SIEMENS

APPLICATION DATA

AD353-122
Rev 2
April 2012

Procidia Control Solutions
Override Control

This application data sheet describes implementing override control in a Siemens 353 controller[1].

Many processes can be controlled satisfactorily using single loop or cascade control strategies. However, abnormal operating conditions during startup, or large load swings, can drive a process beyond safe operating limits. Typically, a process is protected by safety interlocks that will shutdown the unit if operating limits are violated. To avoid these unscheduled shutdowns, an override control strategy can be used to constrain the process within safe operating limits.

Figure 1 shows an override control strategy applied to the base temperature control of a distillation column. The temperature controller (TC) manipulates the steam valve to the reboiler to control the base temperature of the column at setpoint.

During startup, or during load swings, the steam flow required to control column temperature may cause unsafe operating conditions in the column. High steam demand may boilup too much liquid, cause "flooding" in the column (high ΔP) and a loss of inventory (low level). Low steam demand may boil up too little liquid and cause a gain in inventory (high level). Auxiliary controllers on column ΔP (DPC) and base level (LCh and LCl) override the temperature controller through signal selectors to enforce constraints on these variables.

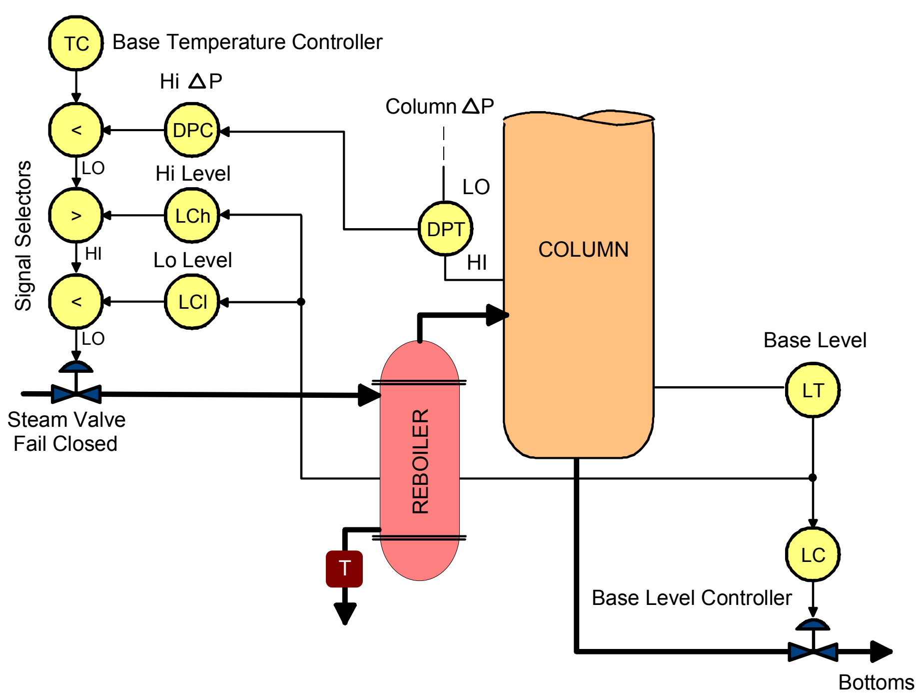


Figure 1 Override Control Strategy

[1]. See Application Support at the back of this publication for a list of controllers.

An override control strategy provides "soft" constraints on the process. Unlike the "hard" shutdown associated with interlocks, overrides "pinch back" the process gradually and get out of the way when normal operating conditions return. Although the primary process variable cannot be controlled at the setpoint when its controller is overridden, it is generally preferred to continue to operate with some setpoint deviation rather than shutdown the process entirely.

Design

An override control configuration is shown in Figures 2, 3, 4, and 5. Configured within a single Siemens 353, the primary controller and each override controller have individual loops with operator faceplates.

The base temperature control loop, shown in Figure 2, is the primary controller, loop 1. During normal process operation, it manipulates the steam valve to control the temperature at the setpoint from the SETPT function block. The override selector ORSL and the low signal selector SEL1 allow any one of three override controllers, shown in loops 2, 3, and 4, to take control of the steam valve, depending on the relative magnitude of their output signals.

The auto/manual A/M switch in loop 1 is located upstream of the override selector to provide override protection in both manual and automatic modes of operation. If unconstrained manual operation is desired, the A/M function block can be located downstream of the override selector.

The column ΔP controller in loop 4, see Figure 3, overrides the base temperature controller if the column ΔP exceeds the override setpoint from the Quickset Hold block QHD1. A standard setpoint function block is not used so the setpoint adjustment will not be readily accessible to the operator, since it is normally a fixed value. It can be changed using the QUICK button on the local faceplate or on the loop detail screen in i|ware™.

In loop 1, input 2 of the override selector (ORSL) is configured as a low selector. The ORSL block will select the output of either the base temperature controller or the column ΔP controller, whichever is lower. The external reset feedback signal (F) to both the base temperature and ΔP controllers provides a smooth transition between the two controllers and prevents reset windup in the integral section of the controller that has not been selected.

The smooth transition is the result of the steady state equation that defines the output of the PID controller function blocks in loops 1 and 4. PID controller output is equal to the proportional deviation plus the reset feedback signal, i.e. [+/- PG(PV-SP)+F]. Whenever the process variable (PV) is in control at setpoint (SP), the proportional deviation is zero, and the output of the controller will equal the value of the reset feedback signal. Using the actual valve loading signal for the reset feedback aligns the controller output with the valve whenever the PV crosses setpoint. The A/M function block in the ΔP Override loop is configured as Auto Only. All manual operations should be performed with the A/M block in the base temperature control loop.

If, for example, the base temperature is at setpoint, and the column ΔP is below setpoint, the output of the base temperature controller will equal the valve loading signal. Since the column ΔP is below setpoint, controller deviation (PV-SP) is negative but the proportional deviation is positive, because the controller has been configured for reverse (-) acting control. The output of the column ΔP controller will be higher than the valve loading signal (F) by an amount equal to the proportional deviation, and the override selector will select the lower output of the temperature controller. If the column ΔP begins to rise, the output of the ΔP controller will decrease and will match the output of the base temperature controller when column ΔP reaches the override setpoint. Any increase in column ΔP beyond the setpoint will drive the output of the ΔP controller below the output of the base temperature to override the steam valve, reducing boilup and reducing the column ΔP.

The low and high base level override loops in Figures 4 and 5 have proportional-only controllers. With proportional-only override controls, there is a fixed relationship between the override process variable and the manipulated variable. For example, the high level override controller in loop 3 might be configured such that a change in level from 75 to 100% drives the output from 0 to 100%, and the low level override might be configured such that a change in level from 25 to 0% drives the output from 100 to 0%.

In loop 1, input 1 of the override selector (ORSL) is configured as a high selector. The ORSL block will select the output of either the base temperature controller or the high level override controller, whichever is higher. As the base level exceeds the setpoint of the high level override controller, its output will increase. As the base level increases, the output of the high level override controller will increase overriding the output from the base temperature controller. This will have the effect of increasing steam flow which will increase boilup of the liquid in the reboiler, thus reducing the level.

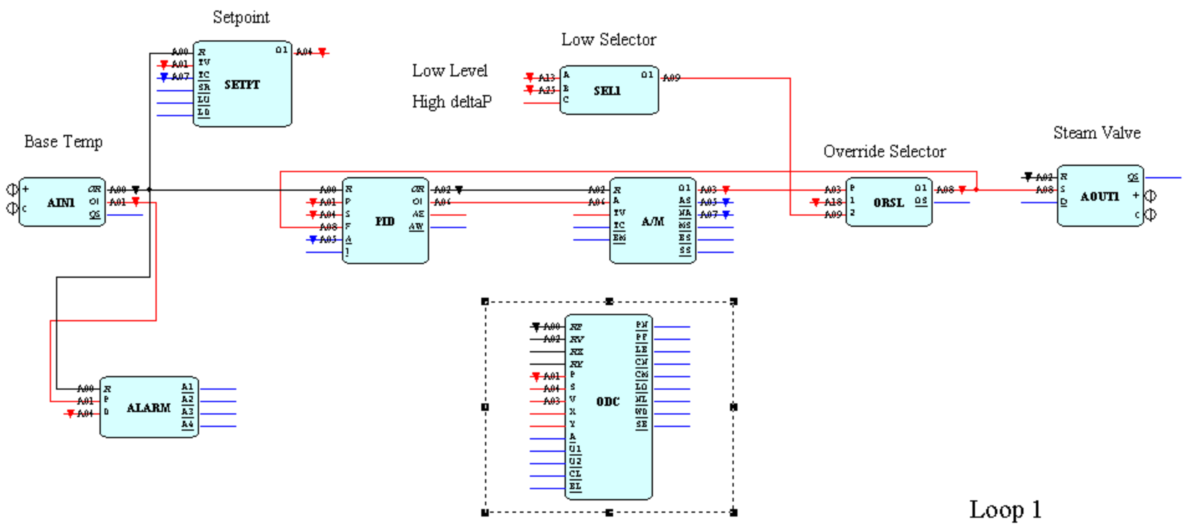


Figure 2 Base Temperature Control Loop (CF353-122)

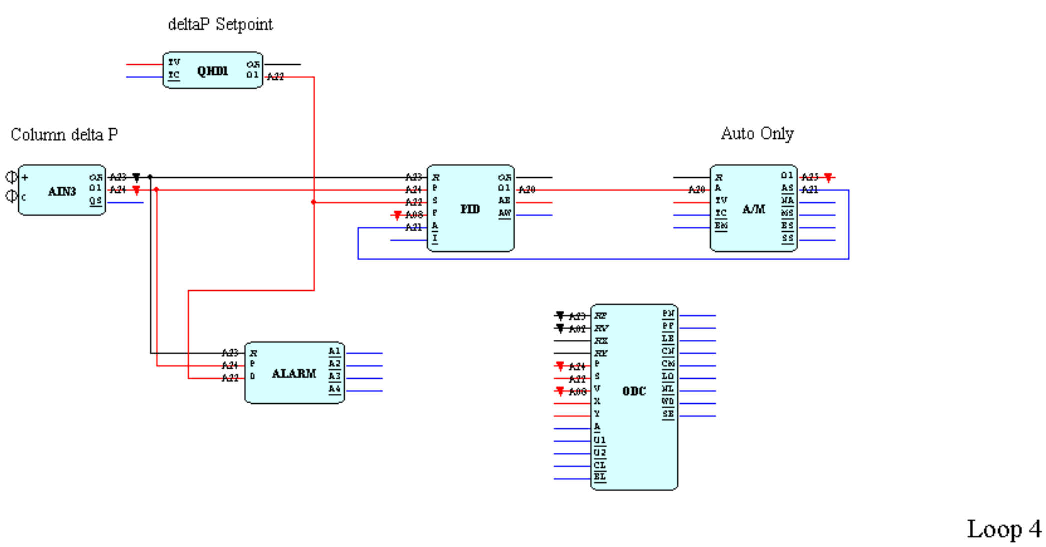


Figure 3 Column DeltaP Override Control Loop (CF353-122)

Input 2 of the override selector (ORSL) is configured as a low selector. The ORSL block will select the output of either the base temperature controller or the low level override controller, whichever is lower. As the base level drops below the setpoint of the low level override controller, its output will decrease. As the base level decreases, the output of the low level override controller will decrease overriding the output from the base temperature controller. This will have the affect of reducing steam flow which will decrease boilup of the liquid in the reboiler, thus increasing the level.

External reset feedback is not used with proportional-only override controllers. Therefore, there is no fixed value of the override variable at which the proportional-only controller will take over. This is not a problem as long as the override controller is configured to reach the maximum (or minimum) value of the manipulated variable before the override variable reaches a hard limit.

The gain of the proportional-only override controllers determines the width of the normal control band. The higher the override gain, the wider the normal control band. It should be noted, however, that there is an upper limit to the override controller gain beyond which the control loop will become unstable whenever the override is active. If the process cannot tolerate sufficiently high override gain, the normal control band may be too narrow, and it will be necessary to use an override controller with integral mode (I-only, PI, or PID) to widen the band and avoid interference with normal control.

Applications

Override control can be incorporated into the control strategy for many process applications with operating constraints. Examples in addition to those provided in this publication are:

- High motor current override on compressor controls
- High ΔT overrides on jacked reactor controls
- Low fuel pressure override on boiler controls

Application Support

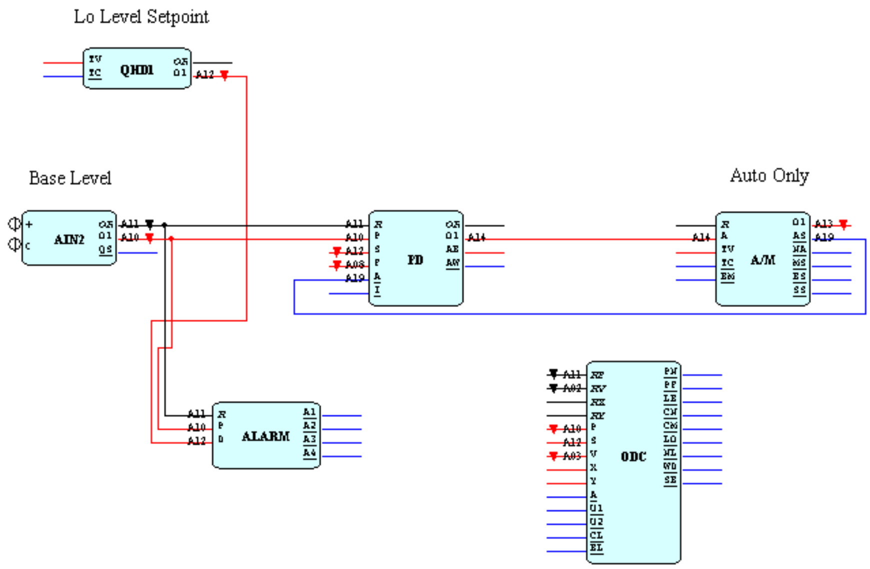
User manuals for controllers and transmitters, addresses of Siemens sales representatives, and more application data sheets can be found at www.usa.siemens.com/ia. To reach the process controller page, click **Process Instrumentation** and then **Process Controllers and Recorders**. To select the type of assistance desired, click **Support** (in the right-hand column). See AD353-138 for a list of Application Data sheets.

The configuration(s) shown in this publication were created in Siemens i|config™ Graphical Configuration Utility. Those with CF353 in parenthesis in the Figure title are available using the above navigation, then click **Software Downloads** > **353 Override Control (Reference AD353-122)**.

The configuration(s) can be created and run in a:

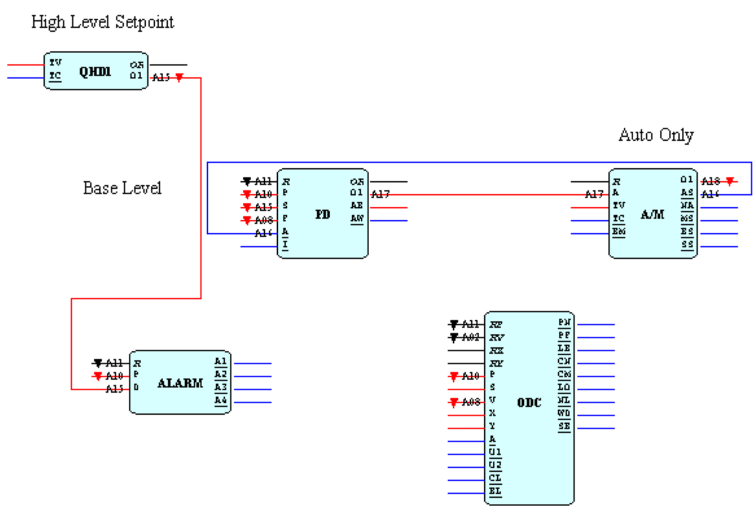
- Model 353 Process Automation Controller
- Model 353R Rack Mount Process Automation Controller*
- i|pac™ Internet Control System*
- Model 352*Plus*™ Single-Loop Digital Controller*

* Discontinued model



Loop 2

Figure 4 Low Base Level Override Control Loop (CF353-122)



Loop 3

Figure 5 High Base Level Override Control Loop (CF353-122)

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