White Paper
July 2022

Key Features of the DeltaV™ PID Function Block

This white paper highlights several advanced features that are included in the DeltaV™ PID function block that can improve process control.

DeltaV™

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Introduction

Within the process control industry, PID has long been the dominant technique for implementing feedback control. As such, PID function blocks are one of the standards found in all commercial distributed control systems. While the DeltaV™ PID function block offers all of the functionality one would expect in a modern DCS such as series and standard execution forms, setpoint filtering, and bumpless tuning entry, DeltaV also provides advanced functionality to further improve control performance using PID. The following sections will detail advanced and powerful functionality found natively in DeltaV's PID function block.

Dynamic Reset Limiting

Dynamic reset limiting provides dynamic compensation of integral accumulation based on output response achieved. If the PID outputs to the field, then output to the field provides the measure of output response. If the PID is a primary loop in a cascade, then the PV of the secondary loop can be used as the measurement of output response. This method provides appropriate behavior in override applications as well as providing a stabilizing effect on cascade tuning.

The performance of a secondary loop in a cascade will often deteriorate as process conditions change. In that case the response of the primary loop will be affected. As illustrated in the following plot, dynamic reset limiting significantly compensates for the deterioration of secondary loop performance.

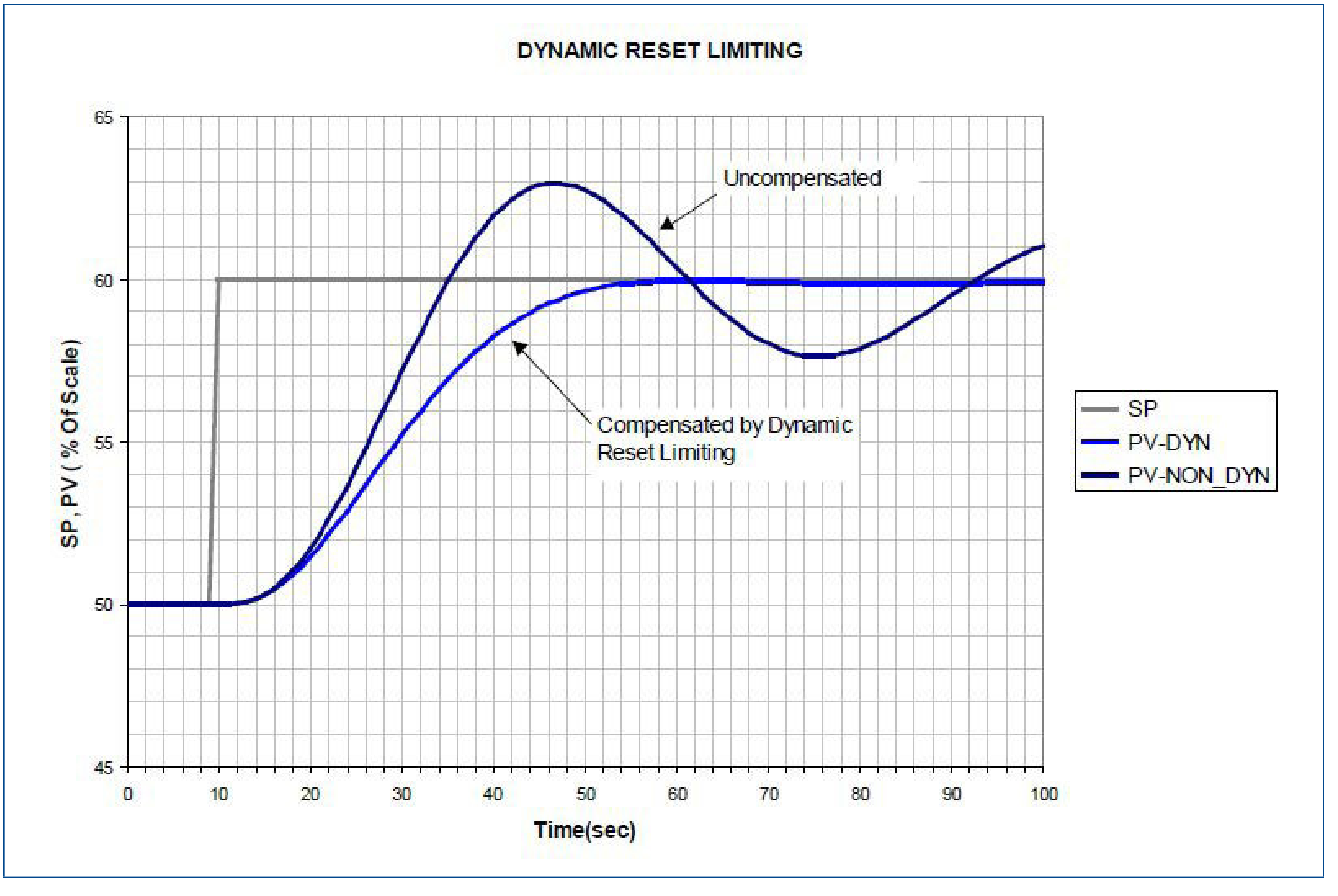

Figure 1. *Dynamic reset limiting.*

Two Degrees of Freedom

Often when tuning a control loop for disturbance rejection the setpoint response will exhibit considerable overshoot. This is particularly true when there is derivative action required and the derivative action is taken only on PV (too avoid large bumps in output as the result of modest setpoint changes). Two Degrees Of Freedom structure, provided by DeltaV, allows shaping the setpoint response by adjusting the proportional and derivative action applied to setpoint; the adjustment parameters are BETA (for proportional) and GAMMA (for derivative); tuning range is from no action to full action (0→1); Two Degrees Of Freedom is selected with the parameter STRUCTURE. The following plot illustrates the setpoint response for a loop tuned for good disturbance rejection with little or no overshoot in the disturbance response. As can be seen, adjustment of BETA and GAMMA can significantly reshape the setpoint response and drastically reduce the overshoot from that of a PID that has full proportional and no derivative action on setpoint.

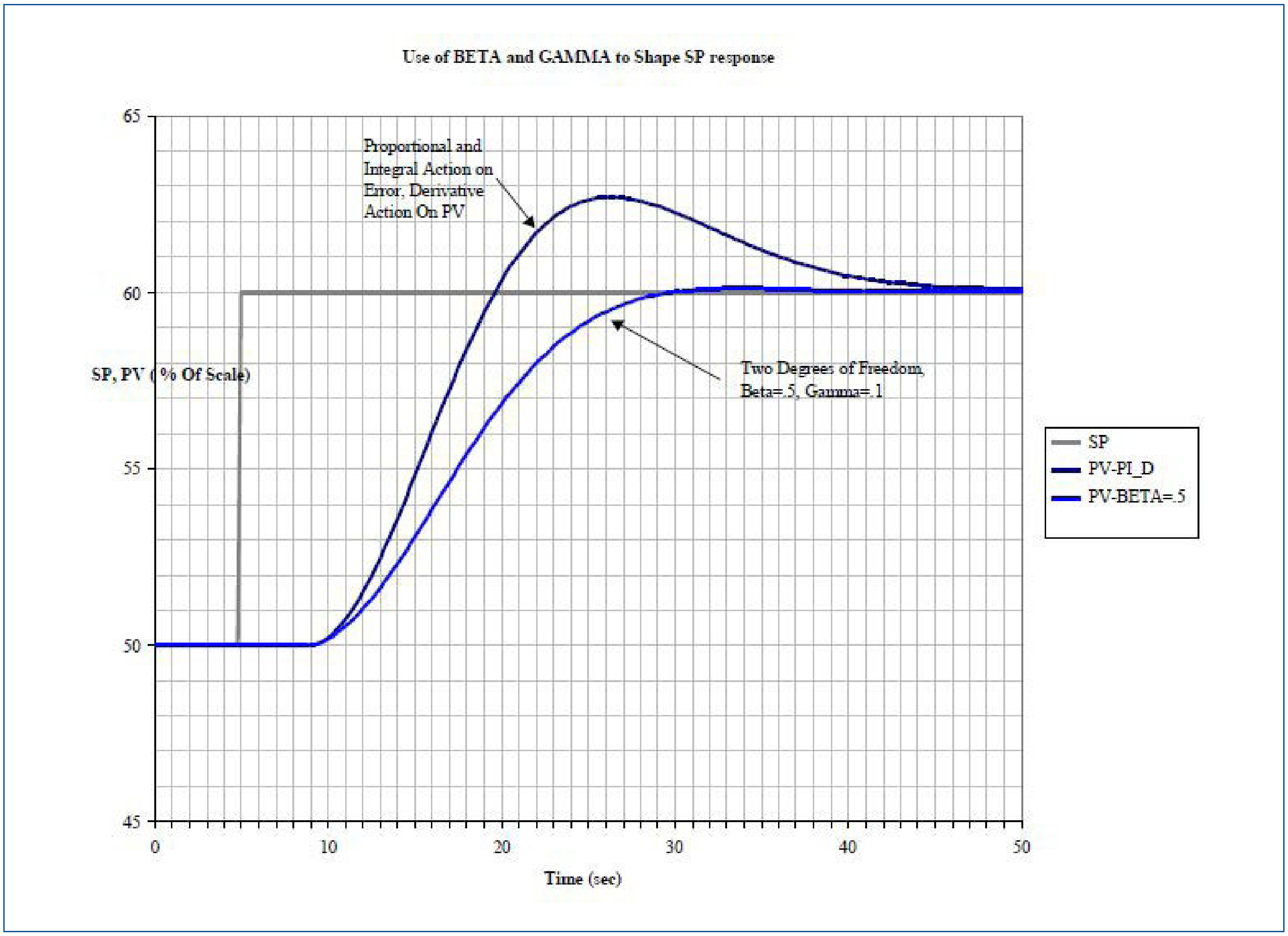

Figure 2. *Use of BETA and GAMMA to shape SP response.*

PIDPlus

Traditional PID controllers can struggle with applications where the update time is much larger than the process response time, for example when using measurements from wireless transmitters or analyzers. In a traditional PID controller, the integral and derivative modes are computed each execution of the PID block. The PID algorithm uses the execution time in the integral and derivative mode calculations. Thus, the reset and derivative contribution calculated by traditional PID may not be appropriate when used with a measurement where the default update rate is significant compared to the process response time. In such cases, the traditional PID will ramp the controller output through continual integral action even though the actual measurement has not changed. The PID is acting on old information. This behavior can make it difficult to achieve tight closed-loop control when using wireless transmitters or analyzers with sample systems.

When the PIDPlus feature of the DeltaV PID function block is enabled, the controller computes the integral and derivative mode contributions to the controller output only when there is a measurement update and uses the elapsed time between updates in its calculations. Thus, the PIDPlus only acts on new information and considers the observed change in the measurement to have occurred not in just the last PID execution time but over the elapsed time. This behavior can enable closed-loop PID control of applications that were not possible with traditional PID control.

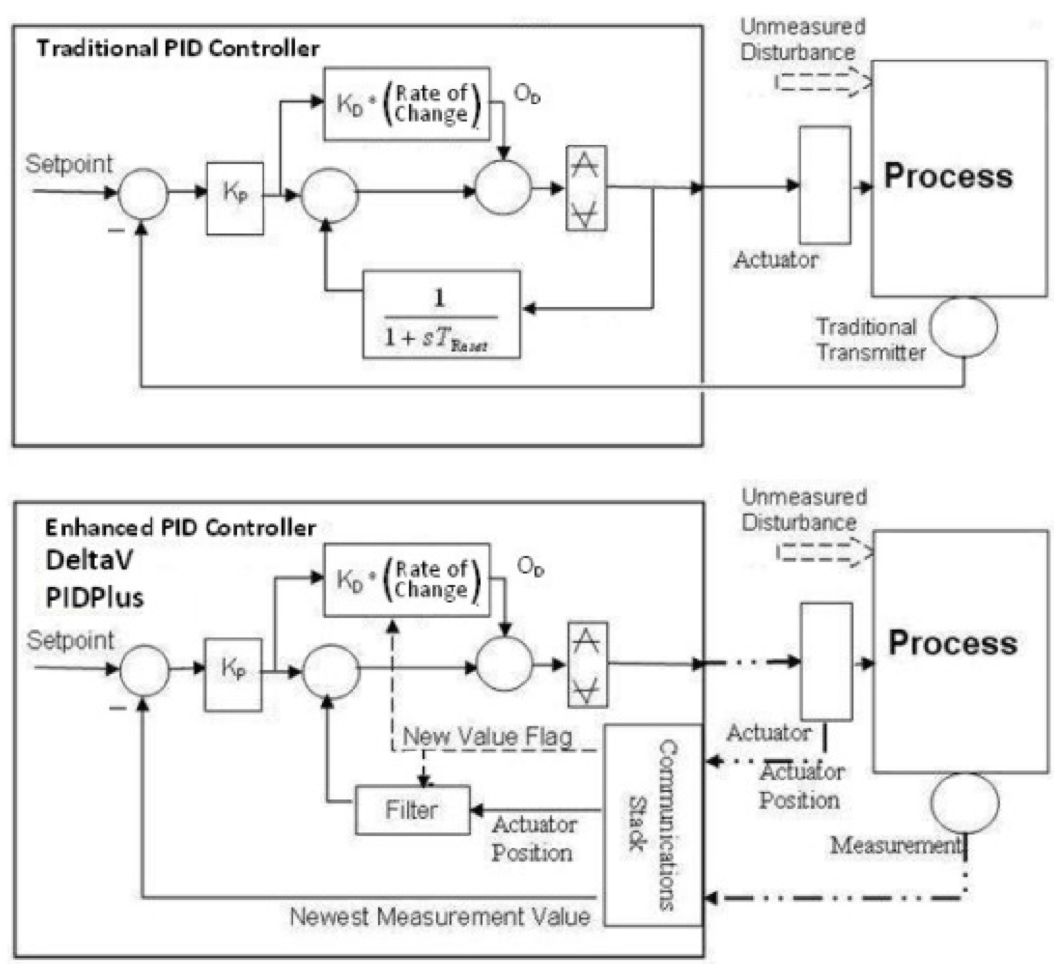

Figure 3. *Comparison of the integral and derivative mode calculations for traditional PID and PIDPlus.*

Enhanced Saturation Recovery with PIDPlus

When PIDPlus is enabled, a feature referred to as enhanced saturation recovery also becomes enabled in the PID function block.

Saturation refers to situations where the controller's output is limited at its low or high limit value. The output may remain saturated during normal operation, for example, in a pressure relief application where the control valve remains closed unless a disturbance increases the pressure to the point where the valve must open to maintain the setpoint. In other applications the control valve continually regulates during normal operation, but the output may temporarily be forced into saturation by a disturbance or setpoint change.

Enhanced saturation recovery provides control over saturation recovery, that is, how soon and at what rate the output moves off the limit. This can be controlled in DeltaV by changing the PID function block RECOVERY_FLTR parameter.

The default value of RECOVERY_FLTR is 1.0. Valid values are between 0.0 and 1.0. A value of 1.0 causes the saturation recovery identical to a PID without this parameter, decreasing RECOVERY_FLTR values result in a less filtered saturation recovery. For example, a value of 0.4 causes the valve in the fore-mentioned pressure relief application to come off the seat sooner and open faster, with less pressure overshoot. A value of 0.0 results in the most aggressive response. The PID function block uses the RECOVERY_FLTR value only when the output has been saturated continuously for a period equal to or longer than the reset time. This prevents noise from causing erratic behavior as the output approaches the limit. The below figures illustrate the change in controller response with enhanced saturation recovery.

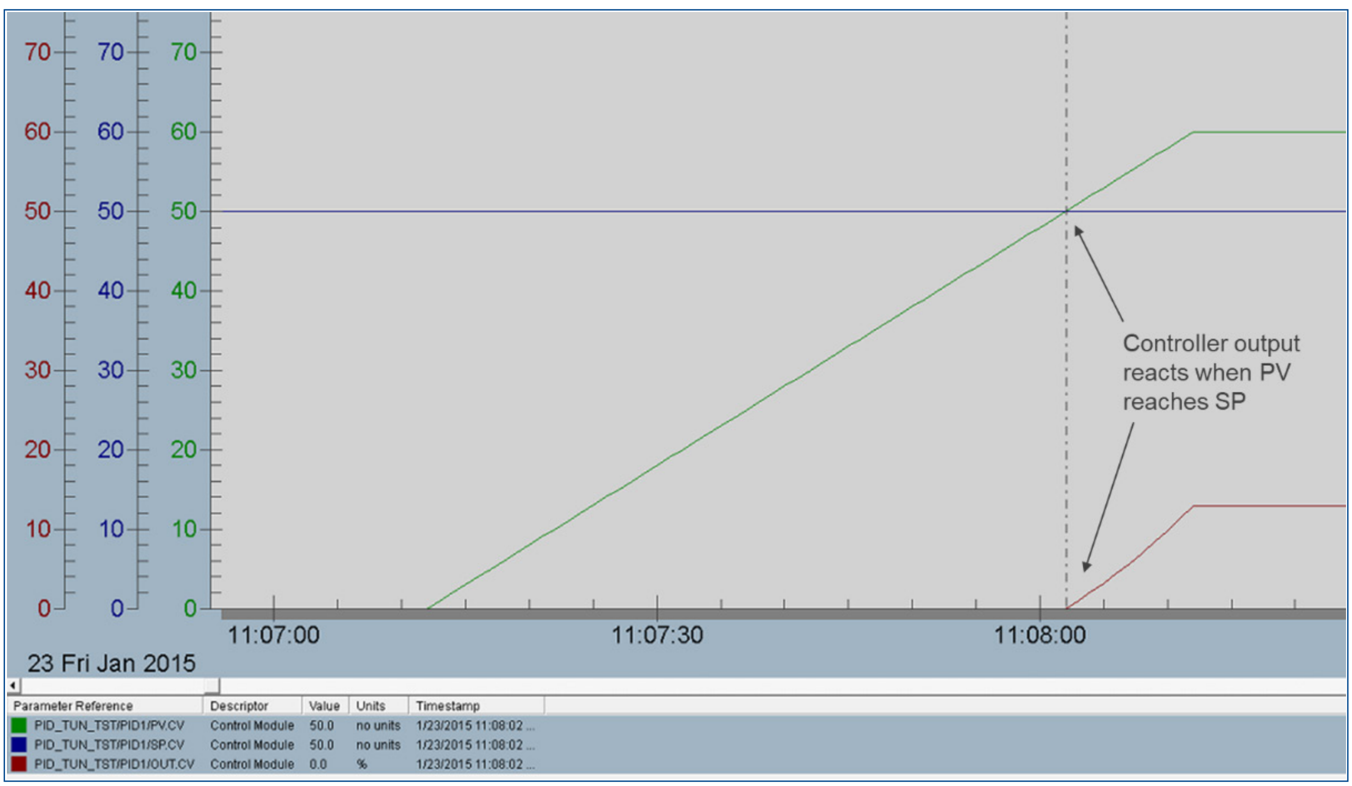

Figure 4. *Output behavior without enhanced saturation recovery.*

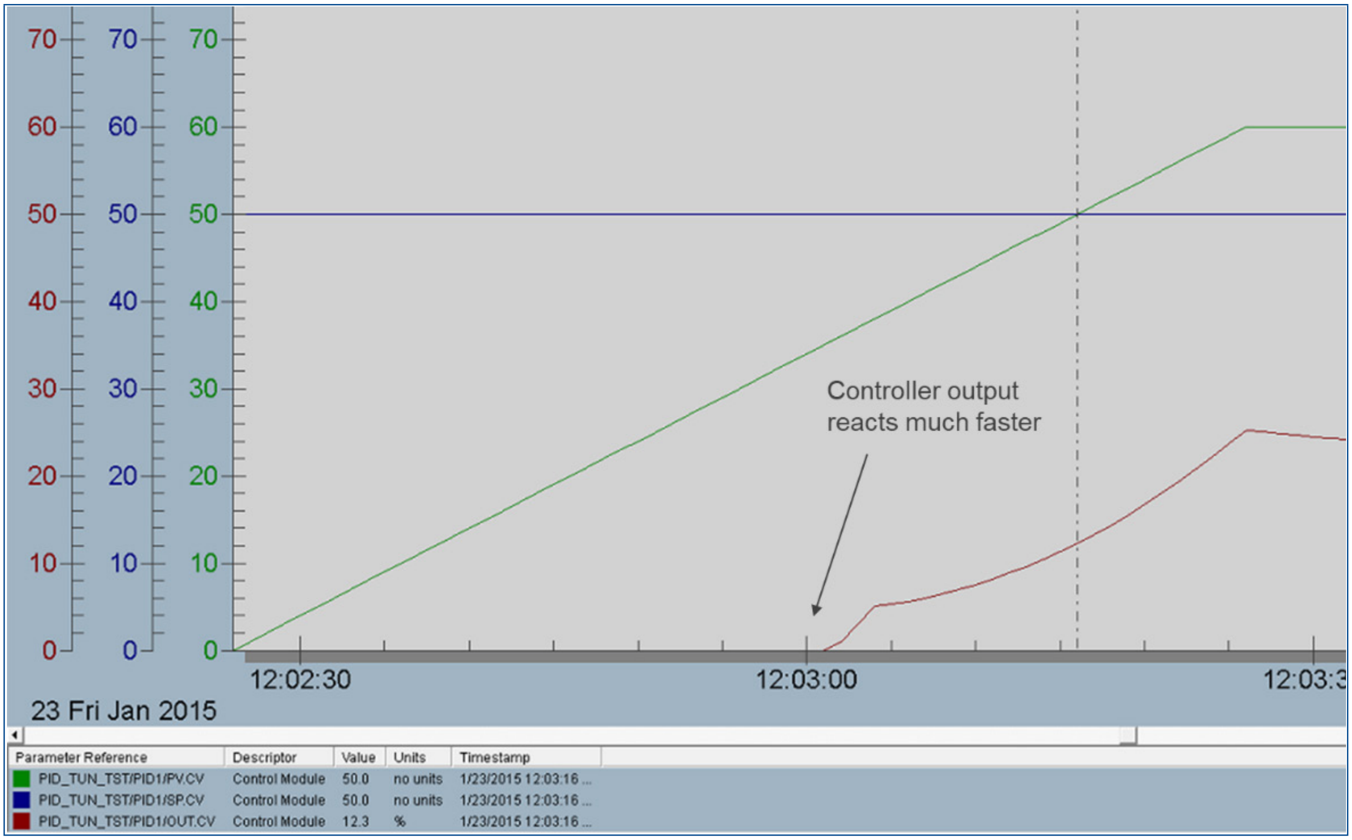

Figure 5. *Output behavior with enhanced saturation recovery (RECOVERY_FLTR = 0.0).*

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