Enhancements of bumpless operation in SVI FF R3

# Purpose

It is desirable to minimize valve movement during configuration process (as opposed to calibration).

For comparison and reference, Masoneilan HART positioners recalculate the (manual) setpoint to ensure that *mechanical* valve position doesn’t change even though the numeric representation of the position changes. The changes of the following parameters cause setpoint recalculation:

1. Air Action (ATO/ATC)
2. Open stop adjustment
3. Cloning (stops replacement)

The purpose of this design document is to bring SVI FF in line with HART positioners and design additional measures related to digital setpoint.

# Terminology

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| Term used | Meaning |
| ATO | Air to Open |
| ATC | Air to Close |
| FINAL\_VALUE\_x | A collective name for FINAL\_VALUE, FINAL\_VALUE\_D, FINAL\_VALUE\_DINT |
| AUTO | Automatic mode |
| MAN | Manual mode |
| LO | Local Override mode |
| APP | Positioner proper. Runs in a separate processor |
| FFP | FF protocol and function block application processor |

# General Design

## How it works today

Position setpoint (in the scaled valve travel domain) is derived from TB.SETPOINT (in flow capacity domain) by applying the configured characterization. In turn, TB.SETPOINT is derived from

* In TB AUTO mode
  + TB.FINAL\_VALUE, TB.FINAL\_VALUE\_D, or TB.FINAL\_VALUE\_DINT depending on TB.SETPOINT\_SOURCE (typically, TB.FINAL\_VALUE)
  + Or, in case of a timeout, from TB.XD\_FSTATE as configured.
* In TB MAN mode
  + User entry of TB.FINAL\_VALUE, TB.FINAL\_VALUE\_D, or TB.FINAL\_VALUE\_DINT (as configured)
* In TB LO mode
  + User entry of setpoint; FINAL\_VALUE\_x is ignored
  + Open-loop control where setpoint is N/A

Additionally, a diagnostic or calibration process may manipulate the position setpoint or use open-loop control.

### R2 behavior

If TB mode changes from MAN or LO, and target mode is AUTO, FINAL\_VALUE\_x is initialized to the current valve position (inversely characterized), FINAL\_POSITION\_VALUE.

### Current R3 behavior

R3 adds the condition of UNCERTAIN.INITIAL\_VALUE status of FINAL\_VALUE to the conditions to initialize FINAL\_VALUE\_x.

## New design

APP decides on conditions when it wants the setpoint tracked in TB.FINAL\_VALUE\_x.

These are

1. Conditions that cause recalculation of position setpoint (same as in HART devices) – changes in
   1. Air Action (ATO/ATC)
   2. Open stop adjustment
   3. Cloning (stops replacement)
2. Change in relation of flow capacity domain and valve travel domain
   1. Change of Characterization Selection
   2. Change in Custom Characterization curve
3. TB mode is LO
4. APP mode is Failsafe
5. A diagnostic or calibration process is running or finished

In any of those conditions, APP sends the desired setpoint to FFP to become FINAL\_POSITION\_x.

This desired setpoint is inversely characterized position setpoint (in closed-loop control mode) or inversely characterized valve position (in an open-loop control mode, such as Failsafe).

Notes:

1. In the backup setpoint configuration, TB.XD\_FSTATE, the fixed setpoint option is not affected. The user must correct it manually if so desired.
2. Setpoint is not tracked if TB is in AUTO
3. Temporary setpoint rate limits imposed by processes are not tracked, only the final destination setpoint. This doesn’t actually matter if the process ends with restoring the setpoint.
4. Bumpless operation in AUTO mode may depend on AO (or DO, as the case may be) options.

### Detailed design of IPC setpoint tracking protocol.

The purpose is to provide robust fault-tolerant interface between APP and FFP.

APP maintains tracking state with the values

* Void – no tracking needed
* Requested – need to send tracking value
* Sent – the tracking value was sent to FFP

When FFP receives the tracking value, it acknowledges the receipt in the *next* message to APP, so it keeps track of a Boolean acknowledge flag.

The following scheme provides robustness against IPC glitches:

In APP, any request to track sets the state to Requested.

When processing IPC request containing Acknowledgment flag, APP changes the state from Sent to Void. Other states are changed to Sent.

When generating IPC response, APP supplies a value if the state is not Void and sets the state to Sent. If the state was Void, APP supplies a NaN instead.

# Advantages of the new design

Eliminates position jump when changing open stop adjustment

Allows the following operations without valve movement:

1. Air Action (ATO/ATC)
2. Cloning (stops replacement)
3. Change of Characterization Selection
4. Change in Custom Characterization curve

Note: Currently, these operations require TB being in OOS. That’s obviously a lot of valve movement!

Additionally,

1. Exit from TB OOS (including) APP Failsafe may be bumpless