

# Benefits of auto shut-off on mass flow controllers

## Technology Update

# UNIT

Auto shut-off is a feature on Celerity's Unit MFCs that ensures that the valve is closed when the setpoint is lower than normal (2-100%) control range.

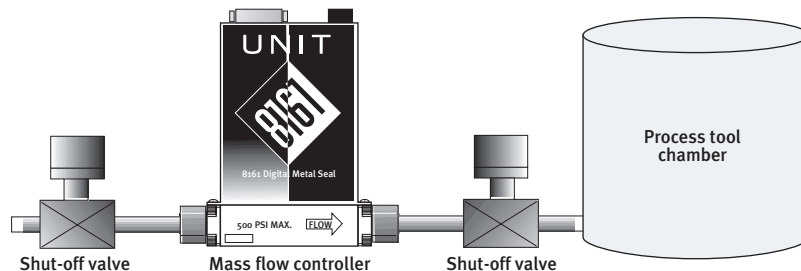


Figure 1. MFC and isolation valve

## background

Auto shut-off is an MFC feature that guarantees that the MFC control valve is closed when the setpoint is lower than the normal 2% to 100% control range. The auto shut-off feature assures repeatable MFC step responses without overshoot, which in turn reduces process contamination from particulate as well as uncontrolled processes. This feature is of tremendous value as the MFC does not attempt to control when the user specifically wishes the MFC to close. The actual function of the auto shut-off feature is to guarantee a valve closed condition if the MFC control setpoint is set below 1.3% of full scale or 65 mV. This means that regardless of the MFC flow sensor output, the valve will be placed in a closed condition if the setpoint is set below the auto shut-off threshold. The auto shut-off feature comes at the expense of losing the MFC control range from 0.0% to 2.0% of full scale. Controller operation between 0.0% and 2.0% of full scale is not specified or recommended so the expense is often considered minimal.

## application example

In this example the MFC control setpoint has been set to 0.0% by the user process controller in an attempt to stop the flow of gas into a process chamber. Also the MFC sensor “no flow” output has drifted to -1.0% of full scale, and has not been re-zeroed. The User Process Tool valves on the inlet and outlet of the flow controller have been shut so that the MFC gas flow is halted (see Figure 1).

## without auto shut-off

If the MFC is not equipped with the auto shut-off feature, the MFC would attempt to control the flow with a setpoint of 0.0% because the MFC control amplifier would see a positive 1.0% setpoint and would flow to the setpoint and attempt to correct the error by opening the control valve. The MFC valve will partially open to flow at 1.0% until the pressure across the MFC equalizes. Then, since the MFC can no longer control the flow, the MFC valve will be forced wide open. When the MFC valve is forced wide open, the current flowing through the valve coil causes an increase in the MFC block temperature, which in turn can degrade the calibration accuracy and increase the valve voltage required to provide proper valve displacement.

If the process is restarted with the MFC control valve fully opened, when the gas isolation valves are opened the MFC flow will surge instantly to many times its full scale value (see Figure 2). The MFC itself sees the overflow condition, but cannot close the valve fast enough to prevent a massive flow into the process chamber. The end result is that the actual mass flow into the process chamber is uncontrolled at the start of the flow as is shown in Figure 2. Because the flow has surged, particulate contamination can be a problem as particles may be “shocked” from plumbing and filters. The process chamber gas mixture is also uncontrolled, which can create particles. The result can be contamination as well as process inconsistencies. If the control valve has been opened for a long time, the MFC temperature will have risen and the calibration accuracy may be compromised. Also, older MFCs may no longer have enough valve displacement control at higher setpoints. Auto shut-off prevents these problems by ensuring that the control valve is always de-energized with zero setpoints.

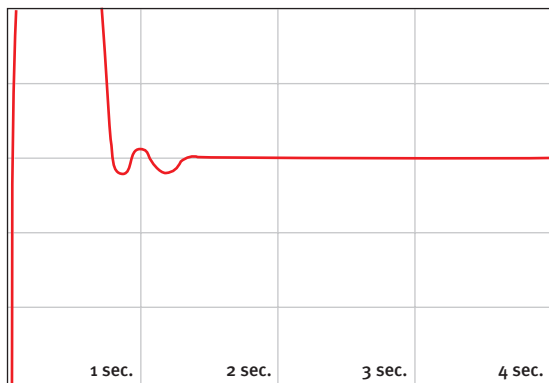


Figure 2. MFC without auto shut-off. Actual flow during overshoot may be several hundred percent of rated flow.

## with auto shut-off

If the MFC is equipped with the auto shut-off feature, the MFC would shut down at setpoints below 1.3% and thus show the actual no-flow MFC output of -1.0% of full scale. Since the MFC valve is fully closed when the user process starts, the MFC does not surge when the shut-off valves are opened and thus operates smoothly and under control. The MFC step response is always under control as the valve is always forced to a fully closed condition prior to the opening of the MFC valve (see Figure 3). Particulate contamination is reduced because the fully controlled gas velocities do not disturb any particles which may be in the gas system.

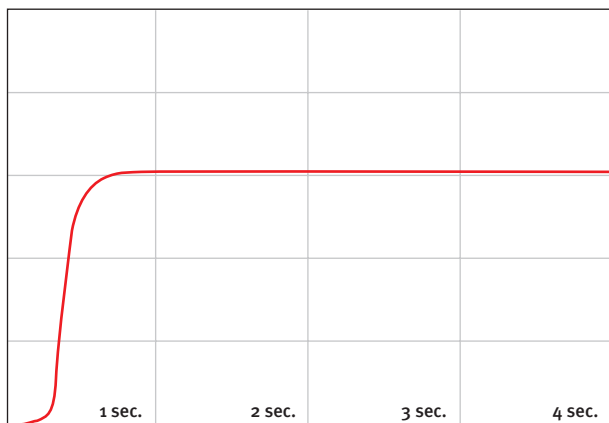


Figure 3. MFC operating with auto shut-off.

## summary

Auto shut-off is standard on Celerity's Unit MFCs and gives better results on nearly all applications. The auto shut-off feature can eliminate conditions in the process tool that force the MFC to start the gas flow with the MFC valve already fully opened. The auto shut-off feature assures consistent non-over-shooting MFC responses and reduced particle contamination.

Unit's MultiFlo™ digital MFCs offer the ability to disable auto shut-off or change the percentage at which the valve will fully close. The combination of digital electronics and Unit's MultiFlo Virtual Interface (ver. 1.01) software allows the user to manually adjust the auto shut-off from 0.0% to 10% of the indicated full scale range of the MFC. If you need assistance or if you think you do not want to use auto shut-off for your application, please contact Celerity Applications Engineering Department at (714) 921-2640. For additional information, please visit [www.celerity.net](http://www.celerity.net).



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