ Enable high alarm (PV)<br>Normalized high alarm limit<br>0.9<br>★ | <u>b.</u>                          |                     |        |
| Completion  | Module<br>Enable analog input error<br>Analog input module position<br>EM 0 | C.                                 |                     |        |
|   | < Previous   Next >   |                                    | Generate            | Cancel |

Step 6: Set the loop alarm option

Figure 8. Set the loop alarm limit value

The wizard provides three outputs to reflect low value alarms for process values (PV), high value alarms, and process value analog module error status. The output is set to 1 when the alarm condition is met. These features work after the corresponding selection box is selected.

- a. Enable the low value alarm and set the low value of the process value (PV) alarm. This value is the percentage of the process value. The default value is 0.10, that is, the low value of the alarm is 10% of the process value. This value can be set to a minimum of 0.01, which is 1% of full scale.
- b. Enable the high value alarm and set the high value of the process value (PV) alarm. This value is the percentage of the process value. The default value is 0.90, that is, the high value of the alarm is 90% of the process value. This value can be set to a maximum of 1.00, which is 100% of full scale.
- c. Enable the process value (PV) analog module error alarm and set the module location where the module is connected when the CPU is connected. "EM0" is the location of the first expansion module.

# Step 7: Define the PID initialization subroutine and interrupt program name and hand/auto mode generated by the wizard

| PID Loop Wizard   | ×  |
|-------------------|--|
| Loops             | Subroutine   |
| Coop 0            | The wizard will create a subroutine for initializing the selected PID configuration.   |
| Output            | PIDO_CTRL @  |
| Memory Allocation | Interrupt  |
| Components        | The wizard will create an interrupt routine for the PID loop execution. This routine will also<br>implement any error checking that was requested.                   |
| Input<br>Output   | Name of interrupt routine:<br>PID_EXE  |
|                   |  |
|                   | Manual control   |
| Components        | Manual control of the PID is allowed and may be selected. When in manual mode, the PID<br>calculation is not executed, and the loop output is under program control. |
|                   | Add Manual Control of the PID  |
|                   |  |
|                   |  |
|                   | < Previous Next > Generate Cancel  |

Figure 9. Specify the subroutine, interrupt service program name, and select manual control.

- a. Specify the PID name of the initial subroutine.
- b. Specify the name of the PID interrupt subroutine.
- c. Here you can choose to add the PID manual control mode. In the PID manual control mode, the loop output is controlled by the manual output setting. At this time, the manual control output parameter needs to be written with a real number of 0.0-1.0, representing 0%-100% of the output instead of directly changing the output value.

| PID Loop Wizard |  | x |
|-----------------|--|---|
| PID Loop Wizard | Memory Allocation Please specify a starting address where the configuration will be placed in the Data Block. The wizard can also suggest an address that represents an unused block of V-memory of the correct size.           Suggest         VB 120         VB239 (120 bytes) | × |
|                 | < Previous Next > Generate Cancel  |   |

Step 8: Specify the PID operation data storage area

Figure 10. Assign the operation data storage area.

The PID instruction (function block) uses a 120-byte V-zone parameter table for the operation of the control loop; in addition, the standardized program of the input/output quantities generated by the PID wizard also requires the arithmetic data storage area. You need to define a starting address for them, and make sure that the first few bytes of the address are not reused elsewhere in the program.

#### Note:

If you click "Suggest", the wizard will automatically set the V area address that has not been used in the current program.

| PID Loop Wizard   |  |   |  |  | X              |
|---|--|---|--|--|----------------|
| Loops   | Components   |   |  |  |                |
| Parameters<br>  | The Subrou<br>this configu<br>subroutine '<br>The reques | tines and Interrupt Ro<br>ration within the progr<br>"PID0_CTRL".<br>ted configuration cons | utines listed below will become p<br>am, place a call in the MAIN pro<br>ists of the following project com | part of the project. To er<br>gram block to the initializa<br>ponents: | nable<br>ation |
| 🗹 Code  | Com  | ponent  | Description  |  |                |
| Memory Allocation   | 0 PIDC   | )_CTRL  | Subroutine used to initialize Pl   | D  |                |
|   | 1 PID_   | EXE   | Interrupt used to cyclically exe   | ecute PID function   |                |
| Parameters  | 2 PIDO   | )_DATA  | Data page with configuration   | placed at (VB120 - VB239   | 9)             |
| - 🔲 Input   | 3 PIDO   | )_SYM   | Symbol table created for this of   | configuration  |                |
| Output     Alarms     Ode     Memory Allocation     Components     Completion |  |   |  |  |                |
|   | < Previous   | Next >  |  | Generate   | Cancel         |

Step 9: Generate PID subroutine, interrupt program and symbol table.

Figure 11. Generate PID subroutine, interrupt routine, symbol table, etc.

Step 10: After configuring the PID wizard, you need to call the PID subroutine generated by the wizard in the program (as shown below).



Figure 12. PID subroutine

| 2 Initializ | ze and mor     | nitor PID bloc | x by calling PID0_CTRL   |
|-------------|----------------|----------------|--|
|             | lways_On:S<br> | \$M0.0         | PID0_CTRL         EN <b>b.</b> VW42         PV_I       Output         PID_Out:VW18 <b>f. C.</b> PID_SP_Auto:VD10         Setpoint_R       HighAlarm         HighAlarm       High_Alarm:V20.1 <b>G.</b> PID_Mode:V20.0         Auto_Manu <sup>®</sup> Low_Alarm:V20.2 <b>e.</b> PID_SP_Man:VD14 |
| Symb        | ol             | Address        | Comment  |
| Alway       | /s_On          | SM0.0          | Always ON  |
| High_       | Alarm          | V20.1          | High Alarm   |
| Low_        | Alarm          | V20.2          | Low Alarm  |
| PID_1       | Mode           | V20.0          | PID AUTO MAN Mode -1 = AUTO 0= MAN   |
| PID_0       | Out            | VW18           | PID Output   |
| PID_S       | SP_Auto        | VD10           | PID SP Auto  |
| PID_        | SP_Man         | VD14           | PID SP Manual Mode   |

Figure 13. Calling the PID subroutine

When the PID subroutine is called in the user program, the PID subroutine generated by the wizard can be double-clicked in the block of the instruction tree. In the local variable table, the interpretation and value range of the formal parameters can be seen.

- a. The PIDx\_CTRL subroutine must be enabled with SM0.0. No other conditions can be concatenated after SM0.0, and there must be no jumps over it. If the PIDx\_CTRL subroutine is called in a subroutine, the subroutine calling it must also Use only SM0.0 calls to keep it up and running.
- b. Enter the process value or analog value (feedback) here.
- c. Enter the set value variable address (VDxx) here, or directly input the set value constant. According to the setting in the wizard, 0.0-100.0, you should enter a real number of 0.0-100.0.
- d. Here V20.0 is used to control the PID hand/auto mode. When V20.0 is 1, it is automatic, and it is output from VW18 through PID operation. When V20.0 is 0, PID will stop calculation, and output is ManualOutput. This item does not appear if the PID manual function is not selected in the wizard.
- e. Here you can enter the variable address (VDxx) of the manual setpoint or enter the number directly. The value range is a real number between 0.0 and 1.0, representing the percentage of the output range. Example: If you enter 0.5, set it to 50% of the output. This item does not appear if the PID manual function is not selected in the wizard.
- f. Type the output address of the control amount here.
- g. When the high alarm condition is met, the corresponding output is set to 1. If the high alarm function is not enabled in the wizard, this item will not appear.
- h. When the low alarm condition is met, the corresponding output is set to 1. If the low alarm function is not enabled in the wizard, this item will not appear.

#### 2.3.2 PLC Programming

#### **Main Program Block**

Network 1: Scale Analog input with Input Min/Max Count (ISH & ISL) and Output Max / Min Range (OSH/OSL). Real Output converted to Int format for Provide PID PV.



#### Network 2: Initialize and monitor PID block by calling PID0\_CTRL.



| PID output Inte | eger is converte   | ed to Real for tuning display  |   |   |  |   |   |  |
|-----------------|--|--|---|---|--|---|---|--|
| Always_Or       | n:SM0.0  | PID_Out:VW18-IN  | I_DI<br>ENO<br>OUT  | -VD90   | VD90 (II   | DI_R<br>IN  | ENO<br>OUT-VD90   | ⊬  |
| Symbol          | Address  | Comment  |   |   |  |   |   |  |
| Always_On       | SM0.0  | Always ON  |   |   |  |   |   |  |
| PID_Out         | VW18   | PID Output   |   |   |  |   |   |  |
|                 | PID output Inte<br>Always_Or<br>Symbol<br>Always_On<br>PID_Out | PID output Integer is converte<br>Always_On:SM0.0<br>Symbol Address<br>Always_On SM0.0<br>PID_Out VW18 | PID output Integer is converted to Real for tuning display       Always_On.SM0.0       FID_Out:VW18       PID_Out:VW18       Symbol       Address       Comment       Aways_On       SM0.0       Always_On       SM0.0       Always_On       SM0.0       Always ON       PID_Out       YW18       PID_Out | PID output Integer is converted to Real for tuning display         I_DI           Always_On:SM0.0         I_DI           EN         EN           PID_Out:VW18         IN           OUT         OUT           Symbol         Address           Aways_On         SM0.0           Always_On         SM0.0           PID_Out:VW18         IN           OUT         VW18 | PID output Integer is converted to Real for tuning display         I_DI           Always_On:SM0.0         I_DI           PID_Out/W18-IN         OUT           PID_Out/W18-IN         OUT           Symbol         Address           Comment         Aways_ON           PID_Out         VW18           PID_Out         VW18 | PID output Integer is converted to Real for tuning display         Always_On:SM0.0       I_DI         EN       EN         PID_Out:VW18       IN         OUT       VD90         Symbol       Address         Comment         Always_On       SM0.0         Always_ON       SM0.0         PID_Out:VW18       IN         OUT       VD90         VD90       I | PID output Integer is converted to Real for tuning display         Always_On:SM0.0       I_DI         PID_Out:VW18       EN         PID_Out:VW18       OUT         VD90       VD90         Symbol       Address         Always_On       SM0.0         Always_ON       SM0.0         PID_Out       VW18         PID_Out       VD90         VD90       VD90 | PID output Integer is converted to Real for tuning display         Always_On:SM0.0       I_DI         EN       ENO         PID_Out/VW18-IN       OUT-VD90         VD90-IN       OUT-VD90         Symbol       Address         Comment       Always_ON         PID_Out       VW18         PID_Out       VW18         PID_Out       VW18 |

#### Network 3: PID output Integer is converted to Real for tuning display.

#### Network 4: PID Output Move to Analog Output.



#### Network 5 & 6: High Alarm and Low Alarm Logic.



#### Network 7: Call Auto Tune Subroutine.

| Call Auto_1 une | e Subroutine |         |                 |  |
|-----------------|--------------|---------|-----------------|--|
| Always_Or       | n:SM0.0      |         | Auto_Tune<br>EN |  |
|                 |              |         |                 |  |
| Symbol          | Address      | Comment |                 |  |

### Network 8: PLC ON and OFF Logic.

| PLC ON and OF | F Bit<br>SM0.0 | PLC_ON_OFF.V500.0    |
|---------------|----------------|----------------------|
| Symbol        | Address        | Comment              |
| Always_On     | SM0.0          | Always ON            |
| PLC_ON_OFF    | V500.0         | PLC On and Off State |





#### Auto Tune Subroutine

#### Network 1: Update Manual Enable Gain Value to PLC

| 1 | Update Manual E | nable Gain \ | /alue to PLC          |                   |                    |            |       |                |            |
|---|-----------------|--------------|-----------------------|-------------------|--------------------|------------|-------|----------------|------------|
|   | Always_On:S     | 3M0.0 A      | 4uto_Tune_Man:\/500.1 | UPDATE_PLC:V500.2 | AUTO_TUNE_T1:VD504 | EN<br>I-IN | MOV_R | ENO<br>OUT-PID | Gain:VD132 |
|   | Symbol          | Address      | Comment               |                   |                    |            |       |                |            |
|   | Always_On       | SM0.0        | Always ON             |                   |                    |            |       |                |            |
|   | Auto_Tune_M     | V500.1       | Manual Tune Enb/Disb  |                   |                    |            |       |                |            |
|   | AUTO_TUNE       | VD504        | AUTO Tune TAG 1       |                   |                    |            |       |                |            |
|   | PID0_Gain       | VD132        | Loop Gain             |                   |                    |            |       |                |            |
|   | UPDATE_PLC      | V500.2       | Update to PLC         |                   |                    |            |       |                |            |
|   |                 |              |                       |                   |                    |            |       |                |            |

#### Network 2: Update Manual Enable Int. time Value to PLC

| 2 | Update Manual E | Enable Int. tim | e Value to PLC       |          |           |                    |             |         |                |
|---|-----------------|-----------------|----------------------|----------|-----------|--------------------|-------------|---------|----------------|
|   | Always_On:S     | SM0.0 A         | uto_Tune_Man:V500.1  | UPDATE_P | LC:V500.2 |                    | MOV_R<br>EN | ENO     | — X            |
|   |                 |                 |                      |          |           | AUTO_TUNE_T2:VD508 | -IN         | OUT-PID | 0_I_Time:VD140 |
|   |                 |                 |                      |          |           |                    |             |         |                |
|   |                 |                 |                      |          |           |                    |             |         |                |
|   | Symbol          | Address         | Comment              | _        | _         |                    |             | _       |                |
|   | Always_On       | SM0.0           | Always ON            |          |           |                    |             |         |                |
|   | Auto_Tune_M     | V500.1          | Manual Tune Enb/Disb |          |           |                    |             |         |                |
|   | AUTO_TUNE       | VD508           | AUTO Tune TAG 2      |          |           |                    |             |         |                |
|   | PID0_I_Time     | VD140           | Integral Time        |          |           |                    |             |         |                |
|   | UPDATE_PLC      | V500.2          | Update to PLC        |          |           |                    |             |         |                |
|   |                 |                 |                      |          |           |                    |             |         |                |

#### Network 3: Update Manual Enable Derivative time Value to PLC

| 3 | Update Manual E | nable Deriva | tive time Value to PLC |                 |      |                 |    |       |       |                  |
|---|-----------------|--------------|------------------------|-----------------|------|-----------------|----|-------|-------|------------------|
|   | Always_On:S     | M0.0 A       | auto_Tune_Man:V500.1   | UPDATE_PLC:V500 | .2   |                 | EN | MOV_R | ENO   | K                |
|   |                 |              |                        |                 | AUTO | _TUNE_T3:VD512- | IN |       | OUT-P | 1D0_D_Time:VD144 |
|   |                 |              |                        |                 |      |                 |    |       |       |                  |
|   |                 |              |                        |                 |      |                 |    |       |       |                  |
|   | Symbol          | Address      | Comment                |                 |      |                 |    |       |       |                  |
|   | Always_On       | SM0.0        | Always ON              |                 |      |                 |    |       |       |                  |
|   | Auto_Tune_M     | V500.1       | Manual Tune Enb/Disb   |                 |      |                 |    |       |       |                  |
|   | AUTO_TUNE       | VD512        | AUTO Tune TAG 3        |                 |      |                 |    |       |       |                  |
|   | PID0_D_Time     | VD144        | Derivative Time        |                 |      |                 |    |       |       |                  |
|   | UPDATE_PLC      | V500.2       | Update to PLC          |                 |      |                 |    |       |       |                  |
|   |                 |              |                        |                 |      |                 |    |       |       |                  |

| Always_On:S                        | SMO.O                      | o Tune algorithm<br>Auto_Tune_Man:V500.1 | EN ENO<br>VD180-IN OUT-AUTO_ |  |
|------------------------------------|----------------------------|--|------------------------------|--|
|                                    | A data a se                | Ormania                                  |                              |  |
| Symbol                             | Address                    | Comment                                  |                              |  |
| Symbol<br>Always_On                | Address<br>SM0.0           | Always ON                                |                              |  |
| Symbol<br>Always_On<br>Auto_Tune_M | Address<br>SM0.0<br>V500.1 | Always ON<br>Manual Tune Enb/Disb        |                              |  |

#### Network 4: Gain value determined by Auto Tune algorithm.

#### Network 5: Integral time value determined by Auto Tune algorithm.

| 5 | Integral time value | e determined | by Auto Tune algorithm            |  |
|---|---------------------|--------------|-----------------------------------|--|
|   | Always_On:S         | M0.0 A       | uto_Tune_Man:V500.1<br>/ _ EN ENO |  |
|   | Symbol              | Address      | Comment                           |  |
|   | Always_On           | SM0.0        | Always ON                         |  |
|   | Auto_Tune_M         | V500.1       | Manual Tune Enb/Disb              |  |
|   | AUTO_TUNE           | VD508        | AUTO Tune TAG 2                   |  |

# Network 6: Deviation value calculated by algorithm if automatic calculation option set

| 6 | Deviation value ca | alculated by a | Igorithm if automatic calculation option set |          |       |     |
|---|--------------------|----------------|--|----------|-------|-----|
|   | Always_On:S        | M0.0 A         | uto_Tune_Man:V500.1                          | VD188-IN | MOV_R | ENO |
|   | Symbol             | Address        | Comment                                      |          |       |     |
|   | Always_On          | SM0.0          | Always ON                                    |          |       |     |
|   | Auto_Tune_M        | V500.1         | Manual Tune Enb/Disb                         |          |       |     |
|   | AUTO_TUNE          | VD512          | AUTO Tune TAG 3                              |          |       |     |

#### 2.3.3 PID Auto-Tune and PID Tune Control Panel

The PID Auto-Tuner is capable of determining suggested tuning values for both direct-acting and reverse-acting P, PI, PD, and PID loops.

The purpose of the PID Auto-Tuner is to determine a set of tuning parameters that provide a reasonable approximation to the optimum values for your loop. Starting with the suggested tuning values will allow you to make fine tuning adjustments and truly optimize your process.

#### **Auto-Hysteresis and Auto-Deviation**

The hysteresis parameter specifies the excursion (plus or minus) from set point that the PV (process variable) is allowed to make without causing the relay controller to change the output. This value is used to minimize the effect of noise in the PV signal to more accurately determine the natural oscillation frequency of the process. If you select to automatically determine the hysteresis value, the PID Auto-Tuner will enter a hysteresis determination sequence. This sequence involves sampling the process variable for a period of time and then performing a standard deviation calculation on the sample results.

In order to have a statistically meaningful sample, a set of at least 100 samples must be acquired. For a loop with a sample time of 200 msec, acquiring 100 samples takes 20 seconds. For loops with a longer sample time it will take longer. Even though 100 samples can be acquired in less than 20 seconds for loops with sample times less than 200 msec, the hysteresis determination sequence always acquires samples for at least 20 seconds.

Once all the samples have been acquired, the standard deviation for the sample set is calculated. The hysteresis value is defined to be two times the standard deviation.

#### **Auto-Tuning Sequence**

The auto-tuning sequence begins after the hysteresis and deviation values have been determined. The tuning process begins when the initial output step is applied to the loop output. This change in output value should cause a corresponding change in the value of the process variable. When the output change drives the PV away from set point far enough to exceed the hysteresis boundary a zero-crossing event is detected by the auto-tuner. Upon each zero crossing events the auto-tuner drives the output in the opposite direction.

The tuner continues to sample the PV and waits for the next zero crossing events. A total of twelve zero-crossings are required to complete the sequence. The magnitude of the observed peak-to-peak PV values (peak error) and the rate at which zero-crossings occur are directly related to the dynamics of the process.

Early in the auto-tuning process, the output step value is proportionally adjusted once to induce subsequent peak-to-peak swings of the PV to more closely match the desired deviation amount. The auto-tuning sequence will be terminated with an error, if the time between zero crossings exceeds the zero-crossing watchdog interval time. The default value for the zero-crossing watchdog interval time is two hours.

#### **PID Tuned Control Panel**

The PID control panel includes the following fields:

- Current values: The values of the SP (Set point), PV (Process Variable), OUT (Output), Sample Time, Gain, Integral time, and Derivative time are displayed. The SP, PV, OUT is shown in green, red, and blue, respectively; the same color legend is used to plot the PV, SP, and OUT values.
- Graphical display: The graphical display shows color-coded plots of the PV, SP, and Output as a function of time. The PV and SP share the same vertical scale which is located at the left-hand side of the graph while the vertical scale for the output is located on the right-hand side of the graph.
- Tuning Parameters: At the bottom left-hand side of the screen are the Tuning Parameters (Minutes). Here, the Gain, Integral Time, and Derivative Time values are displayed. You click in the "Calculated" column to modify any one of the three sources for these values.
- "Update CPU" button: You can use the" Update CPU" button to transfer the displayed Gain, Integral Time, and Derivative Time values to the CPU for the PID loop that is being monitored. You can use the "Start" button to initiate an auto-tuning sequence. Once an auto-tuning sequence has started, the "Start" button becomes a "Stop" button.

| PID Tune Contro | ol Panel   |             |             |             |            |                       |           | ×  |
|-----------------|------------|-------------|-------------|-------------|------------|-----------------------|-----------|----|
| Defined Loops   | Loop 0 (Lo | oop 0)      |             |             |            |                       |           |    |
|                 |            | 60s 55s 50s | 45s 40s 35s | 30s 25s 20s | 15s 10s 5s | ns                    |           |    |
|                 | 10.00      | )           |             | 203 203 203 |            | 100%                  |           |    |
|                 |            |             |             |             |            |                       |           |    |
|                 |            |             |             |             |            |                       |           |    |
|                 | 8.00       | )           |             |             |            | - 80%                 |           |    |
|                 |            |             |             |             |            |                       |           |    |
|                 |            |             |             |             |            |                       |           |    |
|                 | 6.00       | )           |             |             |            | - 60%                 |           |    |
|                 |            |             |             |             |            |                       |           |    |
|                 |            |             |             |             |            |                       |           |    |
|                 | 4.00       |             |             |             |            | -40%                  |           |    |
|                 |            |             |             |             |            |                       |           |    |
|                 |            |             |             |             |            |                       |           |    |
|                 | 2.00       | )           |             |             |            | - 20%                 |           |    |
|                 |            |             |             |             |            |                       |           |    |
|                 |            |             |             |             |            |                       |           |    |
|                 | 0.00       |             |             |             |            | L <sub>0%</sub>       |           |    |
|                 |            | SP          | PV (        | 9:26:32     | Out        | 1                     |           |    |
|                 | Scaling    |             |             |             | Tur        | ing Parameters        |           |    |
|                 |            | Low         | Value       | High        |            |                       |           |    |
|                 | SP         | 0.00        | 0.00        | 10.00       |            | Enable Manual Tuning  |           |    |
|                 | <b>.</b>   |             |             |             |            |                       |           |    |
|                 | PV:        | 0.00        | 0.00        | 10.00       |            | Current Cal           | u lated   |    |
|                 | OUT        | 0.00        | 0.00        | ,           |            |                       | uiateu    |    |
|                 | 001:       | 0.00        | 0.00        | 100.00      |            | Gain: 1.000 1.0       | )         |    |
|                 |            |             |             |             |            | Integral: 10,000 1 (  | ) minutes |    |
|                 | Compling   |             |             |             |            |                       |           |    |
|                 | Sampling   |             |             |             |            | Derivative: 0.000 1.0 | ) minutes |    |
|                 | Rate       |             | Sampl       | e Time      |            |                       |           |    |
|                 | 000        | 1 secon     | ds 1.00     |             |            | Start Update CF       | U         |    |
|                 | 1          | - Secon     | ,           |             |            |                       |           |    |
|                 |            | Pause       | Clear       |             |            |                       |           |    |
|                 |            |             |             |             | Adv        | anced Options         |           |    |
|                 |            |             |             |             |            | Options               |           |    |
|                 | Status     |             |             |             |            |                       |           |    |
|                 |            |             |             |             |            |                       |           |    |
|                 |            |             |             |             |            |                       |           |    |
|                 |            |             |             |             |            |                       |           |    |
|                 |            |             |             |             |            |                       | Clo       | se |
|                 |            |             |             |             |            |                       |           |    |

| Loop 0 (Lo  | 60s 55s 5   | Os 45s 40s   | s 35s 30  | 0s 25s 20s 15   | s 10s 5s 0               | )s,   |   |  |             |
|---|---|--|---|---|--------------------------|---|---|--|-------------|
| 10.00   |   | ·····  |   | ·····   | ·                        | -100%   |   |  |             |
| 8.00  | +   |  |   |   |                          | - 80%   |   |  |             |
|   |   |  |   |   |                          |   |   |  |             |
| 6.00  |   |  |   |   |                          | - 60%   |   |  |             |
| 4.00  | +   |  |   |   |                          | - 40%   |   |  |             |
| 2.00  |   |  |   |   |                          | 2004  |   |  |             |
| 2.00  |   |  |   |   |                          | - 20%   |   |  |             |
| 0.00  | SP  | PV   | 09:3  | 0:52  | Out                      | - 0%  |   |  |             |
| Scaling   | _ow   | Value  | Hic   | ah  | Tun                      | ing Paramete  | rs  |  |             |
| SP:   | 0.0   | 0  | 2.50  | 10.00   |                          | 🗹 Enable Mar  | nual Tuning   |  |             |
| PV:   | 0.0   |  | 1.00  | 10.00   |                          | Calar   | Current   | Calculated   | _           |
| 001.  | 0.0   | J   1  | 5.99  | 100.00  |                          | Gain:<br>Integral:  | 10.000  | 1.0  | <br>minutes |
| Sampling  |   |  |   |   |                          | Derivative:   | 0.000   | 1.0  | minutes     |
| Rate<br>000   | seco  | onds   | Sample Tir<br>1.00  | me  |                          | Start   | Upda  | ate CPU  |             |
|   | Pause   | Clea   | ar  |   | <b>A</b> .4-             | anood Onlin   |   |  |             |
| Chathar   |   | J  |   |   | Adv                      | Options.  |   |  |             |
| Status  |   |  |   |   |                          |   |   |  |             |
| rol Panel   | oop 0)  | Da 45a 400   | - 25- 26  | 0- 26- 20- 15   | - 10a Fa 0               |   |   |  |             |
| rol Panel<br>Loop 0 (Lo<br>10.00  | 90 <b>0 0)</b><br>60s 55s 5   | 0s 45s 40s   | s 35s 3   | 0s 25s 20s 15   | 5 10s 5s 0               | <sup>IS</sup> -100%   |   |  |             |
| rol Panel   | 000 0)<br>60s 55s 5   | Ds 45s 40s   | s_35s_3(  | 0 <u>s 25s 20s 15</u>   | 5.105.55.0               | <sup>15</sup> 100%  |   |  |             |
| rol Panel<br><b>Loop 0 (Lo</b><br>10.00<br>8.00   | 00 <b>0 0)</b>  | Ds 45s 40s   | 5 35s 3   | Ds 25s 20s 15   | 5. <u>105.5</u> 5.0      | <sup>IS</sup> 100%<br>-80%  |   |  |             |
| rol Panel<br><b>Loop 0 (Lo</b><br>10.00<br>8.00<br>6.00   | юр 0)<br>605 . 555 . 5  | Ds 45s 40:   | 5 355 31  | 0 <u>5 255 205 15</u>   | 5 105 55 C               | <sup>15</sup> 100%<br>- 80%<br>- 60%  |   |  |             |
| rol Panel<br><b>Loop 0 (L</b> 4<br>10.00<br>8.00<br>6.00  | 605 555 5   | Ds 45s 40s   | 5 <u>355 3</u> 1  | 0s 25s 20s 15   | s 10s 5s 0               | <sup>IS</sup> 100%<br>- 80%<br>- 60%  |   |  |             |
| rol Panel<br><b>Loop 0 (L</b><br>10.00<br>8.00<br>6.00<br>4.00  | юр 0)<br>605 555 5  | Ds. 45s. 40s   | 5 355 31  | 0 <u>5 255 205 15</u>   | 5 <u>105 55 C</u>        | <sup>IS</sup> 100%<br>-80%<br>-60%<br>-40%  |   |  |             |
| rol Panel<br><b>Loop 0 (Lt</b><br>10.00<br>8.00<br>6.00<br>4.00   | юр 0)<br>60 <u>5 555 5</u>  | Ds. 455 409  | 5 355 31  | 0s 25s 20s 15   | 5 105 55 C               | 15100%<br>- 80%<br>- 60%<br>- 40%   |   |  |             |
| rol Panel<br><b>Loop 0 (L</b><br>10.00<br>8.00<br>6.00<br>4.00<br>2.00  | юр 0)<br>605 555 5  | Ds. 45s. 40s   | 5 355 3   | 0s 25s 20s 15   | 5 <u>105 55 0</u>        | <sup>15</sup> 100%<br>-80%<br>-60%<br>-40%<br>-20%  |   |  |             |
| rol Panel<br><b>Loop 0 (Lt</b><br>10.00<br>8.00<br>6.00<br>4.00<br>2.00<br>0.00   | юр 0)<br>605, 555, 5<br>  | Ds 455 409   | 5 35 <u>5 3</u>   | Ds 255 205 15   | 5 <u>105</u> 55 <u>0</u> |   |   |  |             |
| rol Panel<br><b>Loop 0 (L</b><br><b>10.00</b><br>8.00<br>6.00<br>4.00<br>2.00<br><b>Scaling</b>   | юр 0)<br>605 555 5<br>  | Ds 45s 40s   | 5 <u>35</u> 53  | 0 <u>s 255 20s 15</u>   | 5 105 55 0               | I <sup>5</sup> 100%<br>-80%<br>-60%<br>-40%<br>-20%<br>-0%  |   |  |             |
| rol Panel<br><b>Loop 0 (Lt</b><br>10.00<br>8.00<br>6.00<br>4.00<br>2.00<br><b>Scaling</b><br>SP-  | op 0)<br>605, 555, 5<br>605, 555, 5<br>7<br>8<br>9<br>8<br>9<br>9<br>9<br>9<br>9<br>9<br>9<br>9<br>9<br>9<br>9<br>9<br>9<br>9<br>9<br>9  | Ds 45s 40<br>PV<br>Value<br>D  | 5.355.31<br>09:3-<br>0.9:3-   | 0s 25s 20s 15<br>   | 5. 105. 55 . 0           | <sup>15</sup> 100%<br>-80%<br>-60%<br>-40%<br>-20%<br>-0%<br>ing Paramete   | rs  |  |             |
| rol Panel<br><b>Loop 0 (L</b><br>10.00<br>8.00<br>6.00<br>4.00<br>2.00<br>0.00<br>Scaling<br>SP:<br>PV:   | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx  | Ds 45s 40s   | 5.355.31<br>09:3-<br>2.50  <br>2.00                                 | Ds 255 205 15<br>Ds 255 205 15<br>4:05<br>10.00<br>10.00              | 5 105 55 0               | <sup>IS</sup> 100%<br>• 80%<br>• 60%<br>• 40%<br>• 20%<br>• 0%<br>ing Paramete<br>Enable Mar                        | rs<br>nual Tuning   |  |             |
| rol Panel<br><b>Loop 0 (L</b><br>10.00<br>8.00<br>6.00<br>4.00<br>2.00<br><b>Scaling</b><br>SP:<br>PV:<br>OUT:                                  | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx  | Ds 45s 40s   | 5 355 3<br>09:3-<br>09:3-<br>10<br>2.50<br>2.00<br>9.40             | Ds 255 205 15<br>255 205 15<br>4:05<br>2h<br>10.00<br>10.00<br>100.00 | 5 105 55 0               | <sup>15</sup> 100%<br>-80%<br>-60%<br>-40%<br>-20%<br>-0%<br>ing Paramete<br>Enable Mar<br>Gain:                    | rs<br>nual Tuning<br>Current<br>1.000                                       | Calculated<br>1.0                                    |             |
| rol Panel<br>Loop 0 (L<br>10.00<br>8.00<br>6.00<br>4.00<br>2.00<br>Scaling<br>SP:<br>PV:<br>OUT:  | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx  | Ds 45s 40s   | 5.355.3<br>09:3<br>2.50<br>9.40                                     | 0s 25s 20s 15<br>0s 25s 20s 15<br>10.00<br>10.00<br>100.00            | 5. 105. 55 . 0           | I <sup>S</sup> 100%<br>-80%<br>-60%<br>-40%<br>-20%<br>-0%<br>ing Paramete<br>⊡ Enable Mar<br>Gain:<br>             | rs<br>nual Tuning<br>Current<br>1.000<br>10.000                             | Calculated<br>1.0<br>1.0                             | minutes     |
| rol Panel<br><b>Loop 0 (L</b><br><b>10.00</b><br>8.00<br>6.00<br>4.00<br>2.00<br><b>Scaling</b><br>SP:<br>PV:<br>OUT:<br>Sampling               | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx  | Ds 45s 40s   | 5 35s 3<br>09:3<br>09:3<br>2.50<br>2.00<br>9.40                     | Ds 255 205 15<br>Ds 255 205 15<br>4:05<br>10.00<br>100.00             | 5 105 55 0               | I <sup>5</sup> 100%<br>80%<br>60%<br>40%<br>20%<br>○0%<br>Ing Paramete<br>Gain:<br>Integral:<br>Derivative:         | rs<br>nual Tuning<br>Current<br>1.000<br>10.000<br>0.000                    | Calculated<br>1.0<br>1.0                             | minutes     |
| rol Panel<br>Loop 0 (Lu<br>10.00<br>8.00<br>6.00<br>4.00<br>2.00<br>Scaling<br>SP:<br>PV:<br>OUT:<br>Sampling<br>Rate<br>1                      | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx  | Ds 45s 40s   | 5. 355. 31<br>09:3<br>2.00 [<br>9.40 [<br>5ample Tir<br>1.00        | 0s 25s 20s 15<br>25s 20s 15<br>10.00<br>10.00<br>100.00<br>me         | 5. 105. 55 . 0           | I <sup>S</sup> 100%<br>80%<br>60%<br>40%<br>20%<br>○0%<br>ing Paramete<br>Gain:<br>Integral:<br>Derivative:<br>Ston | rs<br>nual Tuning<br>Current<br>1.000<br>10.000<br>0.000                    | Calculated<br>1.0<br>1.0<br>1.0<br>1.0<br>1.0<br>1.0 | minutes     |
| rol Panel<br>Loop 0 (L4<br>10.00<br>8.00<br>6.00<br>4.00<br>2.00<br>0.00<br>Scaling<br>SP:<br>PV:<br>OUT:<br>Sampling<br>Rate<br>1              | xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx  | Ds         45s         40s           PV         Value         0           D         0         1           D         0         1           S         1         1           S         1         1           S         1         1  | 09:3-<br>09:3-<br>2.50<br>2.00<br>9.40<br>5ample Tir<br>1.00        | Ds 255 205 15<br>255 205 15<br>4:05<br>2h<br>10.00<br>100.00<br>ne    | 5 105 55 0               | ISTIO0% 80% 60% 60% 20% 20% 0% Enable Mar Gain: Integral: Derivative: Stop  | rs<br>nual Tuning<br>Current<br>1.000<br>10.000<br>0.000                    | Calculated<br>1.0<br>1.0<br>1.0<br>ite CPU           | minutes     |
| rol Panel<br>Loop 0 (L<br>10.00<br>8.00<br>6.00<br>4.00<br>2.00<br>0.00<br>Scaling<br>SP:<br>PV:<br>OUT:<br>Sampling<br>Rate<br>1               | op 0)<br>605. 555. 5<br>605. | Ds         45s         40s           Ds         45s         40s           PV         Value         0           D         1         1           0         1         1           0         1         1           0         1         1           0         1         1           0         1         1   | s, 35s, 34<br>09:3-<br>2.00 [<br>9.40 ]<br>Sample Tir<br>1.00<br>ar | Ds 255 205 15<br>255 205 15<br>4:05<br>2h<br>10.00<br>100.00<br>me    | 5 105 55 0               | I <sup>5</sup> 100% 80% 60% 60% 20% 20% 0% Ing Paramete Gain: Integral: Derivative: Stop anced Option               | rs<br>nual Tuning<br>Current<br>1.000<br>0.000<br>0.000<br>Upda             | Calculated<br>1.0<br>1.0<br>1.0<br>ite CPU           | minutes     |
| rol Panel<br>Loop 0 (L<br>10.00<br>8.00<br>6.00<br>4.00<br>2.00<br>0.00<br>Scaling<br>SP:<br>PV:<br>OUT:<br>Sampling<br>Rate<br>1<br><br>Status | xop 0)           60s. 55s. 5           60s. 55s. 5           50   | Ds         45s         40s           PV         Value         0           Do         1         0           Do         1         0           Oo         1         0 | 09:3-<br>09:3-<br>2.00 [<br>9.40 ]<br>5ample Tir<br>1.00<br>ar      | 0s 25s 20s 15<br>0s 25s 20s 15<br>10.00<br>10.00<br>100.00<br>ne      | 5 105 55 0               | Istop   | rs<br>nual Tuning<br>Current<br>1.000<br>10.000<br>0.000<br>0.000<br>s<br>s | Calculated<br>1.0<br>1.0<br>1.0<br>te CPU            | minutes     |

## 2.4 Error handling

- a. A compile error occured, check non-fatal errors for more information.
- For resolving this type of error change your Region and Language in control panel and restart your computer and download.
- b. This POU contains one or more invalid references to parameterized subroutines.
- > For resolving this, delete present PID block and add new one.

## **3** Operation of the application example

### 3.1 Overview

## Overview and description of the interface



The user interface is made up of 6 menus:

- Start screen (overview)
- Trend view
- Monitoring
- Configuration
- Simulation
- Settings

#### 3.1.1 Overview (start screen)

The overview screen provides information on the topic dealt with.

Configuration is performed with STEP 7 V15.1 (TIA Portal). The operation of the right menu bar is also explained. It is available in every screen



Takes you to the overview screen (this screen).



Takes you to the trend view.



Takes you to the monitoring.



Takes you to the configuration.



Takes you to the simulation.



Takes you to the system functions.

With F8 you can switch between German and English.

The currently selected menu is indicated by the orange background of the symbol: e.g.

(for the overview screen) or the title in the header line (left):

#### 3.1.2 Trend view

| Auto Tune | :           |                         |         |                         |                |                         | 6/11/2  | 019 2:16:3              | 7 PM |        |
|-----------|-------------|-------------------------|---------|-------------------------|----------------|-------------------------|---------|-------------------------|------|--------|
| Input:    | +0          | Setpoint:               | 0       | Man Setpoint:           | 0              | MAN                     | Output: | +0.0 %                  | %    |        |
| 100       |             |                         |         |                         |                |                         |         |                         | 100  |        |
| 80-       |             |                         |         |                         |                |                         |         |                         | -80  |        |
|           |             |                         |         |                         |                |                         |         |                         |      |        |
| 60-       |             |                         |         |                         |                |                         |         |                         | -60  | $\leq$ |
| 40-       |             |                         |         |                         |                |                         |         |                         | -40  | (V)    |
|           |             |                         |         |                         |                |                         |         |                         |      | U      |
| 20-       |             |                         |         |                         |                |                         |         |                         | -20  |        |
| 0         |             |                         |         |                         |                |                         |         |                         | LO   |        |
| 2:15:08   | 8 PM<br>019 | 2:15:31 PM<br>6/11/2019 |         | 2:15:53 PM<br>6/11/2019 |                | 2:16:16 PM<br>6/11/2019 | 2       | 2:16:38 PM<br>5/11/2019 |      |        |
| Scaling   | ):<br>      | ) / = li i =            | L Barla | Tunin                   | ng Paramet     | ers                     |         | ,                       |      |        |
|           | LOW         |                         | High    | - <b>I</b>              | -<br>nable Mar | nual Tuning             |         |                         |      | $\leq$ |
| SP:       | 0.00        | 0.00                    | 0100.00 |                         |                |                         |         |                         |      |        |
| PV:       | 0.00        | 0.00                    | 0100.00 | י ר                     | Jain           | +0.00                   |         | 5.00                    |      |        |
|           |             |                         |         |                         | [ntegral       | +0.00                   |         | 0.00 M                  | lin  |        |
| OUT:      | 0.00        | 0.00                    | 0100.00 | J,                      | Derivative     | +0.00                   |         | 0.00 N                  | tin  |        |
| Samplin   | ng: Sar     | mple time               |         |                         | Servative      |                         |         |                         |      |        |
|           |             | 0                       |         |                         |                | Start                   | Upda    | te CPU                  |      |        |
|           | _           |                         |         | Adva                    | nce Option     | Option                  |         |                         |      |        |
|           |             |                         |         |                         |                |                         |         |                         |      |        |

The "Trend view" image shows the time course over 90 seconds. of the setpoint **Setpoint** (scale left)

- of the process value Input (scale left)
  - the manipulated variable Output (scale right)

#### Manual mode

Use to change to manual mode.

In manual mode, you can enter the manipulated variable directly via the manual value (value range 0 to 100).

### Automatic mode

Use **LAUTO** to change to automatic mode.

Use Setpoint: 0000 to set the setpoint in automatic mode.

•

•

#### 3.1.3 Monitoring

The monitoring screen shows the online status of the PID.

| Monitoring |               |           | 6/11/2019 11:41:48 AM |  |
|------------|---------------|-----------|-----------------------|--|
|            | PID0 C        | TRL       |                       |  |
|            | EN            |           |                       |  |
|            |               |           |                       |  |
| +0         | PV_I          | Output    | +0                    |  |
| +0.000     | Setpoint      | HighAlarm |                       |  |
| MAN        | Auto_Manual   | LowAlarm  |                       |  |
| +0.000     | Manual_Output |           |                       |  |

You can view all input and output values.

Edit the following parameters:

- PV\_I value.
- Setpoint in automatic mode.
- On/Off switching of manual operation.
- Manual Output value.

#### 3.1.4 Configuration

The configuration mask is based on the basic settings of the configuration wizard.



Here you can change the following settings during runtime:

Basic settings

Process value settings

Process value limits

Editing the upper and lower limits of the process value



Process value scaling.

Editing of analog and scaled upper and lower process values



Output value limits.

Editing the upper and lower limits of the output value



#### 3.1.5 Simulation



The block diagram of the PID control is shown with:

- The setpoint "Input" as floating-point number.
- The output of the manipulated variable as a percentage floating point number "Output".

#### 3.1.5 Settings

- The settings menu consists of the following screens
- System time / CPU
- Brightness
- User
- System

| Settings        |                                      | 6/11/2019 11:46:02 AM |     |
|-----------------|--------------------------------------|-----------------------|-----|
|                 | System time                          |                       |     |
| System time/PLC | Date and Time: 6/11/2019 11:46:02 AM |                       |     |
| 🔆 Brightness    | write to PLC                         |                       |     |
| L User view     |                                      |                       | (Ç) |
| System          |                                      |                       |     |
| Current User:   | PLC                                  |                       |     |
|                 | PLC mode:                            |                       |     |
| German          | STOP                                 |                       |     |
| English         |                                      |                       | _   |
| Exit            |                                      |                       |     |
|                 |                                      |                       |     |



#### Time setting/CPU

The application example has a time synchronization between CPU and HMI.



The current CPU operating state is displayed via

# 4 Appendix

### 4.1 Service and support

#### **Industry Online Support**

Do you have any questions or need assistance?

Siemens Industry Online Support offers round the clock access to our entire service and support know-how and portfolio.

The Industry Online Support is the central address for information about our products, solutions and services.

Product information, manuals, downloads, FAQs, application examples and videos – all information is accessible with just a few mouse clicks: <u>support.industry.siemens.com</u>

#### **Technical Support**

The Technical Support of Siemens Industry provides you fast and competent support regarding all technical queries with numerous tailor-made offers

 ranging from basic support to individual support contracts. Please send queries to Technical Support via Web form:

www.siemens.com/industry/supportrequest

#### SITRAIN – Training for Industry

We support you with our globally available training courses for industry with practical experience, innovative learning methods and a concept that's tailored to the customer's specific needs.

For more information on our offered trainings and courses, as well as their locations and dates, refer to our web page:

www.siemens.com/sitrain

#### Service offer

Our range of services includes the following:

- Plant data services
- Spare parts services
- Repair services
- On-site and maintenance services
- Retrofitting and modernization services
- Service programs and contracts

You can find detailed information on our range of services in the service catalog web page:

support.industry.siemens.com/cs/sc

#### Industry Online Support app

You will receive optimum support wherever you are with the "Siemens Industry Online Support" app. The app is available for Apple iOS, Android and Windows Phone: <u>support.industry.siemens.com/cs/ww/en/sc/2067</u>

## 4.2 Support

Siemens Ltd DI FA AS Thane Belapur Road Thane 400601, India

Application Center SUP FA Email: rginslpresales-fa.in@siemens.com

# 4.3 Links and literature

Table 4-1

| No. | Торіс   |
|-----|---|
| \1\ | Siemens Industry Online Support                             |
|     | https://support.industry.siemens.com                        |
| \2\ | Link to this entry page of this application example         |
|     | https://support.industry.siemens.com/cs/ww/en/view/Entry ID |
| \3\ |   |

# 4.4 Change documentation

Table 4-2

| Version | Date    | Modifications |
|---------|---------|---------------|
| V1.0    | MM/YYYY | First version |
|         |         |               |
|         |         |               |