The MFT B-Series Flow Controller.

There are many options available to control a process flow ranging from electronic, mechanical to pneumatic. In the industrial market there are PLCs, PCs, valves and flow meters, all of which are capable of implementing a flow control system. The features on these controllers range from very basic to advanced, with learning curves to match.

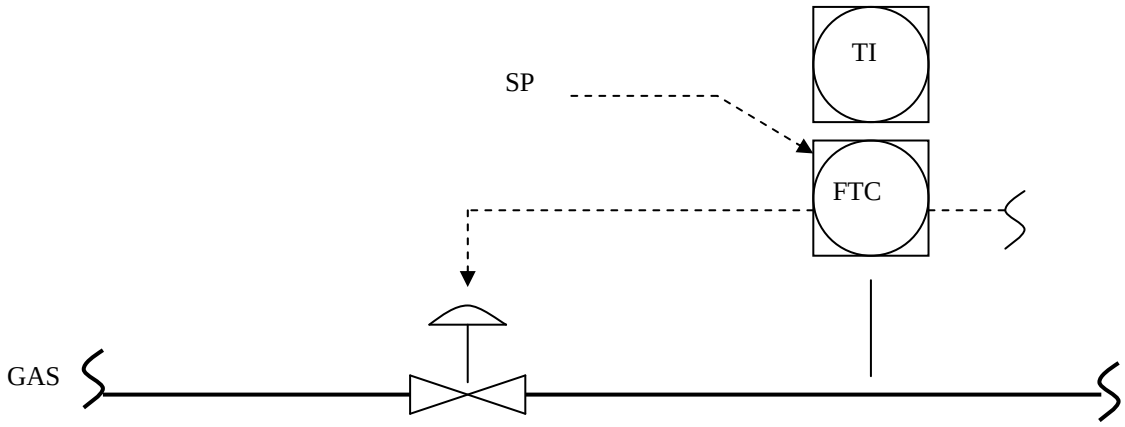
The MFT B-Series has a very basic built-in flow controller which is manually configured. If a simple local flow control PID loop fits into your application, then this may be all you need. This section describes the setup of the flow control functions, nomenclature and also includes a short tutorial on feedback control systems.

Summary of capabilities

Control Output	• 4-20 mA positional signal • Fixed output position control for testing in program mode (% of AO range).
Set Point Register	• Fix flow, menu programmed. • Modbus write register
Analog Input Set point	• 4-20 mA input, engineering units scaled.
Reference Meter	• Meter 1, Flow Rate
PID	• Manual gain setting. • Normalized coefficients **P**: gain **I**: time constant **D**: time constant

Flow Controller Setup

To use the MFT B-Series as an automatic flow controller, you connect one of its 4-20 mA outputs to your control valve, damper or motor controller and it will regulate the flow based on a fixed set point register flow value or an analog Input for the set point.



The example above has the MFT B-Series actuating a valve with external set point of the flow rate. The second 4-20 mA output is sending the flow rate elsewhere, although it could be temperature instead of flowrate. PID control of the process is manually configured. The control output may be commanded from the LCD display to verify full range operation of the control loop or just position the output.

PID Setup Steps

1. Mechanically mount all components, test for leaks and check flow control actuator motion or motor controller action.
2. Electrically connect all components. Decide which 4-20 mA output will be the control output and wire this in. The default output of the MFT units is for loop powered 4-20 mA. If you need it to be self powered, see the wiring diagrams.
3. Configure the output 4-20 mA scale for the control device using engineering units of velocity or flow rate
4. Configure the set-point source:
   - External analog input. Configure the 4-20 mA scale with the proper engineering units.
   - Set point register: In program mode the flow rate value is entered to control the flow at a fixed value.
   - Modbus commanded set point. This is a floating point engineering unit or Flow rate or Velocity based command.
5. Tune the control loop for stable operation over the flow range of interest.

The setup of the above parameters are done from *Program Mode* of the Flow meter which are covered next.

Press **P** to go to the *Program Mode*. Enter the tech password (654321 default) followed by **E**. Press the **P**, **^**, or **v** repeatedly until you reach the display,

```
PRESS E TO SET
PID DATA
```

Press **E** to see or change the PID parameter values.

```
PID IS     ON
^=ON  v=OFF
```

Press the **^** to turn the PID ON or the **v** to turn OFF. Press **E** to accept the selection or **P** to skip to the next display.

```
PID OPERATION
^v AUTOMATIC
```

Press **^** or **v** to select the mode of operation. The selection can be Automatic or Manual, select the automatic for constant flow control or manual for manual control. Press **E** to accept the selection or **P** to skip to the next display.

```
CONTROL TO ^v
FLOW RATE
```

Press **^** or **v** to select the measurement to be controlled. The selection can be Flow rate or Velocity, select the Flow rate for volumetric and Mass flow or the Velocity for Velocity. Press **E** to accept the selection or **P** to skip to the next display.

```
PID SETPT REF ^v
ANALOG INPUT
```

Press the **^** or **v** to select the PID set point reference. The selection can be ANALOG INPUT or SETPT REGISTER for PID reference set point. The SETPT REGISTER is selected in *Program Mode* or with the Modbus 4x register 44. If ANALOG INPUT is selected make sure to setup the External Input parameter

data. If the SETPT REGISTER is selected, enter the set point value in this menu. Press **E** to accept the selection or **P** to skip to the next display.

```
PROPORTIONAL(KP)
GAIN   X.XXXXXX
```

Enter the Proportional gain coefficient and press **E** to accept the new entry or **P** to skip to the next display.

```
INTEGRAL TC
(SEC)  X.XXXXXX
```

Enter the Integral time constant and press **E** to accept the new entry or **P** to skip to the next display. The integral gain is the Proportional gain divided by the Integral time constant. This linking of the integral time constant the proportional gain makes it easier to manually tune the system.

```
DERIVATIVE TC
(SEC)  X.XXXXXX
```

Enter the Derivative time constant and press **E** to accept the new entry or **P** to skip to the next display. The Derivative gain is the Proportional gain multiplied by the Derivative time constant. This linking with the proportional gain make it easier to manually tune the system.

```
PID LOW LIMIT
X.XXXXXX UNIT
```

Enter the PID low flow control limit; this limit is the lowest flow rate or velocity that it can control. It will saturate at this point. Press **E** to accept the new entry or **P** to skip to the next display.

```
PID HIGH LIMIT
X.XXXXXX UNIT
```

Enter the PID high flow control limit; this limit is the highest flow rate or velocity that it can control. It will saturate at this point. Press **E** to accept the new entry or **P** to skip to the next display.

```
SETPT REGISTER
```

```
X.XXXXXX UNIT
```

If SETPT REGISTER reference is selected, enter the control set point value. Press **E** to accept the new entry or **P** to skip to the next display. This parameter can be changed via Modbus using register 44 in the 4x command reference group.

Setup for the PID 4-20 mA Control Output

The PID control output is a 4-20 mA positional signal. It uses either one of the 4-20 mA analog outputs. Before the PID signal is outputted, the analog output must be setup to assign to the PID output. To setup, perform the following instructions:

Press **P** to go to the *Program Mode*. Enter the tech password (654321 default) followed by **E**. Press the **P**, **^** or **v** repeatedly until you reach the display,

```
PRESS E TO SET
ANALOG OUTPUTS
```

Press **E** to see or change the Analog Output parameter values.

```
PRESS ENTER FOR
ANALOG OUT X
```

Press **^** or **v** to select the Analog Output to configure or enter the number (1 or 2). If the flow rate is used on AO1, then the PID output can be set for AO2. Press **E** to accept the selection or **P** to skip to the next display.

```
ANALOG OUT X ^v
ASSIGN TO PID
```

Press **^** or **v** to to select the Analog Output to be assigned to PID. Press **E** to accept the selection or **P** to skip to the next display.

```
LO=X.XXXXX UNIT
AT 4.000 mA
```

Enter the Analog Output scale at 4.00 mA output (zero), this value is usually zero. Press **E** to accept the new entry or **P** to skip to the next display.

```
HI=X.XXXXX UNIT
AT 20.000 mA
```

Enter the Analog Output scale at 20.00 mA output (Span), this value is usually the approximate flow rate or velocity when the valve or damper is 100% open or the fan is at full speed (controlled device). Press **E** to accept the new entry or **P** to skip to the next menu item.

Setup for the External Input for PID Remote Reference

The PID can be operated from a SETPT REGISTER, as a fixed value which also has a Modbus register allowing remote network control. Alternately, a remote ANALOG INPUT (4-20 mA) current can be the set point. To setup the Analog Input for PID set point, perform the following instructions: Press **P** to go to the program mode. Enter the tech password (654321 default) followed by **E**. Press the **P**, **^** or **v** repeatedly until you reach the display,

```
PRESS E TO SET
EXT INPUT DATA
```

Press **E** to see or change the External Input parameter values.

```
NEXT USAGE ^v
PID EXT. REF
```

Press **^** or **v** to select the External Input usage, select the “PID EXT. REF”. Press **E** to accept the selection or **P** to skip to the next display.

```
LO=X.XXXXX UNIT
AT 4.000 mA
```

Enter the External Input scale at 4.00 mA Input (zero), this value is the minimum PID set point that can be used. Press **E** to accept the new entry or **P** to skip to the next display.

```
HI=X.XXXXX UNIT
```

```
AT 20.000 mA
```

Enter the External Input scale at 20.00 mA Input (Span), this value is usually the maximum PID set point that can be used. Press **E** to accept the new entry or **P** to skip to the next display.

```
FILTER TC
IS X.XXXX SEC
```

Enter the External Input digital filter time constant, the default value is 0.5 second. Press **E** to accept the new entry or **P** to skip to the next menu item.

PID CONTROLLER OPERATION

The PID controller can be setup to operate in the Automatic mode or in the Manual mode.

PID Control in Automatic Mode

After all the setup is done, the PID action will start. The flow rate or velocity is maintained to the PID set point value. The PID control is in the Automatic mode if the PID operation selected is AUTOMATIC. Refer to the section “Set PID Data”.

PID Control in Manual Mode

The PID control is in the Manual mode if the PID operation selected is MANUAL. Refer to the section “Set PID Data”. The manual control is performed by manually adjusting the PID output or 4-20 mA position signals. To manually control the PID perform the following instructions: Press **P** to go to the program mode. Enter the user password (654321 default) followed by **E**. Press the **P**, **^** or **v** repeatedly until you reach the display,

```
PRESS E TO MANL
CONTROL PID
```

Press **E** to manually control the PID.

```
OUT=XXX PERCENT
^=OPEN v=CLOSE
```

Press the **^** to increase the gas flow rate, **v** to decrease the gas flow rate and **C** to exit. The 100 percent means that the maximum PID limit equivalent output current is reached and the zero percent means that the minimum PID limit equivalent output current is reached.

Displaying the Flow meter Reading

To see the flow meter reading, hold the Executive scroll reading or press the **D** to get in to the display mode.

```
DISPLAY NEXT ^v
METER #1, FLOW
```

Press **^** or **v** to select the display item, selections are “METER #1, FLOW” for flowrate meter readings, METER #2, TEMP” for temperature readings and “EXTERNAL INPUT”. REF” for External Input readings. To see the flow meter readings, select the “METER #1, FLOW”. Press **E** or **D** accepts the selection or **C** to return to the Executive Mode.

```
ID: FLOW RATE
RT:XXXXXX.XX HRS
```

The first display item is the meter identification and the runtime in hours. Press the **^** or **D** to see the next display or the **v** to scroll through the display backwards.

```
FLOW RATE
XXX.XXX UNIT
```

This is the gas flow rate reading. Press the **^** or **D** to see the next display or the **v** to scroll through the display backwards.

```
UNIT=XXXXX.X
ET= X.XXXX MIN
```

This is the total flow and elapsed time reading. Press the **^** or **D** to scroll through the next display or the **v** to see the display backwards.

```
VELOCITY
XXX.XXX UNIT
```

This is the gas velocity reading. Press the **^** or **D** to see the next display or the **v** to scroll though the display backwards.

```
REF. DENSITY
X.XXXXX UNIT
```

This is the gas reference density. Press the **^** or **D** to see the next display or the **v** to scroll though the display backwards.

```
FLOW AREA
XX.XXXX UNIT
```

This is the effective flow area. Press the **^** or **D** to see the next display or the **v** to scroll though the display backwards.

```
CORRECTION
FACTOR X.XXXX
```

This is the current correction factor reading. Press the **^** or **D** to see the next display or the **v** to scroll though the display backwards.

Displaying the PID Remote Reference Reading

To see the External Input reading, press the **D** to get in to the *Display Mode*. The following are the displayed items:

```
DISPLAY NEXT ^v
ANALOG INPUT
```

Press **^** or **v** to select the display item, selections are “METER #1, FLOW” for flowrate meter readings, METER #2, TEMP” for temperature readings and “EXTERNAL INPUT”. for External Input readings. To see remote PID reading,

select the “EXTERNAL INPUT”. Press **E** or **D** accepts the selection or **C** to return to the Executive Mode.

```
IN=XX.XXX mA
AT YYYY.YY UNIT
```

This is the PID reference reading. Press the **D** or **C** to return to the *Executive Mode.* The mapping of input current to flow rate or velocity was previously configured in the Set External Input data menu.

PID Tuning.

Manual tuning of a PID loop can be done by following the steps listed below.

1. Place the unit in manual control mode or open loop control. Increase or decrease the 4-20 mA output by 5 to 10%. Note the flow response change.

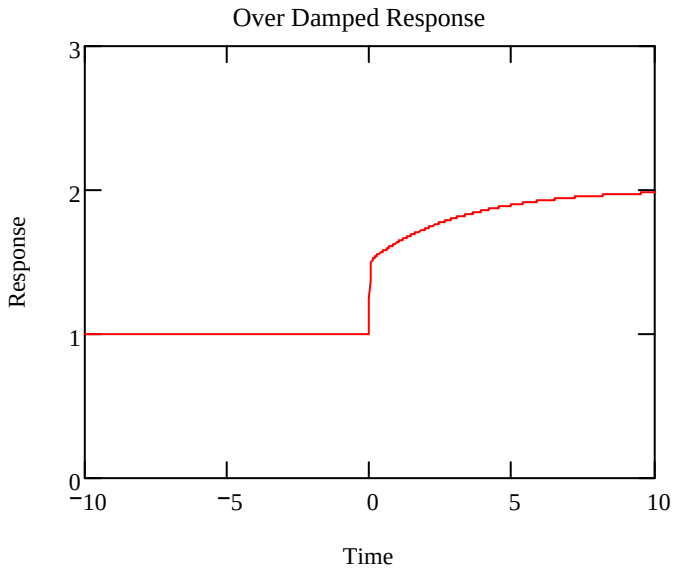
   Then the Proportion Gain starting point is: 2 x Output change (engineering units)/(Flow Response change) *(this is a unit less number)*

   Note the system response time (0 to 63% change) to the change. Set the Integral response time to this number.

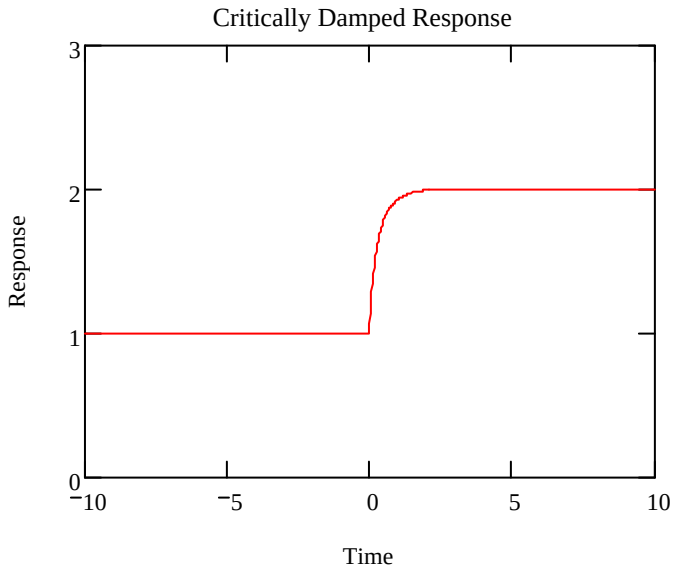
   Set the derivative time constant to 1/6 of the integral time.

2. Now place the system in closed loop or automatic operation. Do a small change of the set point and observe how it reacts.

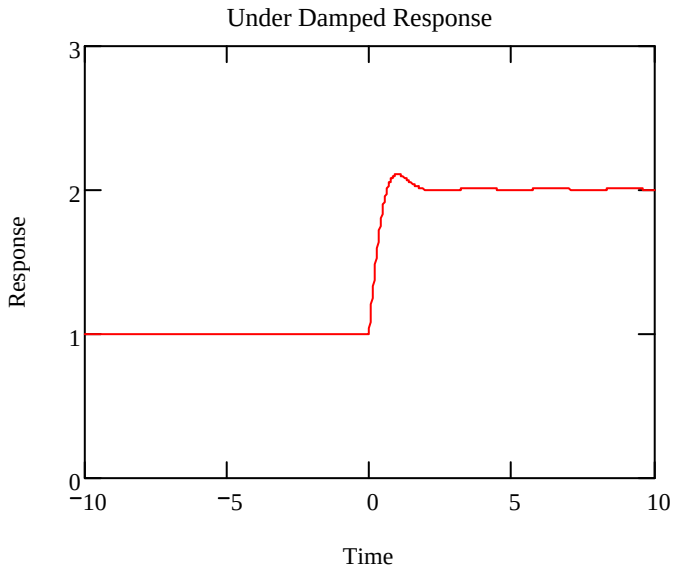
Example system responses



Increase the proportional Gain and reduce the integral time constant.



System tuned just right. Note the parameters and you are done.



Reduce the proportional gain and increase the integral time constant by the same percentage, say 25%.

3. Some systems require different parameters at different operating points. The best way to handle this is to optimally tune it at the normal flow rate and live with the non-ideal response at the other flow rates. If the variation in loop stability is too large over the normal operating flow ranges, then an advanced PID controller with variable gain settings will be required instead of the built-in flow controller.