Z. Add-on notes:

Z-1 Newly added instructions

FNC No.	Instruction Title			Function	Applicable PLC Type		
	D		P		M	VB	VH
88		PID		PID control loop		○	
92		TPID		Temperature PID Control		○	
149		MBUS		MODBUS Communication		○	○
169		HOUR		Hour Meter		○	

FNC 88 PID	PID S1 S2 S3 D	PID control loop	M	VB	VH
				○	

Operand	Devices															
	X	Y	M	S	KnX	KnY	KnM	KnS	T	C	D	SD	P	V,Z	K,H	VZ index
S1											○					
S2											○					
S3											○					
D											○					

- S3 occupies 25 consecutive registers

```
        S1 S2  S3   D
  X0
──┤ ├──[PID D0 D1 D100 D200]
```

S1 : Set point value (SV)
S2 : Measured current value (PV)
S3 : The initiatory ID number of the parameters
D : Output value in destination device (MV)

- This instruction takes a current value from S2 and compares it to a predefined set value S1 , then uses the parameters (initiated with S3) to process the PID operation. The calculate result will be stored to destination register D .
- When X0= “ON”, this instruction starts to perform; When X0= “OFF”, this process stops but the content value of D200 will be kept as the current value before X0= “OFF”.
- The PID instruction’s parameters are headed from S3 , which require occupy 25 consecutive registers.
- When the control parametesr S1 or S3 +3 ~ S3 +6 of setting values are changed, can rerun the PID instruction for the instant response of output value D .
- There’s no limitation on the times used of the PID instruction.
- This instruction provided with the “Auto-tuning” function, it can help users to decide three of parameters in the PID instruction. (Please refer to follow pages.)
- Ecause the PID instruction uses the PLC's program Scan Time to accumulate the sampling time, to plan the program must pay attention on two following points:

  ① Even though, this instruction is allow to use it in a subroutine, interrupted subroutine, step ladder chart or conditional jump instructions, But at some of the PID instruction's processing duration, must make sure at every Scan Time of the program, it has been processed this instruction once. If this instruction has been processed more than once or had not been executed, it will cause some estimate error on the sampling time.

  ② When the sampling time is shorter than a Scan Time, it would make a PID process error. Then the PLC automatically sets the “sampling time = Scan Time” to execute the PID process.
- All the parameters must finished the settings before the PID instruction executes.

The Equations of the PID Instruction

This instruction is according to the differential of speed, to operation the PID instruction, the equations are shown in the table below:

Direction of Operation	The Equations of the PID Instruction
"Forward" $PV_{nf} > SV$	$\triangle MV = K_P \{ (EV_n - EV_{n-1}) + \frac{T_S}{T_I} EV_n + D_n \}$ $EV_n = PV_{nf} - SV$ $PV_{nf} = \alpha PV_{nf-1} + (1-\alpha) PV_n$ $D_n = \frac{T_D}{T_S + K_D \cdot T_D} (-2PV_{nf-1} + PV_{nf} + PV_{nf-2}) + \frac{K_D \cdot T_D}{T_S + K_D \cdot T_D} \cdot D_{n-1}$ $MV_n = \Sigma \triangle MV$
"Reverse" $SV > PV_{nf}$	$\triangle MV = K_P \{ (EV_n - EV_{n-1}) + \frac{T_S}{T_I} EV_n + D_n \}$ $EV_n = SV - PV_{nf}$ $PV_{nf} = \alpha PV_{nf-1} + (1-\alpha) PV_n$ $D_n = \frac{T_D}{T_S + K_D \cdot T_D} (2PV_{nf-1} - PV_{nf} - PV_{nf-2}) + \frac{K_D \cdot T_D}{T_S + K_D \cdot T_D} \cdot D_{n-1}$ $MV_n = \Sigma \triangle MV$

EV_n : The current error value
EV_{n-1} : The previous error value
SV : The set point value (S_1)
PV_n : The current process value (S_2)
PV_{nf} : The calculated process value
PV_{nf-1} : The previous process value
PV_{nf-2} : The second previous process value
$\triangle MV$: The change in the output manipulation values
MV_n : The current output manipulation value (D)

D_n : The derivation value
D_{n-1} : The previous derivation value
K_P : The proportion constant
α : The constant of input filter
T_S : The sampling time
T_I : The integral time constant
T_D : The time derivative constant
K_D : The derivative filter constant

- The description of parameters (S_3 ~ S_3 +24)

Para-meter	Parameter Name/Function	Description		Setting range
S_3	Sampling time (Ts)	The time interval should longer than the Scan Time and the current Process Value of the system		1 ~ 32767mS
S_3+1	Direction of action-reaction and alarm control	b0	0: "Forward" operation	—
			1: "Reverse" operation	
		b1	0: Process Value (PV_{nf}) alarm disable	
			1: Process Value (PV_{nf}) alarm enable	
		b2	0: Output Value (MV) alarm disable	
			1: Output Value (MV) alarm enable	
		b3	Reserved	
		b4	0: Disable the Auto-tuning	
			1: Enable the Auto-tuning, it will reverting to 0 after the Auto-tuning is finished	
		b5	0: Disable the limit of the output range	
			1: Enable the limit of the output range	
		b6 ~ b15	Reserved	
S_3+2	Input filter (α)	Alters the effect of the input filter to smooth the changes of measured current value		0 ~ 99%
S_3+3	Proportional gain (K_P)	This is the P (Proportional) part of the PID loop		1 ~ 32767%
S_3+4	Integral time constant (T_I)	This is the I (Integral) part of the PID loop, (this parameter disables the I effect if it is set to "0")		(0 ~ 32767) ×100mS
S_3+5	Derivative gain (K_D)	This is a factor used to align the derivative output in a know proportion to the change in the Process Value (PV_{nf})		0 ~ 100%
S_3+6	Derivative time constant (T_D)	This is the D (Derivative) part of the PID loop, (this parameter disables the D effect if it is set to "0")		(0 ~ 32767) ×10mS
S_3+7 ~ S_3+19	Working space	Reserved for the internal processing of the PID instruction		—
S_3+20	Process Value (PV_{nf}) changed alarm (+)	Maximum limit of positive change (upper limit); Active when S_3+1's b1= "ON"(1)		0 ~ 32767
S_3+21	Process Value (PV_{nf}) changed alarm (−)	Maximum limit of negative change (lower limit); Active when S_3+1's b1= "ON"(1)		
S_3+22	Output Value (MV) changing alarm (+)	Maximum limit of positive change (upper limit); Active when S_3+1's b2="ON"(1)		0 ~ 32767
	The range limit of Output Value (MV) change (+)	The range limit of the Output Value (MV) maximum positive change (upper limit); Active when S_3+1's b5= "ON"(1)		− 32768 ~ 32767
S_3+23	Output Value (MV) changing alarm (−)	Maximum limit of negative change (lower limit); Active when S_3+1's b2= "ON"(1)		0 ~ 32767
	The range limit of Output Value (MV) change (−)	The range limit of the Output Value (MV) maximum negative change (lower limit); Active when S_3+1's b5= "ON"(1)		− 32768 ~ 32767
S_3+24	Alarm flags (for read only)	b0	High limit exceeded in Process Value (PV_{nf})	—
		b1	Below low limit for the Process Value (PV_{nf})	
		b2	Excessive positive change in Output Value (MV)	
		b3	Excessive negative change in Output Value (MV)	

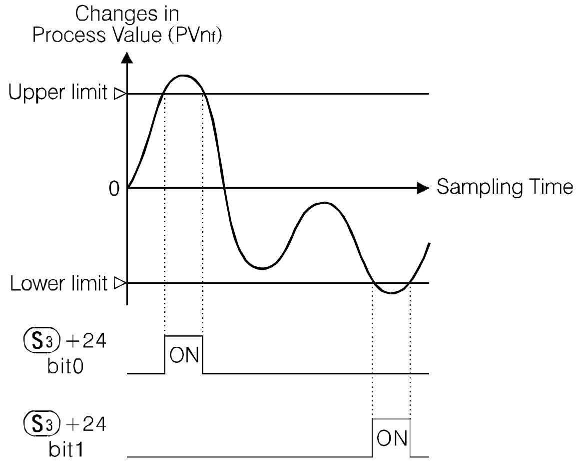
- S_3 +1's b2 and b5 should not be active at the same time.
- When any one of the S_3 +1's b1, b2 or b5 is "ON", the parameters of the PID instruction of S_3 will occupy S_3 ~ S_3 +24 total 25 consecutive registers.
- When all of the S_3 +1's b1, b2 and b5 are "OFF", the parameters of the PID instruction of S_3 will occupy S_3 ~ S_3 +19 total 20 consecutive registers.

The Description of "Forwar"d and "Reverse" Operation

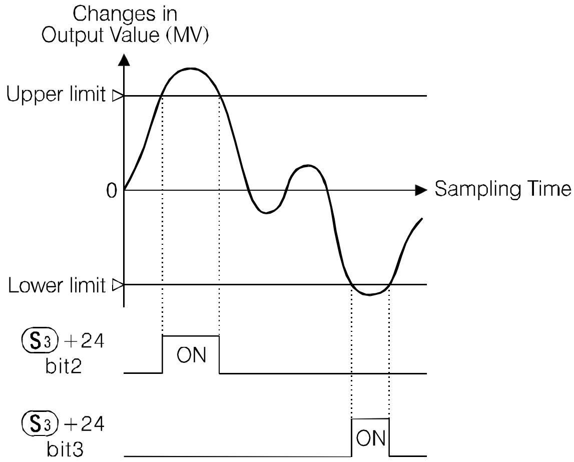
- If the parameter of S3 +1's b0= "OFF" then the PID instruction will process the "Forward" operation; If the parameter of S3 +1's b0="ON" then the PID instruction will process the "Reverse" operation.
- When the calculated Process Value (PVnf) > the Set Point Value (SV), it will generate a positive deviation and increase the control effect is called "Forward" operation.
  ex. An air conditioning system: before the system turns on, usually the indoor temperature is higher than the set point value. (PVnf) > (SV), this is a typical "Forward" operation control sample.
- When the calculated Process Value (PVnf) < the Set Point Value (SV), it will generate a negative deviation and increase the control effect is called "Reverse" operation.
  ex. An oven: before the heater of the oven turns on, usually the temperature of the oven is lower than the set point value. (PVnf) < (SV), this is a typical "Reverse" operation control sample.

The Description of Process Value (PVnf) Changed Alarm And Output Value (MV) Changing Alarm Functions

- If the of S3+1's b1= "ON", PID instruction provides the Process Value (PVnf) changed alarm. The parameters setting of the Process Value's changed alarm are stored in S3+20 and S3 +21 then the results will put in S3+24's b0 and b1. The content of S3+21 is used as a negative value.
- If the S3+1's b2= "ON", PID instruction provides the Output Value (MV) changing alarm. The parameters setting of the Output Value's changing alarm are stored in S3 +22 and S3+23 then the results will put in S3 +24's b2 and b3. The content of S3+23 is used as a negative value.
- The definition of the change in Manipulation Values: Change = (Current value) – (Previous current value)
- The diagram of Process Value (PVnf) change:

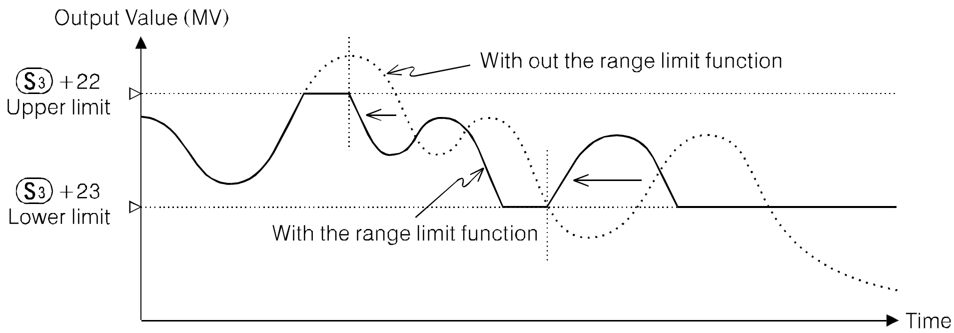


- The diagram of Output Value (MV) change:



The Description of Process Value (PVnf) Changed Alarm And Output Value (MV) Changing Alarm Functions

- If the parameter of S3+1's b5= "ON", the PID instruction provides the range limit function of Output Value (MV) changing. The parameters setting of the Output Value's changing limits are store in S3 +22 and S3 +23.
- As a result both (limit and alarm) of the functions are occupy the same parameter registers S3 +22 and S3 +23. So, only one of the functions can be selected, the parameters in S3 +1's b2 and b5 should not be "ON" at the same time.
- This function is very useful for limit the raise of the PID derivative value.
- The diagram of the range limit function of Output Value (MV) changing:



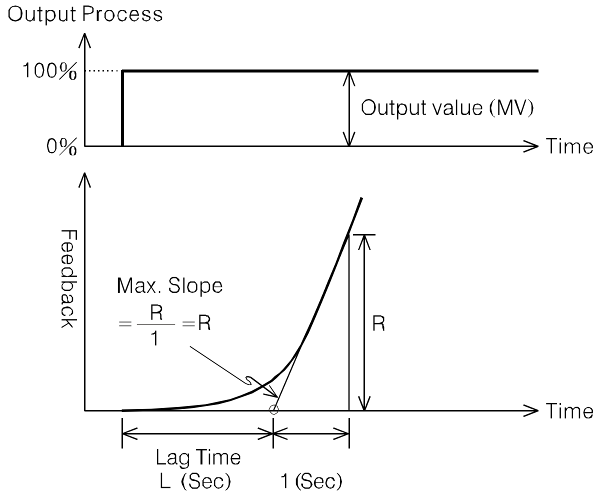
The Error Information of the PID Instruction

- If a setting value of parameter is not correct or the operation of a PID instruction occurs error, the special coil M9067 will be turned "ON". And the special register D9067 will store the error code.

Error Code	Error Occurrence	Treatment
6730	The setting value of Sampling Time (Ts) is beyond the range ($T_S < 1$)	The PID instruction stops operation
6732	The setting value of Input Filter (α) is beyond the range ($\alpha < 0$ or $\alpha >= 0$)	
6733	The setting value of Proportion Constant (K_P) is beyond the range ($K_P < 1$)	
6734	The setting value of Integral Time constant (T_I) is beyond the range ($T_I < 0$)	
6735	The setting value of Derivative Filter Constant (K_D) is beyond the range ($K_D < 0$ or $K_D > 100$)	
6736	The setting value of Time Derivative Constant (T_D) is beyond the range ($T_D < 0$)	
6740	The Sampling Time <= The Scan Time of PLC	The PID instruction keeps operation
6742	The variance of current Process Value is too large ($\triangle PV < -32768$ or $\triangle PV > 32767$)	
6743	The variance of current Error Value is too large ($\triangle EV < -32768$ or $\triangle EV > 32767$)	
6744	The calculating value of Integral process exceeds –32768 ~ 32767	
6745	The value of Proportion Constant (K_P) is too large, it cause the calculating value of proportion which exceeds the range	
6746	The calculating value of Derivative process exceeds –32768 ~ 32767	
6747	The calculating result value of the PID instruction which exceeds –32768 ~ 32767	

The Method to Get The Parameters of a PID Instruction

- For a better control result of a PID instruction, we should get the correct parameters of the PID operation. It means we need to find the apropos values of Proportion Constant (K_P), Integral Time constant (T_I) and Time Derivative Constant (T_D).
- To get those three parameters, we have many different ways, usually the method of Process/Feedback Loop will be used. The following is the reference.
- The method of Process/ Feedback Loop gets the parameters is through step by step to control the system output between 0 ~ 100%. And then, observes the variation between processes and feedbacks, by those dynamic characteristics gets the parameters of PID.



Use the curve to get the PID's parameters

Control Method	Proportion Constant K_P(%)	Integral Time Constant T_I (× 100ms)	Time Derivative Constant T_D (× 10 ms)
P	$\frac{1}{RL}$ × Output value (MV)	—	—
PI	$\frac{0.9}{RL}$ × Output value (MV)	33L	—
PID	$\frac{1.2}{RL}$ × Output value (MV)	20L	50L

Auto-tuning Function

- The VB series provided the Auto-tuning function which can uses some PID correlative parameters from user (such as: the direction of action S3 +1, Sampling Time Ts, constant of Input Filter (α), Derivative Filter Constant K_D and Set Point Value S1) then via the PID instruction executes the Auto-tuning function, the system will get three important parameters of PID.
- The Auto-tuning function can help user to get those three important parameters of the PID then to simplify the operation of PID instruction.
- This instruction is using relay "ON"/"OFF" to execute the Auto-tuning function, then evaluates three important parameters of the PID: Proportional gain (K_P), Integral time constant (T_I), Derivative time constant (T_D).
- The steps to execute the Auto-tuning function:

① Input the direction of action S3 +1, Sampling Time Ts, constant of Input Filter (α), Derivative Filter Constant K_D and Set Point Value S1.

② Input the parameters S3 +14 and S3 +15.

Parameters	Parameter Name/Function	Description
S3 +14	The Max. Output Value	The output value when it is at 100% output operation
S3 +15	The Mini. Output Value	The output value when it is at 0% output operation

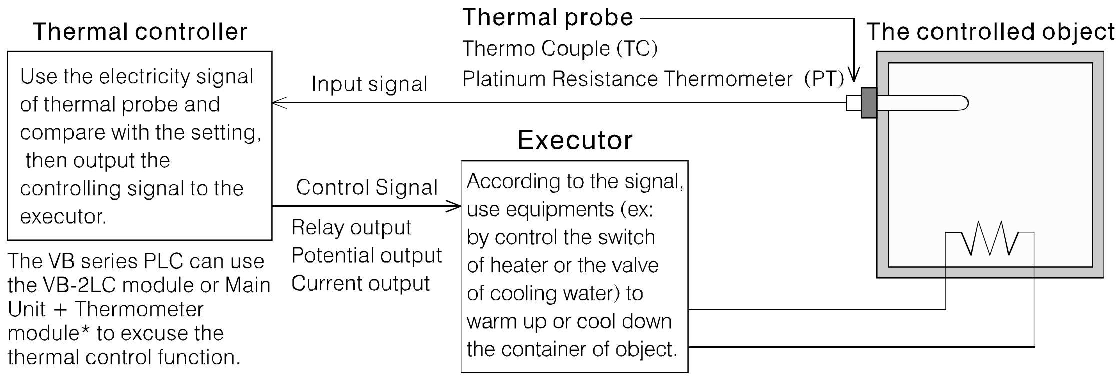
③ Let the parameter of S3 +1's b4= "ON", then it will start to execute the Auto-tuning operation.

④ When the Auto-tuning operation is finished, the parameter of S3 +1's b4 will automatically turned "OFF".

The General Idea of Thermal Control

Usually use the PID instruction contain in a PLC control system is for the thermal control. The following pages are the brief expositions about the thermal control.

- The construct of a thermal control system



※ The VB series PLC provide various thermometer module:

VB-8T ：8 points K or J type Thermo Couple input thermometer module.
VB-4T ：4 points K or J type Thermo Couple input thermometer module.
VB-4PT：4 points 3 wires PT-100 / 3850 ppm/°C input thermometer module.
VB-2PT：2 points 3 wires PT-100 / 3850 ppm/°C input thermometer module.

- The brief explanation of the thermal control

  To set up the set piont value of thermal controller and let it functioning. The object may not steady changing the temperature immediately to the target temperature because the characteristic of the object.

  In general, to expedite the responsive speed, it may cause overheat or waved temperature control. If want to reduce the those reaction, we should lower the volume of the response.

  Some of the perform is like the Chart (1), which wants to control the temperature to the set point value as soon as possible. Under this condition, the temperature of object may overshooting the set point value, so it can be used only at the object is not concerned about overheat.

  Some of the perform is like the Chart (2), which spends more time to get the smoothly thermal control. It is required the suppression of overshooting, so the longer time is required for stabilize temperature.

  The Chart (3) is showing a compromise curve. That has an ideal responsive value, so it is the most popular type.

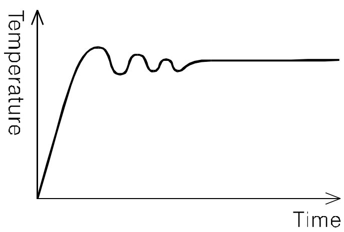


Chart (1), the Overshooting and Waving Response

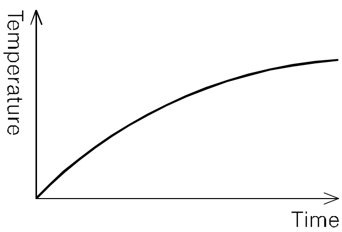


Chart (2), the Inert Response

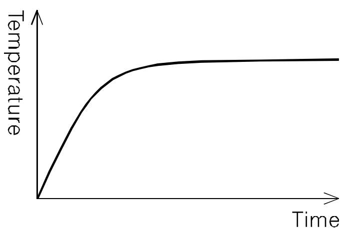


Chart (3), the Ideal Response

- The brief explanation of the thermal control

  For the purpose of an ideal thermal control, when choose a thermal sensor and pick the controlling parameters, it is necessary to fully understand the characteristics of controlled object.

  (1) Heat Capacity： How difficult to change the temperature, it may relate to the size of object.

  (2) Heating Static Characteristics：It is indicate the capability of heating, which depends on the output capacity of heater.

  (3) Initially Dynamic Characteristic：At the beginning of heating, the characteristic of temperature changing which is complicated relationship with container and heater.

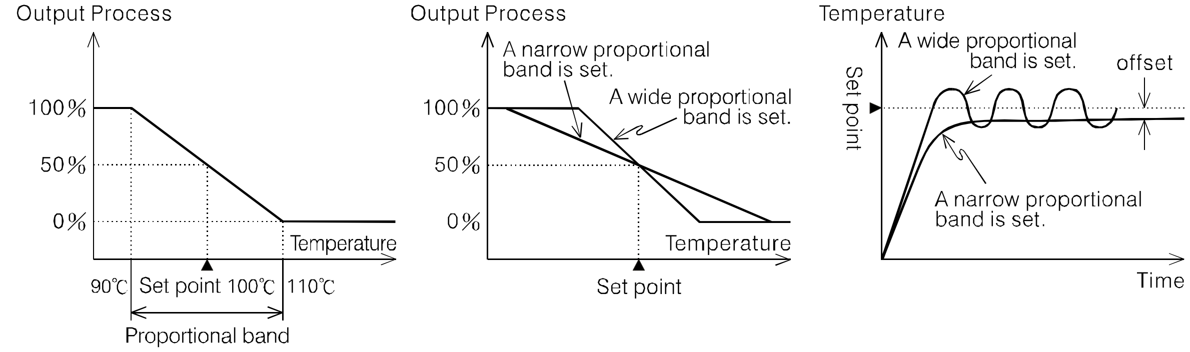
  (4) External Disturbances : Some of the interference changes the temperature. ex. a door of the constant temperature furnace is opened.

- The PID Parametric Explanations

(1) P (Proportional Control) Action

The control action is used for obtaining the output in proportion to the input.

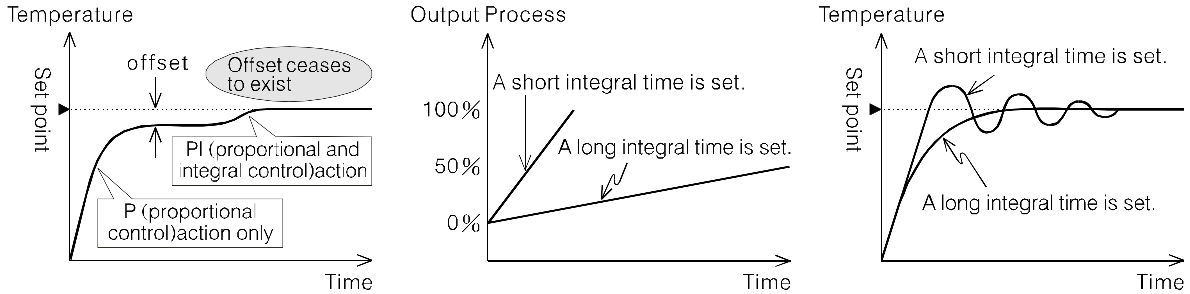
In a normal operation, a 100% control output will be "ON" if the process value is lower than the proportional band. The control output will be decreased gradually in proportion to the deviation if the process value is within the proportional band, and a 50% control output will be "ON" if the set point coincides with the process value.



(2) I (Integral Control) Action

It helps to achieve control at the set point and used for obtaining the output in proportion to the time integral value of the input.

P action causes an offset. Therefore, if proportional control action and integral control action are used in combination, the offset will be reduced as the time goes by until finally the control temperature will coincide with the set point and the offset will cease to exist.

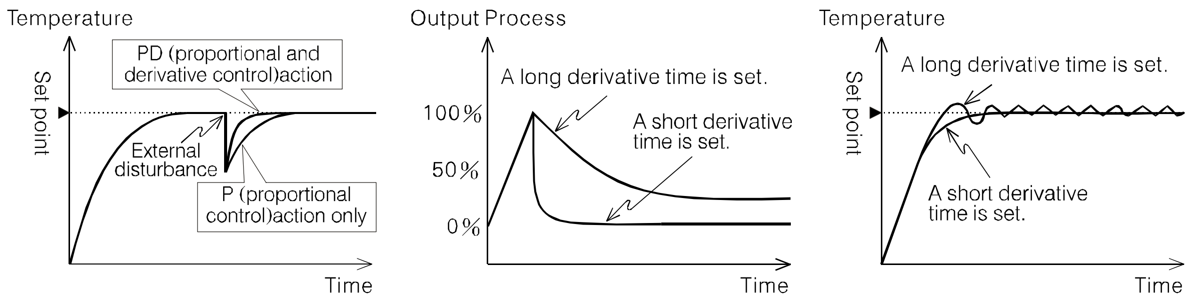


(3) D (Derivation or Rate Control) Action

D action (derivative or rate control action) is used for obtaining the output in proportion to the time derivative value of the input.

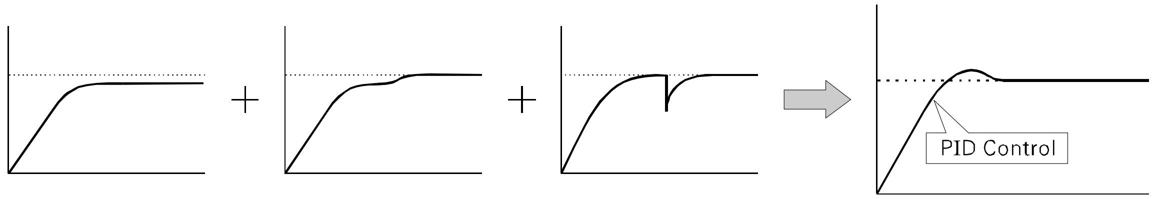
It provides a sudden shift in output level as a result of a rapid change in actual temperature. Proportional control action corrects the result of control and so does integral control action. Therefore, proportional control action and integral control action respond slowly to temperature change, which is why derivative control action is required. Derivative control action corrects the result of control by adding the control output in proportion to the slope of temperature change.

A large quantity of control output is added for a radical external disturbance so that the temperature can be quickly in control.



(4) PID Control

PID control is a combination of P(proportional), I (integral) and D (derivative) control actions, in which the temperature is controlled smoothly by proportional control action without hunting, automatic offset adjustment is made by integral control action, and quick response to an external disturbance is made possible by derivative control action.



- Control Cycle and Time-Proportioning Control Action

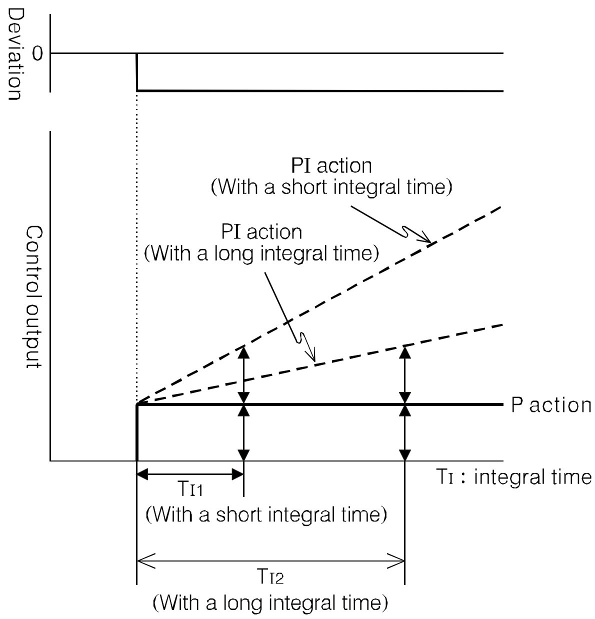
When the temperature control is used with a relay or SSR to control the output, it will follow the premeditated timing cycle to turn “ON” or “OFF” a specified time intermittently. This preset cycle is called control cycle and this control method is called time-proportioning control action. A PLC system in the main unit is always using this method to procure temperature control.

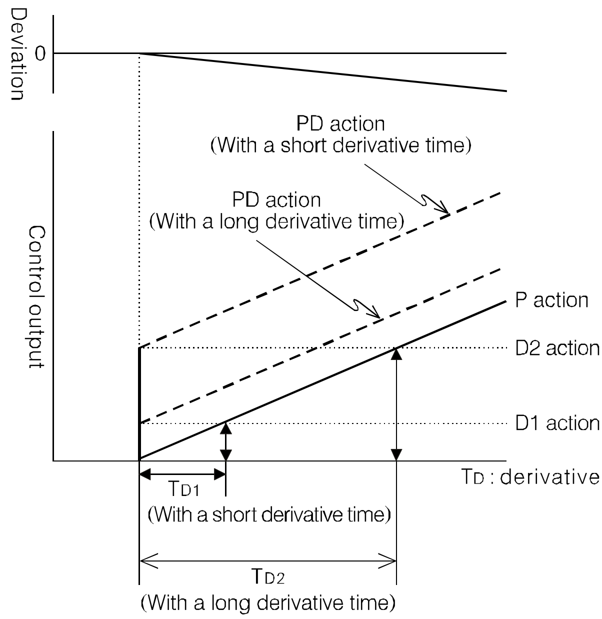
- The Definition of Integral Time

Integral time is the period required for a step-type deviation in integral control (e.g., the deviation shown in the following graph) to coincide with the control output in proportional control action. The shorter the integral time is, the stronger the integral control action is. If the integral time is too short, it will cause a quick and huge correction then the temperature wave may result.

- The Definition of Derivative Time

Derivative time is the period required for a ramp-type deviation in derivative control (e.g., the deviation shown in the following graph) to coincide with the control output in proportional control action. The longer the derivative time is, the stronger the derivative control action is.





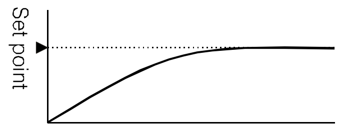
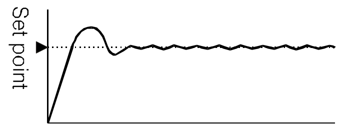
- Auto-Tuning

  All PID process/temperature controllers require the adjustment of the P, I, D and other parameters in order to allow accurate control of the load. There have been a variety of conventional methods but the Auto-tuning methods make it possible to obtain PID constants suitable to a variety of objects automatically.

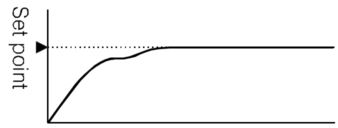
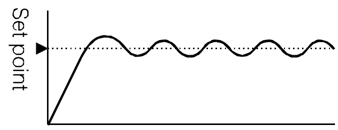
- Adjust the PID Parameters

  It is convenient while the PID constants calculated via the auto-tuning operation and normally they are more correct than tuning by manual. Usually, the auto-tuning do not cause problems and we will suggest using it to set up the parameters. Except for some particular applications if the more accurate constants is necessary. In which case, refer to the following to readjust the PID constants.

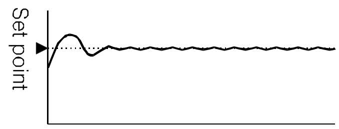
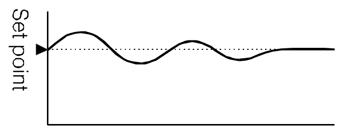
Response to Change in Proportional Band

Wider		It is possible to suppress overshooting although a comparatively long startup time and set time will be required.
Narrower		The process value reaches the set point within a comparatively short time and keeps the temperature stable although overshooting and waving will result until the temperature becomes stable.

Response to Change in Integral Time

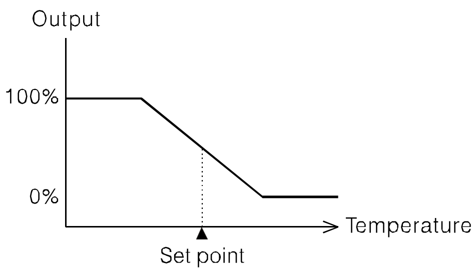
Wider		It is possible to reduce waving, overshooting and undershooting although a comparatively long startup time and set time will be required.
Narrower		The process temperature reaches the set point within a comparatively short time although overshooting, undershooting and waving will result.

Response to Change in Integral Time

Wider		The process value reaches the set point within a comparatively short time with comparatively small amounts of overshooting and undershooting although fine-cycle waving will result due to the change in process value.
Narrower		It will take a comparatively long time for the process value to reach the set point with heavy overshooting and undershooting.

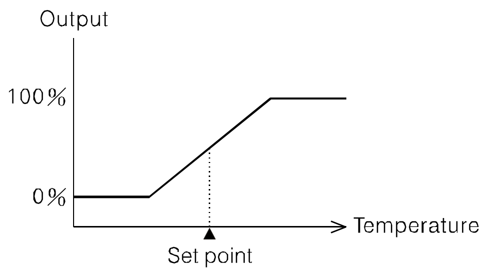
- The Definition of Integral Time

  To increase the control output operation when the temperature of object is higher than the set point.



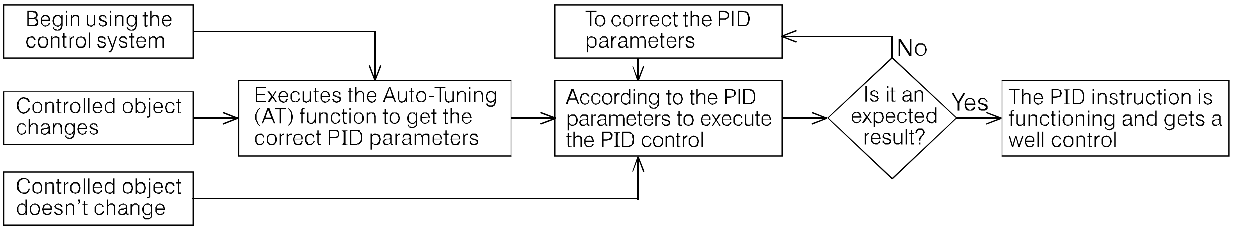
- The Definition of Derivative Time

  To increase the control output operation when the temperature of object is lower than the set point.

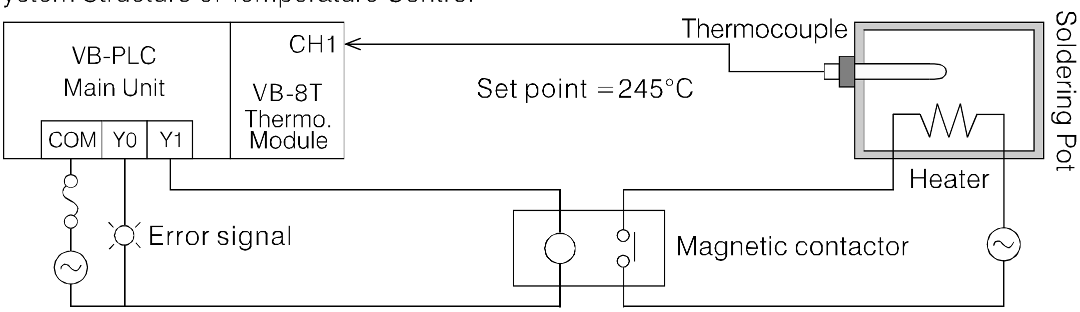


The Example of PID Temperature Control

- When design a PID temperature control program, the method below is the recommendable procedure to perform the PID instruction.

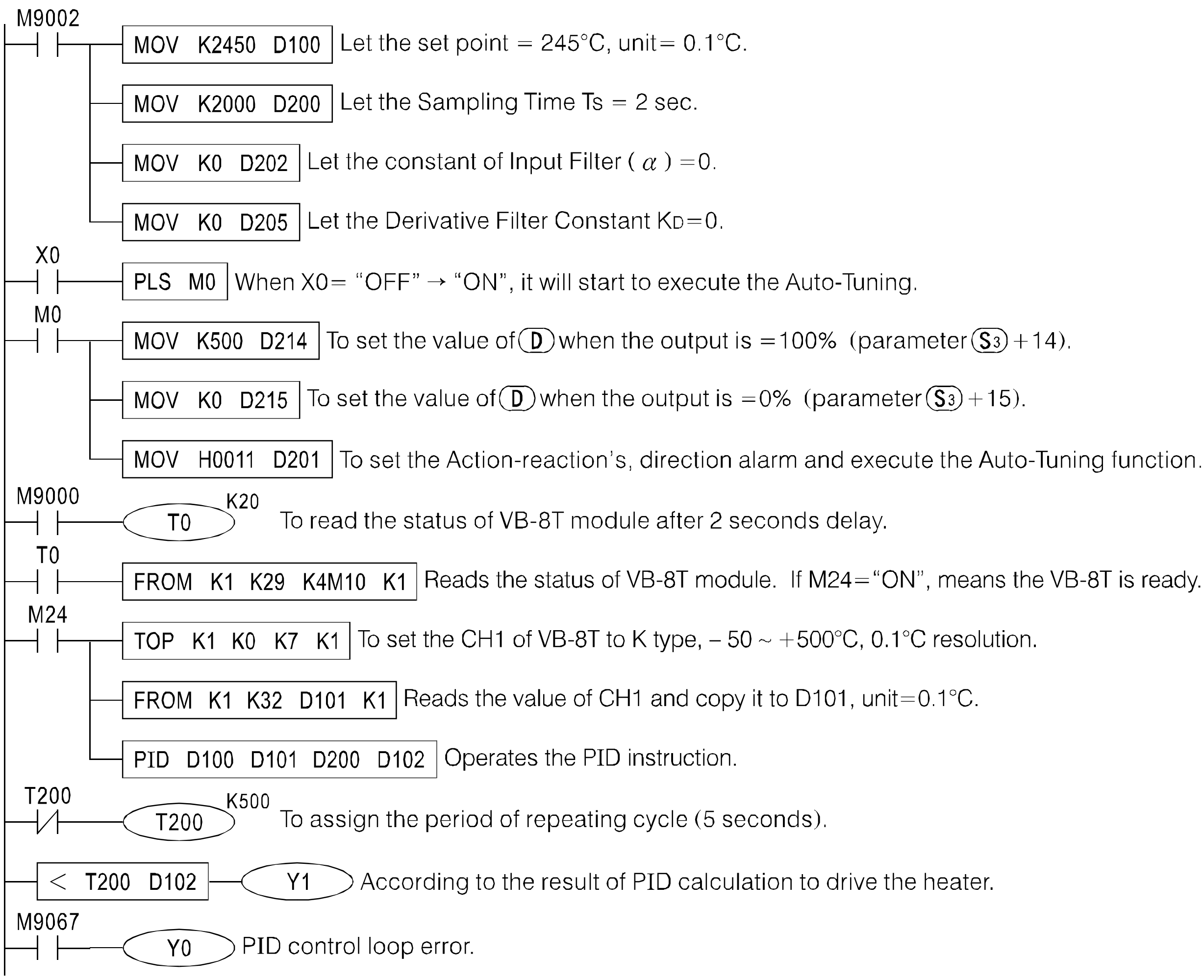


- The System Structure of Temperature Control



- Program Example

When X0="ON", it will executes Auto-Tuning function, and then starts the PID control; Otherwise, when X0= "OFF", it will executes the PID function directly.
This program is to control the "ON"/"OFF" length percentage in a specific time-span (5 seconds).
When this program starts at the first time, must let X0= "ON", then by the Auto-Tuning to get parameters of PID. Otherwise, the PID control will occur error because the related parameters aren't ready yet.



FNC 92 TPID	TPID S1 S2 S3 S4 n	Temperature PID Control	M	VB	VH
				O	

Operand	Devices															
	X	Y	M	S	KnX	KnY	KnM	KnS	T	C	D	SD	P	V,Z	K,H	VZ index
S1											○					
S2											○					
S3											○					
S4											○					
n															○	

- S1 occupies n consecutive registers
- S2 occupies n consecutive registers
- S3 occupies $(10\times n)+10$ consecutive registers
- S4 occupies $6\times n$ consecutive registers
- $1\leq n\leq 16$

```
        S1    S2   S3    S4    n
  X0
──┤ ├──[TPID D7000 D0 D100 D7100 K16]
```

S1 : Head register ID of the Setting Value (SV) block

S2 : Head register ID of the Present Values (PV) block

S3 : Head register ID of the parameters & outputs

S4 : Head register ID of the parameters of PID & other setting values

n : Number of object channels need to control by this instruction

- This TPID instruction is especially for temperature application at the multi-object (1~16) PID control. The instruction provides temperature PID control, Auto-Tuning (AT), Auto/Manual control functions and alarms. So, the instruction can easily procure a smooth temperature control.
- Uses the difference between S1 (one in the setting value block) and S2 (correlated one in the present value block), then via the values of parameters in S3 and S4 to process the PID operate.
  The control result signal of coil ON/OFF will effect relative bit at S3+5. If the analog control output is required, the resulted value of PID will appear at correlated register of S3 .
- When X0= "ON", this instruction starts to perform; When X0="OFF", this process stops and all the output contacts at S3+5 will be turned "OFF" also all the analog output values in the S3 will be reseted to "0".
- There's no limitation on the times used of the TPID instruction.
- This instruction provided with the "Auto-Tuning (AT)" function, it can help users to decide the parameters of P (K_P), I (T_I) and D (T_D) at the TPID instruction. (Please refer to following pages.)
- This instruction accumulates the values of difference between S1 & S2 block at every PLC Scan Time, those with parameters become parts of operand then effect the control output cycles. So, to use this instruction must pay attention to the suggestion below:
  This TPID instruction can be used in the SFC Ladder Chart, Subprogram, Interrupted Subprogram and the block of Jump instruction. If it has been pass over or process more than once, the input values may be calculated none or repetitiously. So, make sure the active instruction has been process once and only once at every Scan Time otherwise the result may be incorrect.
- The specification of Setting Value (SV) S1 block
  By the content value of parameter n to establish the number of object channels then the S1 block will occupy n registers.
  The content value of S1 is the Setting Value (SV) for the first object channel; the content value of S1+1 is the Setting Value (SV) for the second object channel; and so on.
- The specification of Present Values (PV) S2 block
  By the content value of parameter n to establish the number of object channels then the S2 block will occupy n registers.
  The Present Value (PV) in S2 is from the sensor of the first object channel; the Present Value (PV) in S2+1 is from the sensor of the second object channel; and so on.

- The specification of parameter block S_3

Para-meter	Parameter Name/Function	Description	Setting range
S_3	Control Cycle Setting	To assign the outputs period interval (the length of one ON/OFF cycle)	10 ~ 32767 × 10 ms.
S_3+1	Responsive Sensitivity	To assign the sensitive level of the instruction which is for all channels ("0": Fast / "1": Medium / "2": Slow)	0 ~ 2
S_3+2	Operational Direction	By relative bits at this register to assign the reacted direction of channels ("0": "Reverse" / "1": "Forward")	H0000 ~ HFFFF
S_3+3	Auto/Manual Select	By relative bits at this register to assign the control method of channels ("0": Automatic / "1": Manual)	H0000 ~ HFFFF
S_3+4	AT Command	By relative bits at this register to start the Auto-Tuning (AT) function of channels ("1": start AT; reset to "0" when AT has been finished)	H0000 ~ HFFFF
S_3+5	Outputs	Output the control signals for object channels by relative bits	—
S_3+6	Limitation Alarm Status	Display the limitation alarms for object channels by relative bits	—
S_3+7	Deviation Alarm Status	Display the deviation alarms for object channels by relative bits	—
S_3+8 S_3+9	System Operating Area	Reserved for the internal processing of the TPID instruction	—
S_3+10	The First Object Analog Output	Display the analog output value of the first object channel	0 ~ 1000 ×0.1%
S_3+11 S_3+19	The First Object Operating Area	Reserved for the internal processing of the TPID instruction	—
S_3+20	The Second Object Analog Output	Display the analog output value of the second object channel	0 ~ 1000 ×0.1%
S_3+21 S_3+29	The Second Object Operating Area	Reserved for the internal processing of the TPID instruction	—
⋮	⋮	⋮	⋮

- The values in S_3 ~ S_3+9 are the common parameters for all object of this instruction. And, to add any object channel will occupy extra 10 registers form S_3+10 to $S_3+(10\times n)+9$.

- The parameter at S_3 is the control output period setting for this instruction.
  Usually, the length of control period depends on the type of loading.
  If the the equipment is driven by a Magnetic Contactor (MC), to set the value bigger than 1000 (1000×10ms. = 10 Sec.) is recommend that is for extend its lifespan.
  If the the equipment is driven by a Solid State Relay (SSR), can set the value to 200 (200×10ms.=2 Sec.)

- The parameter at S_3+1 is to set up control sensitivity for the response of this instruction.
  The value in S_3+1 will affect all object channels in the instruction.
  To control the temperature of a system, always expect its response as soon as possible but in some condition the quick response will cause temperature waving then occur a unsuccessful control. Therefore, could adjust its level of sensitivity to get a better control. To input the value equal to "0" is the fast response; "1" is medium; "2" is slow.

- Each bit at S_3+2 is for set up control direction of every single object channel.
  When the measured Present Value (PV) < the Setting Value (SV), it will generate a negative deviation and increase the control effect, that is called the "Reverse" operation. Ex. An oven: before the heater of the oven turns on. Usually the temperature of the oven is lower than the setting value. (PV) < (SV), this is a typical "Reverse" operation control sample.
  When the measured Present Value (PV) > the Setting Value (SV), it will generate a positive deviation and increase the control effect, that is called the "Forward" operation. Ex. An air conditioning system: before the system turns on. Usually the indoor temperature is higher than the setting value. (PV) > (SV), this is a typical "Forward" operation control sample.

S_3+2 b15 … b1 b0

"0" stands for the "Reverse" (heating) control;
"1" stands for the "Forward" (cooling) control

b0: To assign the direction of the first object channel

b1: To assign the direction of the second object channel

⋮

b15: To assign the direction of the sixteenth object channel

- Each bit at(S3)+3 is for set up Auto/Manual control of every single object channel.

(S3)+3 b15 … b1 b0

"0" stands for PID automatic control; "1" stands for manual control. When using the manual control mode, should input the expected output value (0 ~ 1000) directly to relative register.

To assign the A / M method of the first object channel

To assign the A / M method of the second object channel

⋮

To assign the A / M method of the sixteenth object channel

- Each bit at(S3)+4 is for trigger the Auto-Tuning (AT) function of every single object channel.

(S3)+4 b15 … b1 b0

To trigger the b0 "ON", the first object channel will start to process the AT function; when its AT function finished, the b0 will be reset to "OFF" and the parameters P (K_P), I (T_I) and D (T_D) will put into relative registers in (S4) block.

To trigger the AT function of the first object channel

To trigger the AT function of the second object channel

⋮

To trigger the AT function of the sixteenth object channel

- Each bit at(S3)+5 is for output the "ON" / "OFF" control signal of every single object channel.

(S3)+5 b15 … b1 b0

By the (S3) period and the calculated result of TPID instruction to produce outputs (proportional "ON" / "OFF" rate in every period).

To output the control signal of the first object channel

To output the control signal of the second object channel

⋮

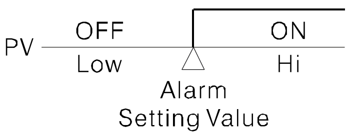
To output the control signal of the sixteenth object channel

Each object channel will also generate an analog PID output value.
The results are output to(S3)+10×m (m=1 ~ n). Ex. The(S3)+10 is the output value of the first object channel; the(S3)+20 is the output value of the second object channel; and so on. Those output values can be used for the digital-analog (D/A) convert circuits to perform the analog control outputs. This(S3)+5 outputs are using those values in(S3)+10×m (m=1 ~ n) to produce proportional "ON" / "OFF" output signals.
But at the manual control method, should put the expected output values (0 ~ 1000) into relative registers.

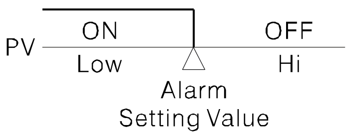
- This instruction provides two alarm signals for each object channel. See the illustrations below.

① Limitation Alarm

When a object channel uses the "Reverse" operation, the Limitation Alarm will "ON" if the PV is higher then the alarm setting value.

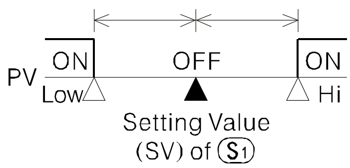


When a object channel uses the "Forward" operation, the Limitation Alarm will "ON" if the PV is lower then the alarm setting value.



② Deviation Alarm

Allowably (+/–) deviant value.



- Each bit at S_3 + 6 is for storage the status of Limitation Alarm of every single object channel.

b15 b1 b0

S_3 + 6

The status of Limitation Alarm from the first object channel

The status of Limitation Alarm from the second object channel

The status of Limitation Alarm from the sixteenth object channel

A object channel has a setting value of Limitation Alarm which is put in S_4 + 6m + 4 (m = 0 ~ n–1); the S_4 + 4 is for the first object channel; the S_4 + 10 is for the second object channel; and so on.

- Each bit at S_3 + 7 is for storage the status of Deviation Alarm of every single object channel.

b15 b1 b0

S_3 + 7

The status of Deviation Alarm from the first object channel

The status of Deviation Alarm from the second object channel

The status of Deviation Alarm from the sixteenth object channel

An object channel has a setting value of Deviation Alarm which is put in S_4 + 6m + 5 (m = 0 ~ n–1); the S_4 + 5 is for the first object channel; the S_4 + 11 is for the second object channel; and so on.

- The exposition of parameter block (S4) (K_P, T_I, T_D & other setting values)

Para-meter	Parameter Name/Function	Description	Setting range
S4	Proportional Gain (K_P) of the First Object Channel	The P (Proportional) part of the PID loop	1～32767 ×0.01
S4+1	Integral Time Constant (T_I) of the First Object Channel	The I (Integral) part of the PID loop, (this parameter disables the I effect if it is "0")	0～32767 ×100 ms.
S4+2	Derivative Time Constant (T_D) of the First Object Channel	The D (Derivative) part of the PID loop (this parameter disables the D effect if it is "0")	0～32767 ×10 ms.
S4+3	Overshoot Repression Value of the First Object Channel	To set this repression deviation appropriately could repress the overshoot at the beginning	0～32767
S4+4	Limitation Alarm Setting Value of the First Object Channel	For the "Reverse" operation: Limitation Alarm "ON" if PV > this setting value. For the "Forward" operation: Limitation Alarm "ON" if PV < this setting value.	–32768～32767
S4+5	Deviation Alarm Setting Value of the First Object Channel	Deviation Alarm "ON" if PV > (SV + this setting value) or PV < (SV - this setting value)	–32768～32767
S4+6	Proportional Gain (K_P) of the Second Object Channel	The P (Proportional) part of the PID loop	1～32767 × 0.01
S4+7	Integral Time Constant (T_I) of the Second Object Channel	The I (Integral) part of the PID loop, (this parameter disables the I effect if it is "0")	0～32767 ×100 ms.
S4+8	Derivative Time Constant (T_D) of the Second Object Channel	The D (Derivative) part of the PID loop, (this parameter disables the D effect if it is "0")	0～32767 ×10 ms.
S4+9	Overshoot Repression Value of the Second Object Channel	To set this repression deviation appropriately could repress the overshoot at the beginning	0～32767
S4+10	Limitation Alarm Setting Value of the Second Object Channel	For the "Reverse" operation: Limitation Alarm "ON" if PV > this setting value. For the "Forward" operation: Limitation Alarm "ON" if PV < this setting value.	–32768～32767
S4+11	Deviation Alarm Setting Value of the Second Object Channel	Deviation Alarm "ON" if PV > (SV + this setting value) or PV < (SV - this setting value)	–32768～32767
⋮	⋮	⋮	⋮

- The register block starting from (S4) is for storage every channel's K_P, T_I, T_D parameters, starting Overshoot Repression and two alarm setting values.
  Every channel will occupy 6 sequential registers. The (S4)~(S4)+5 keep parameters for the first channel; the (S4)+6 ~(S4)+11 keep parameters for the second channel; and so on.

- Registers for the block of (S4) are usually assigned to latched registers.

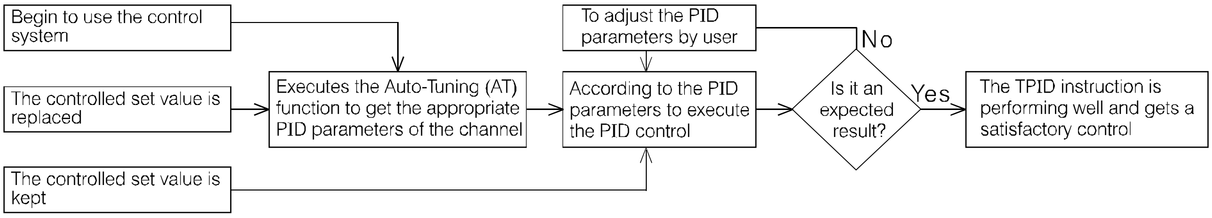
- Every channel's K_P, T_I and T_D parameters could use the Auto-Tuning (AT) function to get the values, also available given by user.

- The unit of the Overshoot Repression follows the SV value. If the unit of SV is 0.1°C (usually), then to use the function of starting Overshoot Repression, its unit is equal to 0.1 °C also.
  If the application of temperature control which is sensitive to the starting overshoot, the channel could use this function and appropriately set the deviation value then it can effectively repress starting overshoot. To get this repressive value, could observe the maximum overshoot at AT processing. Or, approximately preset a value (10.0 ~ 20.0 °C) to do an experiment then use the result to adjust the repressive value.

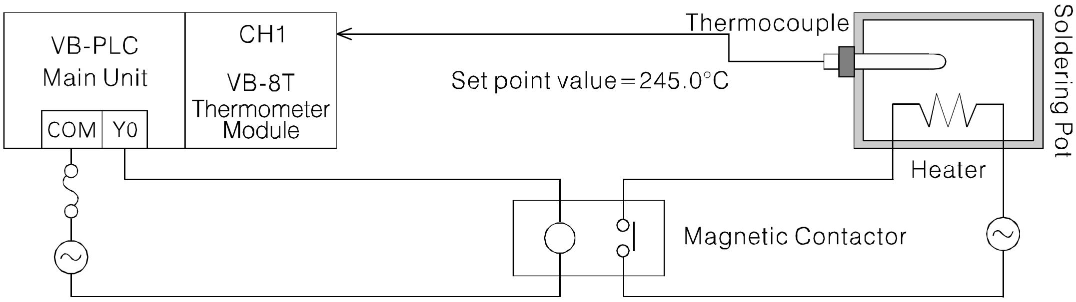
- To read the statuses of alarms which are appointed by the parameter block (S4) , please refer to the instruction of (S3)+6 and (S3)+7.

TPID Instruction Temperature Control Example I

- When design a PID temperature control program, the method below is the recommendable procedure to perform the TPID instruction.

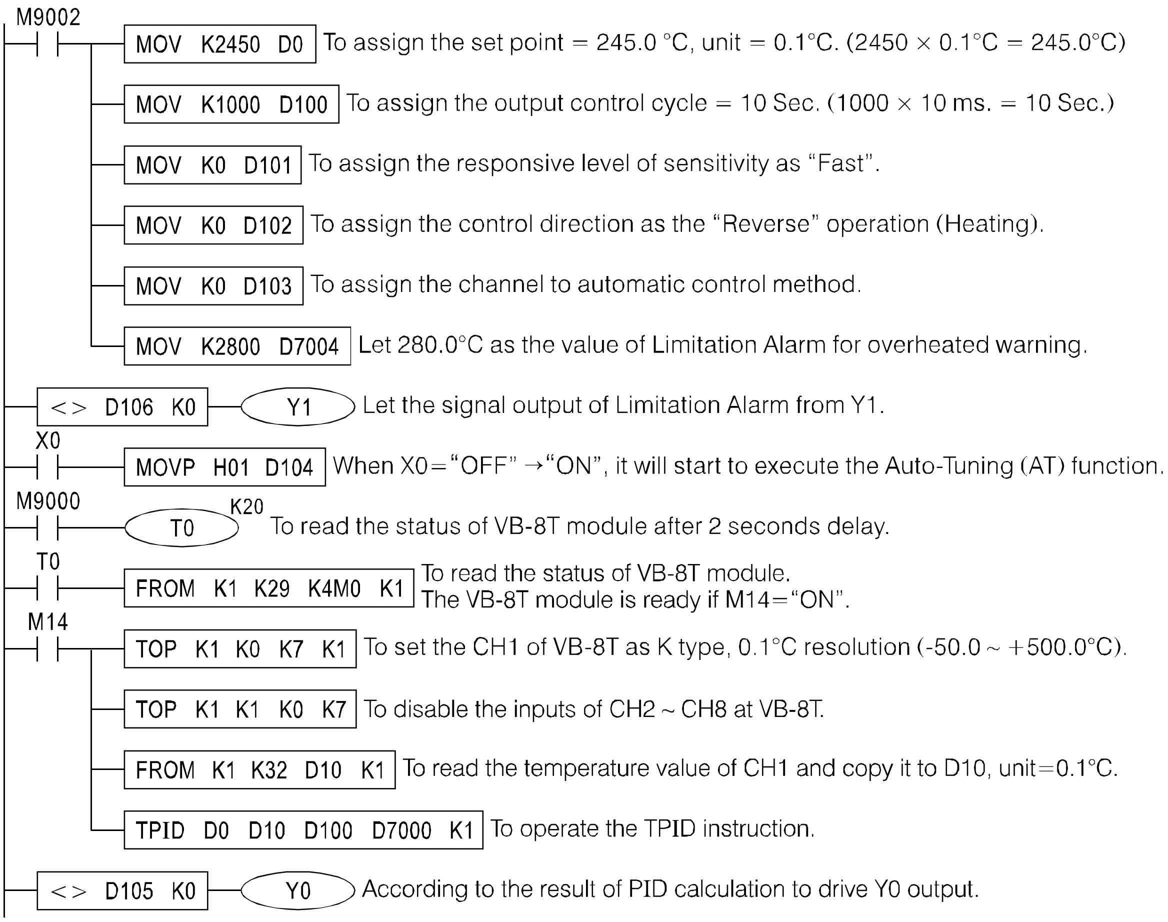


- The System Structure of Temperature Control



- Program Example

When X0="ON", it will execute the Auto-Tuning (AT) function first and then start the PID control; Otherwise, when X0="OFF", it will execute the PID operation directly.
Must be trigger the X0="ON" once if this program is started at the first time, then by the Auto-Tuning (AT) function to get the P, I and D parameters of the channel. Otherwise, the PID control will occur error because the related parameters are not ready yet.



TPID Instruction Temperature Control Example II

This is a 16 channels temperature control example, which needs a 32 points VB series Main Unit and two VB-8T modules also a HMI (Human Machine Interface) is required for data settings and statuses display.

- The components list at this example:

Controlled CH #	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Auto/Manual Select	M2015	M2014	M2013	M2012	M2011	M2010	M2009	M2008	M2007	M2006	M2005	M2004	M2003	M2002	M2001	M2000
AT Command	M35	M34	M33	M32	M31	M30	M29	M28	M27	M26	M25	M24	M23	M22	M21	M20
AT Status	M55	M54	M53	M52	M51	M50	M49	M48	M47	M46	M45	M44	M43	M42	M41	M40
Output Point	Y17	Y16	Y15	Y14	Y13	Y12	Y11	Y10	Y7	Y6	Y5	Y4	Y3	Y2	Y1	Y0
Limitation Alarm Status	M75	M74	M73	M72	M71	M70	M69	M68	M67	M66	M65	M64	M63	M62	M61	M60
Deviation Alarm Status	M95	M94	M93	M92	M91	M90	M89	M88	M87	M86	M85	M84	M83	M82	M81	M80
Temp. Setting Value (SV)	D7015	D7014	D7013	D7012	D7011	D7010	D7009	D7008	D7007	D7006	D7005	D7004	D7003	D7002	D7001	D7000
Temp. Present Value (PV)	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Parameter of P Phase (K_P)	D7190	D7184	D7178	D7172	D7166	D7160	D7154	D7148	D7142	D7136	D7130	D7124	D7118	D7112	D7106	D7100
Parameter of I Phase (T_I)	D7191	D7185	D7179	D7173	D7167	D7161	D7155	D7149	D7143	D7137	D7131	D7125	D7119	D7113	D7107	D7101
Parameter of D Phase (T_D)	D7192	D7186	D7180	D7174	D7168	D7162	D7156	D7150	D7144	D7138	D7132	D7126	D7120	D7114	D7108	D7102
Overshoot Repression Value	D7193	D7187	D7181	D7175	D7169	D7163	D7157	D7151	D7145	D7139	D7133	D7127	D7121	D7115	D7109	D7103
Limitation Alarm Value	D7194	D7188	D7182	D7176	D7170	D7164	D7158	D7152	D7146	D7140	D7134	D7128	D7122	D7116	D7110	D7104
Deviation Alarm Value	D7195	D7189	D7183	D7177	D7171	D7165	D7159	D7153	D7147	D7141	D7135	D7129	D7123	D7117	D7111	D7105

Besides the components on the table above, this instruction will occupy the registers D100 ~ D269. When actually use this instruction, some unnecessary control items (Ex. Auto/Manual control selection) could remove from the program then those items would not occupy components.

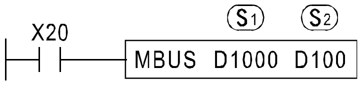
- Program Example

```
M9002
--| |--+----[MOV K1000 D100]      To assign the output control cycle = 10 Sec. (1000 × 10 ms. = 10 Sec.)
         +----[MOV K0 D101]        To assign the responsive level of sensitivity for CH1 ~ CH16 as "Fast".
         +----[MOV H0 D102]        To assign the control direction of CH1 ~ CH16 as the "Reverse" operation
                                   (Heating).
M9000
--| |--+----[MOV K4M2000 D103]    To setup Auto/Manual control method of CH1 ~ CH16 by Latched
         |                          M2000 ~ M2015.
         +----[WOR K4M20 D104 D104] Use the M20 ~ M35 to trigger the AT function of CH1 ~ CH16.
         |                          At this application must use the WOR instruction, can't use the
         |                          MOV instruction.
         +----[MOV D104 K4M40]     Use the M40 ~ M55 to display the status of AT function of CH1 ~ CH16.
         |                          If a coil "ON", the corresponded channel processing the AT function.
         +----[MOV D105 K4Y0]      To assign the Y0 ~ Y17 become the control outputs of CH1 ~ CH16,
         |                          by the output signals to drive the loaders.
         +----[MOV D106 K4M60]     To assign the M60 ~ M75 become the Limitation Alarm outputs of
                                   CH1 ~ CH16.
M9013
--| |-------(C0) K3600             After one hour, C0 turns "ON" to start the Deviation Alarm monitors, that
                                   could ensure the system is processing under normal temperature.
C0
--| |-------[MOV D107 K4M80]      To assign the M80 ~ M95 become the Deviation Alarm outputs of
                                   CH1 ~ CH16.
M9000
--| |-------(T0) K20               To read the status of VB-8T modules after 2 seconds delay.
T0
--| |--+----[FROM K1 K29 K4M100 K1] To read the status of the first VB-8T module.
         |                            The first VB-8T module is ready if M114="ON".
         +----[FROM K2 K29 K4M120 K1] To read the status of the second VB-8T module.
                                      The second VB-8T module is ready if M134="ON"
M114
--| |--+----[TOP K1 K0 K7 K8]     To set all the channels of the first VB-8T as K type, 0.1°C resolution
         |                          (–50.0 ~ +500.0°C).
         +----[FROM K1 K32 D0 K8]  To read the temperature values of CH1 ~ CH8 from the first VB-8T
                                   and copy it to D0 ~ D7, unit=0.1°C.
M134
--| |--+----[TOP K2 K0 K7 K8]     To set all the channels of the second VB-8T as K type, 0.1°C
         |                          resolution (–50.0 ~ +500.0 °C).
         +----[FROM K2 K32 D8 K8]  To read the temperature values of CH9 ~ CH16 from the second
                                   VB-8T and copy it to D8 ~ D15, unit=0.1°C.
M114   M134
--| |----| |----[TPID D7000 D0 D100 D7100 K16]  To operate the TPID instruction.
```

FNC 149 MBUS	MBUS (S1) (S2)	MODBUS Communication	M	VB	VH
				O	

Operand	Devices															
	X	Y	M	S	KnX	KnY	KnM	KnS	T	C	D	SD	P	V,Z	K,H	VZ index
S_1											O					O
S_2											O					

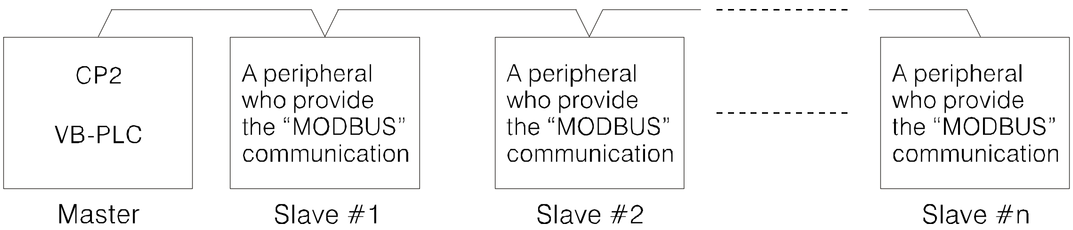
- S_2 occupies 4 consecutive registers



S_1 : To indicate the head ID number of receiving/sending data registers

S_2 : Instruction working area, occupies 4 consecutive registers

- This section is for VB series PLC only; for the MBUS instruction in a VH series PLC, please revere to page 359.
- When a VB Series Main Unit has been installed a communication card (VB-232R or VB-485) or a communication module (VB-485A, VB-CADP etc.), the Main Unit will have the CP2 (2nd Communication Port). Then, via this instruction to proceed data transfer between the PLC and a device who has MODBUS communication protocol.
- The CP2 is a multi-functional expanded communication port, it can be used for multiplex communication types. When the CP2 would like to use for this instruction, the communication type of CP2 should chose the “MODBUS”. To select and relative parameters setting about the manipulation type of CP2, please use the option in the programming tool Ladder Master “System---2nd COM Port Setting...”to get the right setting.
- As the diagram below, use the CP2 to connect the PLC and other peripherals, use the program develop devices (e.g. Ladder Master) to set the “MODBUS” communication mode and the communication parameters. Then, to properly finish all the setting of station IDs (the range of station ID number is 1 ~ 255, but when this system link is used the RS-232, there is only one slave available) and parameters for slaves (or peripherals). Write the data transmission/receiving command to the PLC (Master station), to drive the data transmission between PLCs or peripherals.



- When X20=“ON”, the MBUS instruction will start to be performed. Based on the designated register string (which initiating from D1000), to process writes/reads data into/from an appointed Slave PLC or peripheral. At the same time, D100 ~ D103 store the status of the instruction execution.
- Every time the transmission/receiving operation which designated by (S1) is duly completed, the M9199 will be “ON” for a scan time. And then, it will repeat the data transmission/receiving processes from the first data again.
- When X20=“ON” → “OFF”, the instruction will be stopped and the data transmission/receiving will be discontinued immediately.
- The MBUS instruction can be used once only in the program.
- For avoid the corresponding breakup, when the MBUS instruction sends a communication request to a particular Slave, if the respondent time of the Slave exceeds the Time-out duration (designated by D9129), the MBUS instruction will stops communication from the specific Slave and operates next communication command.
- The setting value of the Time-out duration is restored in D9129. The Time-out duration = (the content value of D9129) ×10ms. When D9129=0 (the default value), the Time-out duration is 100 ms.
- Most of the applied situation is not necessary to change the Time-out duration.
  But, if an equipment in the communication link, its response is very slow, then the longer Time-out duration is necessary.

- The register headed with (S1) is used to describe the data transmission/receiving information:

(S1)	Content Value	Description
D1000	1 ~ 255	To designate the number of transferred and received data sets. Each data transmission/receiving set should be described with 7 registers.
D1001	1 ~ 247	Designates the Slave station ID number, to proceed data transmission/receiving for the particular Slave station
D1002	1 ~ 3	Instruction commend. 1: read data from the Slave station; 2: write a series of data into the Slave station; 3: write one device's data into the Slave station.
D1003	1 ~ 64	Length of data transferred or received. If the instruction code ((S1)+2)= 3, this data will be ignored.
D1004	1 ~ 6 10,11,13	Designates the device type of the Master station 1: Input Contact X 2: Output Contact Y 3: Auxiliary Coil M 4: State Coil S 5: Timer Contact T 6: Counter Contact C 10: The Present-value Register of the Timer 11: 16-bit Counter, Present-value Register 13: Data Register D
D1005		Designates the initial component ID number of the Master station device
D1006	0,1,3,4	Designates the device type of the Slave station 0: A readable/writable bit device 1: A readable only bit device 3: A readable only 16 bits data Register 4: A readable/writable 16 bits data Register
D1007	0 ~ 32767	Designates the initial component data ID number of the Slave station device
D1008	1 ~ 247	Designates the Slave station ID number
D1009	1 ~ 3	Instruction commend
D1010	1 ~ 64	Length of data transferred/received
D1011	1 ~ 6 10,11,13	Designates the device type of the Master station
D1012		Designates the initial component ID number of the Master station device
D1013	0,1,3,4	Designates the device type of the Slave station
D1014	0 ~ 32767	Designates the initial component data ID number of the Slave station device
⋮	⋮	

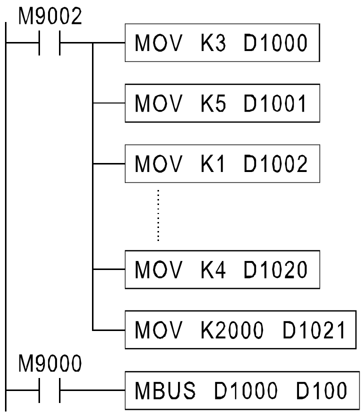
D1001 ~ D1007: Description of the 1st data transmission/receiving operation

D1008 ~ D1014: Description of the 2nd data transmission/receiving operation

- The attributes of the devices designated in a data transmission/receiving operation should be the same. For example, if the device designated by the Master station is a bit device, then the designated device of the Slave station should be also a bit device.
- The instruction working area headed with (S2) :

(S2)		Description
D100	Lower 8 bits	The Slave station ID number when a communication error occurs
	Upper 8 bits	Instruction working status 0: Normal data transmission/receiving 2: Error of the length of the transferred/received data (unequal to 1 ~ 64) 4: Error of the designated device type 5: Error of the designated device ID number 6: The characteristic of devices between the Master and Slave stations are different A: Normal communications but no response from Slave stations B: Abnormal communications
D101 ~ D103	The working area required when the instruction is performed	

Description by an Example (For the VB series only)



To create a communication table.
This block can be replaced by the function of File Registers

MODBUS communication instruction

There are totally 3 transmission/receiving data sets in this example.

① To read the data in 40000 ~ 40009 of Slave station #5 and put they to D2000 ~ D2009 of the Master station.

② To write the data in D2010~D2014 of the Master station into 41000 ~ 41004 of Slave station #2.

③ To write the data in D2015 of the Master station into 42000 of Slave station #3.

S1	Content Value		
D1000	3	Three transmission/receiving data sets	
D1001	5	Designates Slave station #5	The first transmission/receiving data sets: 40000 ~ 40009 of Slave station #5 ↓ D2000 ~ D2009 of the Master
D1002	1	Reads data from the Slave station	
D1003	10	Length of the data to be read	
D1004	13	Designates the device in the Master station which headed with D2000	
D1005	2000		
D1006	4	Designates the device in the Slave station which headed with 40000	
D1007	0		
D1008	2	Designates Slave station #2	The second transmission/receiving data sets: D2010 ~ D2014 of the Master ↓ 41000 ~ 41004 of Slave station #2
D1009	2	Write a series of data into the Slave station	
D1010	5	Length of the data to be written	
D1011	13	Designates the device in the Master station which headed with D2010	
D1012	2010		
D1013	4	Designates the device in the Slave station which headed with 41000	
D1014	1000		
D1015	3	Designates Slave station #3	The third transmission/receiving one data set: D2015 of the Master ↓ 42000 of Slave station #3
D1016	3	Write the device's data to the Slave station	
D1017	1	This information will be ignored	
D1018	13	Designates the data in the Master station D2015	
D1019	2015		
D1020	4	Designates the data in the Slave station 42000	
D1021	2000		

- Use the File Registers to set up the communication table
  In the VB series PLC, the File Registers are read only registers and the their contents are assumed as a part of program.
  When a user copy or access the program file, the program itself and the File Registers will be handled together. Since the File Registers have this characteristic, use they to store the communication table were suitable. They are not only to copy the data of File Registers easily but also can minimize the program size. Please refer to CH 2-9 "File Register (D)" for more information about the File Register.
  To plan the contents of File Registers, which can use the programming tool software "Ladder Master", it provide the edit tool "System ---- File Register Edit....", easily to set the data in the registers.

- Edit Communication Table
  In addition to the File Registers' layout function; and further, the Ladder Master provides more user friendly and easily of data input interface, it provide the user to create and edit the Communication Table List.
  Please select the Ladder Master's "Tools ---- Edit Communication Table ...." function to start the Communication Table List document edit window. By the interlocutory pop-up window, user can easily create and edit the communication table step-by-step. After the Communication Table has been finished, the user can put the communication data into the designated File Registers then this communication table is completed. And also, this function provides user to retrieve, access and edit the Communication Table back from the File Registers.
  For the VB series PLCs, the File Register is read-only, and its value will be treated as a part of the user program. When user copy or save program file, the File Register together with the program itself will be copied or saved. This feature makes the File Register very suitable for communication table storing; it can be easily copied from and helps to save PLC program space. For detailed introduction on the File Register, please refer to the section "2-9 File Register (D)".

- Communication Table example :

Instruction: MBUS ▼ Start of File Reg: D1000 Length of Reg: 22

Number	Command	Master Data		Slave ID	Slave Data Type	Slave Data #	Length	Word / Bit
1	Read	D2000	<--	5	4	0	10	W
2	Write	D2010	-->	2	4	1000	5	W
3	Single Write	D2015	-->	3	4	2000	1	W

There are totally 3 transmission/receiving data sets in this Communication Table example.

(1) To read the data in 40000 ~ 40009 of Slave station #5 and put they to D2000 ~ D2009 of the Master station.

(2) To write the data in D2010 ~ D2014 of the Master station into 41000 ~ 41004 of Slave station #2

(3) To write the data in D2015 of the Master station into 42000 of Slave station #3.

The "Slave Data Type" and "Slave Data No." in the communication table refers to the component ID number of the slave station equipment.
For example, there is a MODBUS component:

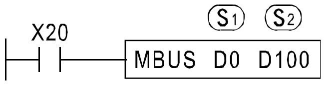
4 0000

0000 — The component data ID No.

4 — The component data type 0:Writable & Readable Bit Component
1:Read Only Bit Component
3:Read Only Data Register (16 bits)
4:Writable & Readable Register (16 bits), the most often type.

FNC 149 MBUS	MBUS (S1) (S2)	MODBUS Communication	M	VB	VH
					○

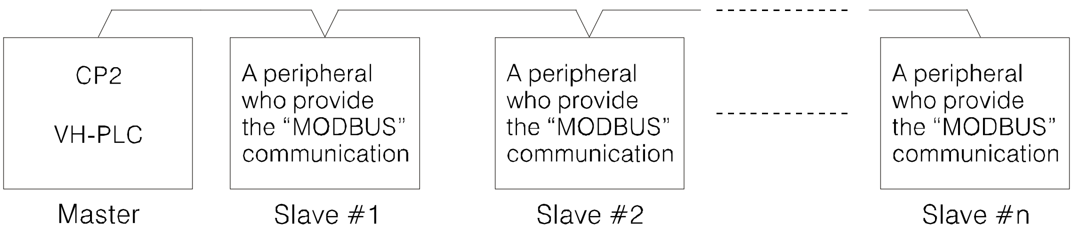
Operand	Devices															
	X	Y	M	S	K*n*X	K*n*Y	K*n*M	K*n*S	T	C	D	SD	P	V,Z	K,H	VZ index
S1											○					○
S2											○					
• S2 occupies 4 consecutive registers																



S1 : To indicate a virtual register for the communication table

S2 : Instruction working area, occupies 4 consecutive registers

- This instruction is for the VH series PLC only. The MBUS instruction for VB series, please referee to page 355
- When a VH Series Main Unit has been installed a communication card (VB-232R or VB-485) or a communication module (VB-485A, VB-CADP etc.), the Main Unit will have the CP2 (2nd Communication Port). Then, via this instruction to proceed data transfer between the PLC and a device who has MODBUS communication protocol.
- The CP2 is a multi-functional expanded communication port, it can be used for multiplex communication types. When the CP2 would like to use for this instruction, the communication type of CP2 should chose the "MODBUS". To select and relative parameters setting about the manipulation type of CP2, please use the option in the programming tool Ladder Master "System---2nd COM Port Setting..."to get the right setting.
- As the diagram below, use the CP2 to connect the PLC and other peripherals, use the program develop devices (e.g. Ladder Master) to set the "MODBUS" communication mode and the communication parameters. Then, to properly finish all the setting of station IDs (the range of station ID number is 1 ~ 255, but when this system link is used the RS-232, there is only one slave available) and parameters for slaves (or peripherals). Write the data transmission/receiving command to the PLC (Master station), to drive the data transmission between PLCs or peripherals.



- When X20="ON", the MBUS instruction will start to be performed. Based on the designated Comm Table string (which initiating from D1000), to process writes/reads data into/from an appointed Slave PLC or peripheral. At the same time, D100 ~ D103 store the status of the instruction execution.
- Every time the transmission/receiving operation which designated by(S1)is duly completed, the M9199 will be "ON" for a scan time. And then, it will repeat the data transmission/receiving processes from the first data again.
- When X20="ON" → "OFF", the instruction will be stopped and the data transmission/receiving will be discontinued immediately.
- The MBUS instruction can be used once only in the program.
- For avoid the corresponding breakup, when the MBUS instruction sends a communication request to a particular Slave, if the respondent time of the Slave exceeds the Time-out duration (designated by D9129), the MBUS instruction will stops communication from the specific Slave and operates next communication command.
- The setting value of the Time-out duration is restored in D9129. The Time-out duration = (the content value of D9129) ×10ms. When D9129=0 (the default value), the Time-out duration is 100 ms.
- Most of the applied situation is not necessary to change the Time-out duration.
  But, if an equipment in the communication link, its response is very slow, then the longer Time-out duration is necessary.
- The attributes of the devices designated in a data transmission/receiving operation should be the same. For example, if the device designated by the Master station is a bit device, then the designated device of the Slave station should be also a bit device.

- The instruction working area headed with S2 :

S2		Description
D100	Lower 8 bits	The Slave station ID number when a communication error occurs
	Upper 8 bits	Instruction working status 0: Normal data transmission/receiving 2: Error of the length of the transferred/received data (unequal to 1 ~ 64) 4: Error of the designated device type 5: Error of the designated device ID number 6: The characteristic of devices between the Master and Slave stations are different A: Normal communications but no response from Slave stations B: Abnormal communications
D101 ~ D103	The working area required when the instruction is performed	

- Edit Communication Table
  In addition to the File Registers' layout function; and further, the Ladder Master provides more user friendly and easily of data input interface, it provide the user to create and edit the Communication Table List.
  Please select the Ladder Master's "Tools ---- Edit Communication Table ...." function to start the Communication Table List document edit window. By the interlocutory pop-up window, user can easily create and edit the communication table step-by-step. After the Communication Table has been finished, the contents will become a part of the user program. The communication commands in the table will go with the user program and keep in VH PLC's system process area. And also, this function provides user to retrieve, access and edit the Communication Table.

- Communication Table Example:

```
 M9000
 |—| |———[MBUS  D0  D100]
```

Instruction: MBUS ▼ Length of Reg: 22

Number	Command	Master Data		Slave ID	Slave Data Type	Slave Data #	Length	Word / Bit
1	Read	D200	<--	5	4	0	10	W
2	Write	D210	-->	2	4	1000	5	W
3	Single Write	D215	-->	3	4	2000	1	W

This example is for communication table to execute 3 data receiving/transmitting operations.

(1) To read the data in 40000 ~ 40009 of Slave station #5 and put they to D200 ~ D209 of the Master station.

(2) To write the data in D210 ~ D214 of the Master station into 41000 ~ 41004 of Slave station #2

(3) To write the data in D215 of the Master station into 42000 of Slave station #3.

The "Slave Data Type" and "Slave Data No." in the communication table refers to the component ID number of the slave station equipment.
For example, there is a MODBUS component:

```
4 0000
|  └────── The component data ID No.
└───────── The component data type  0:Writable & Readable Bit Component
                                    1:Read Only Bit Component
                                    3:Read Only Data Register (16 bits)
                                    4:Writable & Readable Register (16 bits) , the most often type.
```

D	FNC 169 HOUR		D HOUR (S) (D1) (D2)	Hour Meter	M	VB	VH
						O	

Operand	Devices														
	X	Y	M	S	KnX	KnY	KnM	KnS	T	C	D	SD	P	V,Z	K,H	VZ index
S					O	O	O	O	O	O	O	O		O	O	O
D1											O	O				O
D2		O	O	O												O

- D1 occupies 2 consecutive devices

```
        (S)    (D1)  (D2)
 X0
─┤ ├───HOUR K1000 D7000 Y0
```

S : The period of time in which D2 will turns "ON" (the unit of (S) is hour)

D1 : The current value of the time meter (the unit of (D1) is hour)

D2: The output device of the time meter

- This instruction is used one hour as the unit of timer.
- The timer counts the time by up counting clock pulse. When the current value of the time meter (D1) ≥ the period setting value (S), the contact of the time meter (D2) = "ON".
- The real setting period of the time meter = One hour * the setting value of (S).
- (D1) stores integer number of the current value (in hours); The register next to (D1) stores the current value which is less than 1 hour (in seconds).
- As the diagram above

  When X0= "ON", the current value of the register (D1) will begin to do the cumulatively up counting (hourly). If the current value of D7000=K1000 (1000 hours), the contact of output device Y0= "ON".

  When X0= "OFF", this instruction will provides retentive function for the current value of time meter, the current value of register D7000 will be retain.
- Mostly, this instruction is used to monitor the lifespan of a component or to remind the regularly maintenance. For retain the register's current value of time meter during power failure, please assign (D1) to a latched register. If assign (D1) to a general register, when the power failure or the PLC states "STOP" → "RUN", the content value of (D1) will reset to "0".
- After the output device of time meter (D2) = "ON", the current value of time meter (D1) will continuously execute the up counting.
- When the current value of time meter (D1) reaches the maximum value of a 16-bit or 32-bit register, the counting will be stopped.