SINGER VALVE
Result-Based Solutions. Globally.™

12850-87th Avenue
Surrey, BC. Canada. V3W 3H9
Ph: 604-594-5404
Fx: 604-594-8845
www.singervalve.com

SINGER MODEL: MV1-TP
Drawing: A-9023E
Operation: Rate Flow Control, Metering Valve

General Description:

The Singer Model MV1-TP is specifically designed to control Singer Model 106/206 2SC-PCO & 106/206-PT-4SC-PCO control valves. The MV1-TP is capable of Rate Flow Control, Metering Valve using valve-mounted solenoids.

The MV1-TP includes the following features:

- PLC Programed w/ Singer Multi Process Control Algorithm
- Color Touch screen Display (HMI) w/ Singer Multi Process Control Display
- 110 – 240VAC External Power Connection, 50-60Hz
- 24 VDC Internal Power Supply
- Solid State Relay Control for Valve Mounted Open and Closing Solenoids
- Line Filters and Surge Protection
- 4 – 20mA Analog Input Signals for Process Variables and Remote Control Set Points
- 4 – 20mA Analog Output Signals for Process Variable Retransmission
- Dry Contact Alarm System Outputs
- Local or Remote Manual Valve Operational Control
- Terminal Block Connections for Solenoids, Process Variables, Remote Set Points, Alarms and others
- Modbus Serial Communication(Optional)

Description of Operation:

The Model MV1-TP is designed, primarily, to control the Singer Control Valve by actuating the closing or opening solenoids to match the current system variables to a process control set point. The system set points can be supplied via the local Singer HMI display screen or via a remote source. Based on real time process variable inputs supplied via system instrumentation the Singer Control Valve will open or close until the process variable matches the set point.

The MV1-TP has the following pre-programmed process controller:

Rate Flow Control (RF)

When flow control is ON, the controller monitors the flow rate through the valve. If the flow rate is above the set point, the controller energizes the closing solenoid of the valve until the flow reaches the set point or is within the fixed dead band. If the flow is below the set point, the controller energizes the opening solenoid to open the valve and allow the flow to reach the set point or a point within the fixed dead band.

Meter Valve (MV)

The metering valve option calculates the flow rate through the valve using a proprietary algorithm, the position of the valve and the pressure differential across the valve. The calculated flow rate may be used as a feedback value to the controller and may be used for flow control.

12850-87th Avenue
Surrey, BC. Canada. V3W 3H9
Ph: 604-594-5404
Fx: 604-594-8845
www.singervalve.com

Installation:

Refer to drawing number A-9023E for wiring field connections.

1. Mount the panel in a suitable location according to all local and federal regulations.
2. Check the valve mounted pilot solenoids for orientation and voltage.
3. Before wiring any connection to panel ensure to use hubs or fittings with the same environmental rating as the enclosure.
4. Wire the solenoids to the panel as required.
5. Wire process variable transmitters to panel as required.
6. Wire remote set point to panel as required.
7. Wire process variable retransmission as required.
8. Wire alarm contacts as required.
9. Verify that correct terminal wiring connections have been made.
10. Confirm the power input voltage available is 110VAC-240VAC.
11. Following all local and federal codes, connect the power to the panel.

Control Operation:

The MV1-TP panel is equipped with a colored touch screen interface. All supervisory and control features are accessed through this HMI (human machine interface). Most graphics and all buttons are interactive. Touching a button or graphic will open a window to more options and functions or activate devices on the valve.

Login Window:

Touch the LOGIN button to enable the PASSWORD input box.

The HMI is equipped with access controls that allow specific users to access certain parts of the controller and restrict them from others. There are two users: OPERATOR and ADMINISTRATOR.

Operators have restricted access and can adjust the following options:

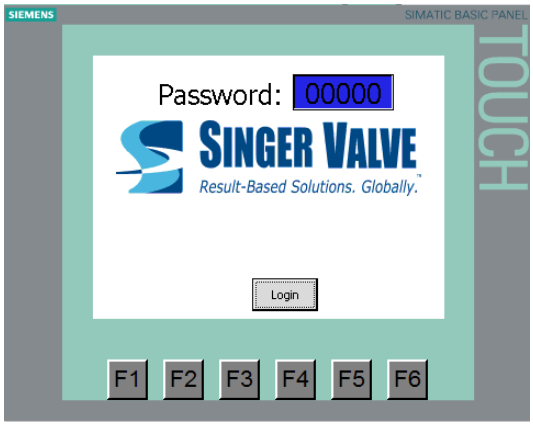
- Change Process Control Set Points
- Enable/Disable Specific Process Controls
- Enable/Disable Manual Control

Administrators have full access to the following configuration options in addition to operator options:

- Configure Process Variable Transmitter Ranges and Calibration Factors
- Configure Remote Set Point Input Ranges and Calibration Factors
- Configure Controller Tuning Parameter for Stabilizing Control

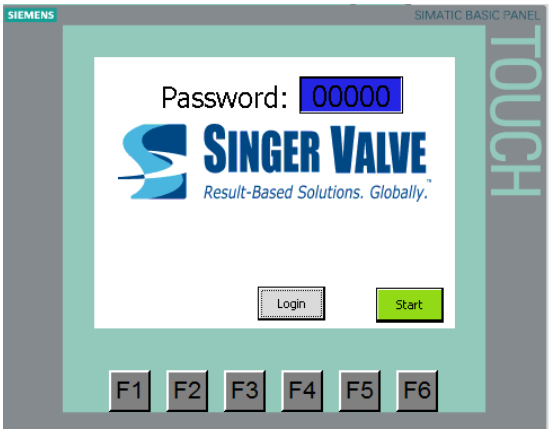
12850-87th Avenue
Surrey, BC. Canada. V3W 3H9
Ph: 604-594-5404
Fx: 604-594-8845
www.singervalve.com

Login Window:



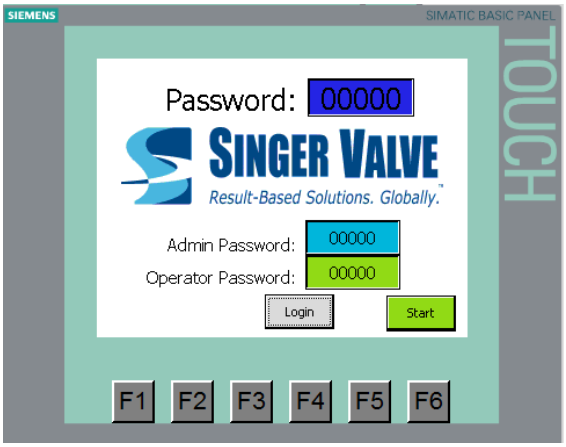
- To enter the password, touch the blue box to initiate keypad entry
  - Default Operator Password: **9999**
  - Default Administrator Password: **9998**

Operator Window:



Touch the START button to complete the login procedure and move to Main System Window

Administrator Window:



Touch the START button to complete the login procedure and move to Main System Window

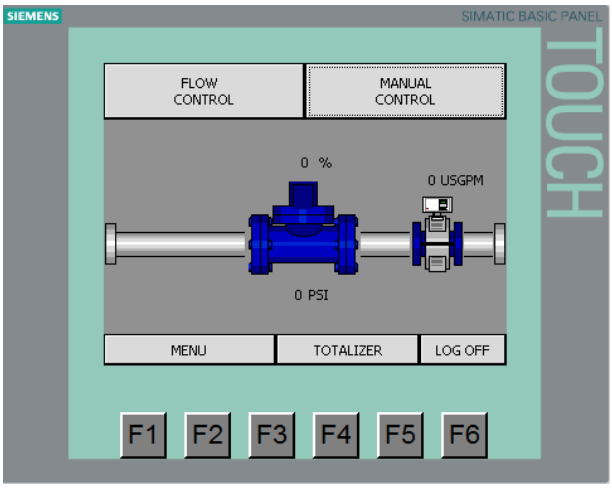
12850-87th Avenue
Surrey, BC. Canada. V3W 3H9
Ph: 604-594-5404
Fx: 604-594-8845
www.singervalve.com

Changing Passwords (Administrators Only):

- Log-In as an Administrator
- Upon successful password entry, the current passwords for the operators and administrators will appear.
- Change the passwords by touching the light blue/green box and entering the new passwords.
- Reenter the new password in the blue box.
- Touch the START button to complete the login procedure and move to Main System Window

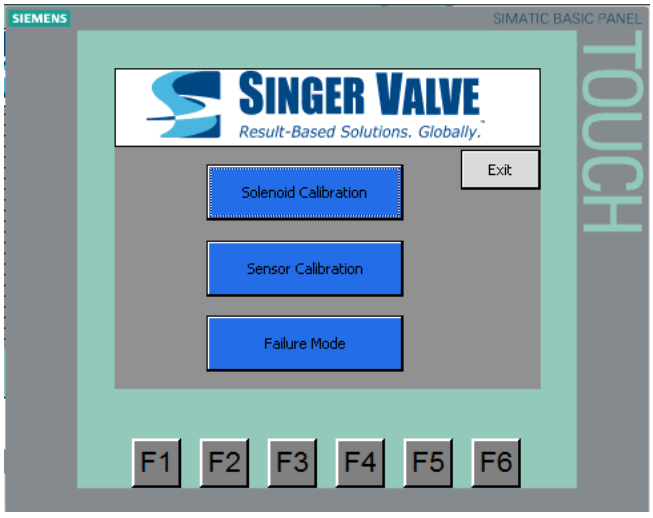
Main System Window:

The System Window is the main supervisory window of the HMI. In this window, users will be able to enter set points, configure the controller and view current system variables.



Menu Window:

Touch the MENU button to open the Menu Window. The Menu Window allows the user to access to the calibration windows.



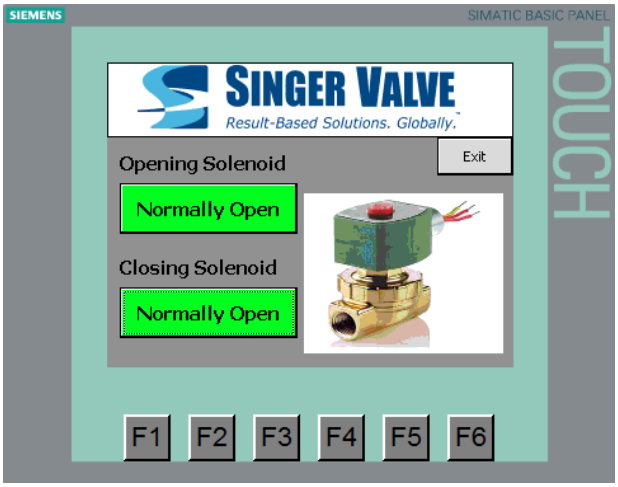
*****WARNING: When making any changes to any calibration menus ensure that all process controls and manual control of the valve are off!!**

12850-87th Avenue
Surrey, BC. Canada. V3W 3H9
Ph: 604-594-5404
Fx: 604-594-8845
www.singervalve.com

Solenoid Calibration Window:

Touch the MENU button, then the SOLENOID CALIBRATION button to open the Solenoid Calibration Window. Solenoid Calibration Window allows the user to specify the orientation of the solenoids. Specify the opening and closing solenoids orientation by pressing the NO/NC toggle button until the correct orientation is selected.

- NO: Normally Open Orientation Solenoid. The Solenoid de-energized allows water to flow through it. When the solenoid is energized no water can flow through it
- NC: Normally Closed Orientation Solenoid. The Solenoid de-energized does not allow water to flow through it. When the solenoid is energized water can flow through it

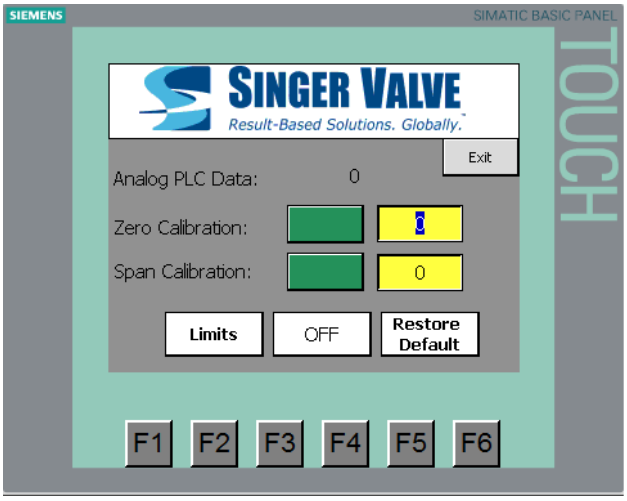


Sensor Calibration Window:

Touch the MENU button, then the SENSOR CALIBRATION button to open the Sensor Calibration Window. The Sensor Calibration Window allows the user to calibrate the input analog signals for the Process Variables and Remote Control Set Points. Calibrating the signal is useful to ensure proper operation and set point accuracy.

To calibrate a specific analog input signal touch the button matching that specific input. This will bring up the Calibration Window with the real time Analog Signal being received.

12850-87th Avenue
Surrey, BC. Canada. V3W 3H9
Ph: 604-594-5404
Fx: 604-594-8845
www.singervalve.com



The PLC controller has an analog input that receives a 4-20mA signal from the Process Variables or Remote Control Set Points. The real time signal being received by the PLC is displayed in the Analog PLC Data field. This value should range from 5400 to 27600.

****NOTE: If the Analog PLC Data is currently reading near zero, the Process Variables or Remote Control Set Points are malfunctioning or are wired incorrectly.**

To begin calibration of the Process Variables or Remote Control Set Points the first step is to press the ON/OFF toggle button to the ON position. Remember to press the ON/OFF toggle to the OFF position once the calibration has been completed.

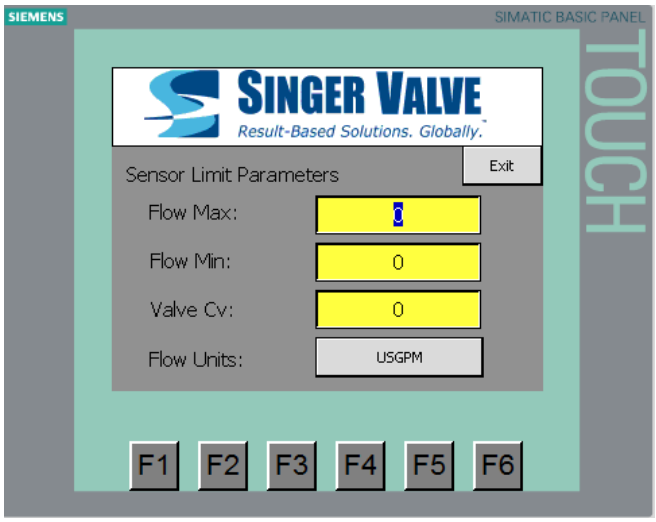
Zero Calibration: Apply a 4 mA signal (zero value of Process Variables or Remote Control Set Point) to the transmitter signal line. The PLC Analog Data should show a value that is approximately 5400. Press the green button to set.

Span Calibration: Apply a 20mA signal (max value of Process Variables or Remote Control Set Point) to the transmitter signal line. The PLC Analog Data should show a value that is approximately 27600. Press the green button to set.

Restore Default: Pressing the RESTORE DEFAULT button will restore manufactures estimated zero and span values.

12850-87th Avenue
Surrey, BC. Canada. V3W 3H9
Ph: 604-594-5404
Fx: 604-594-8845
www.singervalve.com

To specify the limits of the input signal touch the LIMITS button. This will bring up the Limits Calibration Window for the specific sensor being set. Enter in the Sensor Min (value of Process Variable Transmitter at 4mA) and Sensor Max (value of Process Variable Transmitter at 20mA). Also specify the units of the sensor by pressing the Units button.



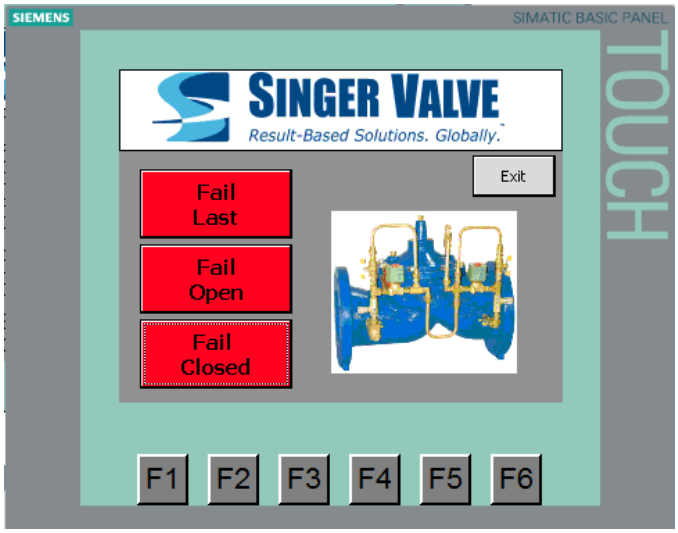
****NOTE: See manufacture details of the Process Variable Transmitters when specifying Sensor Min and Sensor Max.**

Failure Mode Calibration Window:

Touch MENU button, then the FAILURE MODE button. The failure modes are programmed to force the valves into a condition where the valve will fail in a safe manner in case the Process Variables or Remote Control Set Points signals are lost.

The following failure modes are available:

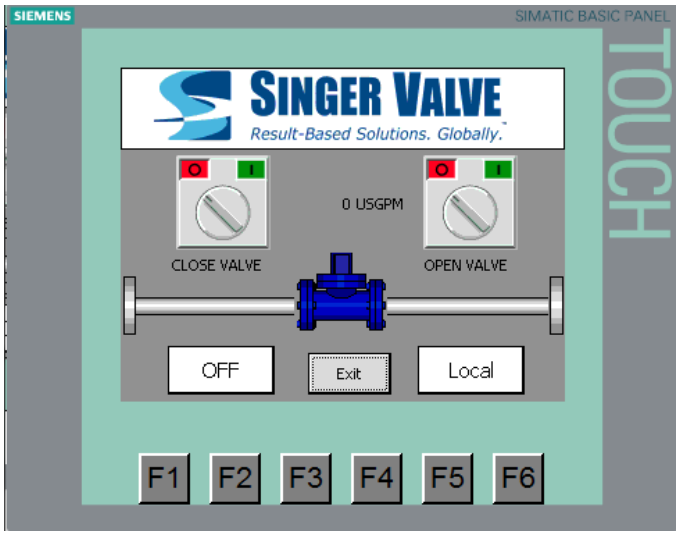
- **Last Position**: Valve will fail on its last position. If signals are lost, the valve will remain in its current position
- **Fail Open**: If signals are lost, valve will be forced open.
- **Fail Close**: If signals are lost, valve will be forced to close



12850-87th Avenue
Surrey, BC. Canada. V3W 3H9
Ph: 604-594-5404
Fx: 604-594-8845
www.singervalve.com

Control Window:

Touch the CONTROL button. The Control Window allows the user to manually control of the valve using the HMI. Turning the ON/OFF toggle switch to the ON position will turn off all other process controls and enable manual control. The user can then toggle the Open Valve and Close Valve switches until the required position is reached.



Toggling the LOCAL/REMOTE switch to the REMOTE position will give manual control to a remote system input. This will allow a remote SCADA input to have access to toggling the ON/OFF switch and the Open Valve and Close Valve toggles switches. Switching to REMOTE position will also disable the local user from being able to toggle the ON/OFF switch. To regain local control the LOCAL/REMOTE toggle needs to be put back to LOCAL

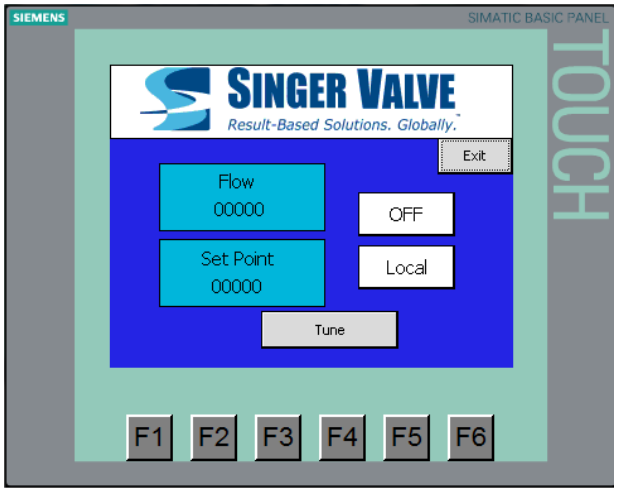
****NOTE: Only put the LOCAL/REMOTE toggle in the Remote position if the remote input signals are features that are available in the users system.**

12850-87th Avenue
Surrey, BC. Canada. V3W 3H9
Ph: 604-594-5404
Fx: 604-594-8845
www.singervalve.com

Flow Control Window:

Touch the FLOW CONTROL button. The Flow Control Window gives the user the ability to locally control the flow set point. Turning the ON/OFF toggle switch to the ON position will turn off manual control, disable all other process controllers, and enable flow control.

The TUNE button allows the user to access the tuning parameters for Flow Control. See Tune Window for more information on settings.



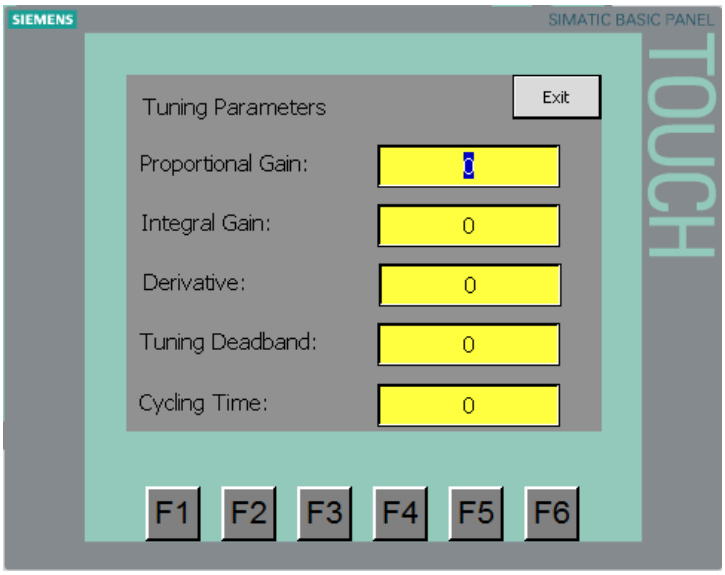
Toggling the LOCAL/REMOTE switch to the REMOTE position will allow the system to receive a remote set point. This will allow a remote SCADA input to have control over the valve process control. Switching to REMOTE position will also disable the local user from being able to toggle the ON/OFF switch. To regain local control, the LOCAL/REMOTE toggle needs to be put back to LOCAL

****NOTE: Only put the LOCAL/REMOTE toggle in the remote position if the remote input signals are available. If the remote set point is not connected the valve will go into failure mode.**

12850-87th Avenue
Surrey, BC. Canada. V3W 3H9
Ph: 604-594-5404
Fx: 604-594-8845
www.singervalve.com

Tuning Window:

The tuning window allows the user access to the tuning parameters of the process control. Each process control has its own tuning parameters.



PID Control

The MV1-TP uses a PID control algorithm for precise control of the process variable. A measure of the error is given by the difference between the set point (SP) and the process variable (PV). The algorithm uses the coefficients to derive a "corrective effort" factor. This factor controls the duty cycle of the relay outputs, which in turn controls the position of the valve to bring the error to zero (Actual flow equals required flow or SP = PV).

PID algorithm consists of three different control functions:

- The P control or the ***Proportional*** control produces a proportional corrective effort with respect to the SP and PV error. When the error is large, the corrective effort will be high; when the error is small, the corrective effort will be low. Consequently, a small **P** value would produce a smaller corrective effort than a high **P** value, given the same error between SP and PV.
- The I control, or ***Integral*** control, looks at the accumulated error over a period, and produces a corrective effort based from this "history" of errors. Once the PV equals the SP (error equals 0), the accumulated errors are "reset" to 0.
- The D control, or ***Derivative*** control, determines the rate of change of the PV and produces a corrective effort based from this rate of change. The **D** coefficient determines the corrective action when the flow (PV) changes rapidly.

A properly tuned PID controller will steadily and precisely drive the PV towards the SP, with minimum or no overshoot and oscillation. Note these points when adjusting the PID coefficients:

Too high *Proportional* gain will cause overshoot and oscillation of the PV around SP, too low causes slow response of the PV.

Too low *Integral* time causes overshoot and oscillation of the PV around SP. A high integral time will cause a slower the corrective effort.

Too high *Derivative* time causes the corrective effort to fluctuate and causes overshoots of the PV. Low derivative causes slow response to fast changing PV.

12850-87th Avenue
Surrey, BC. Canada. V3W 3H9
Ph: 604-594-5404
Fx: 604-594-8845
www.singervalve.com

Singer valve implements Parallel (non-interacting) PID algorithm in the closed loop control. The PID equation is as follows:

$$Output = K_C(Error) + \left[\frac{T_S}{T_i}(Error) + Bias\right] + \left[\frac{T_D}{T_S}(Error - Old\ Error)\right]$$

- Error = $SP_n - PV_n$,
- Old Error = $SP_{n-1} - PV_{n-1}$
- K_c= Gain 0-100%;
- T_i = integral time in minutes;
- T_d = derivative time in minutes;
- T_s = sampling time in seconds;
- Bias = summation of errors every sampling

The MV1-TP is also factory configured for the following initial start-up conditions:

- PROPORTIONAL Gain 1.0
- INTEGRAL Coefficient 9999 seconds
- DERIVATIVE Coefficient 0 seconds

Tuning Deadband

To stop the process control from constantly being active a dead band is attached to the set point. Therefore when the process variable is within the set point +/- dead band the valve solenoids will remain inactive. This stops the solenoids from constantly energizing and de energizing hunting for the set point. The finer tuning use a smaller deadband.

For example:

Set point: 100
Deadband: 5
The controller will stop searching for the set point at a process value between 95 to 105.

Cycle time

The solenoids are controlled using pulse width modulation. The solenoid is controlled based on a fixed cycle time with a variable duty cycle.

For example:

Given: Cycle Time - 10 seconds

Event:		Reaction
Controller Output:	100%	Duty cycle is 100%, Solenoid On for 10 seconds
Controller Output:	10%	Duty cycle is 10%, Solenoid On for 1 second

Adjust the cycle time if the valve is required to open/close slowly or fast. For finer tuning use a smaller cycle time.

****WARNING: Too small a cycle time may prevent the valve from moving. Per each pulse duty cycle there is not enough time allotted for water to be removed/added to the diaphragm.**