Application Note

2500 Series®

Programmable Automation Control System

PID Loop Bumpless Transfer with CTI 2500 Series and Simatic/TI 505 Series PLC's

What is Bumpless Transfer and why do we need it?

Definition of Bumpless Transfer:

> *Bumpless Transfer is the method by which a loop control can be transitioned from Manual mode to Automatic mode without disrupting the process.*

Bumpless Transfer Background and Overview

Bumpless Transfer comes into play when Loop control changes from Manual to Automatic. There are many reasons why machine operators place control loops in Manual mode. The most common reasons are:

Following procedures for machine start-up,

Troubleshooting equipment problems,

Troubleshooting process problems,

Preparing for expected process upsets (batch or feedstock changes),

Responding to unexpected process upsets (power blips),

Improper tuning of controllers.

When the machine operator decides to transfer a control loop from Manual mode to Automatic mode, they need this transfer to occur without having to worry about disturbing the process. Without bumpless transfer this transition could create major process upsets due to a large bump (or movement) of the controlled element (valve, pump, etc.). This bump could also be responsible for setting off multiple alarms and in general erodes the confidence that the operator has in the control system.

Details presented in the remainder of this document require familiarity with the CTI2500 Series PLC and Simatic/TI 505 Series PLC PID Loop functionality and WorkShop programming software.

While the PLC PID Loops have a built-in bumpless transfer, it may be found that this feature is not suitable for all process applications.

The default PID Loop bumpless transfer works in this way:

When Loop mode changes from MANUAL mode to AUTOMATIC mode -

The controller makes the SETPOINT equal to PROCESS VARIABLE (SP=PV)

This is to ensure a bumpless transfer from MANUAL to AUTO mode.

There are two aspects of the PID loop operation that we can override for better performance for processes that may be sensitive. Let us begin by reviewing the Loop modes and variables that can be modified:

Loop AUTOMATIC mode - you can write to (or change) the Loop Setpoint (LSP)

Loop MANUAL mode - you can write to (or change) the Loop Output (LMN)

Overriding how Loop Setpoint and Output interact and operate are illustrated in the following sections.

Bumpless Transfer and Loop Setpoint

Based on the default bumpless transfer operation, every transition into AUTOMATIC mode could potentially result in a new Loop Setpoint unless the operator diligently manipulates the manual control to exactly match the automatic mode setpoint value.

This activity is undesirable for many reasons:

> It will take additional time to dial in this manual control variable.
>
> On each transition you still could lose your previous setpoint.

You can keep the existing setpoint by overriding the built-in bumpless mechanism of the Loop:

- In the Loop configuration for the given PID Loop:
  - Select 'Special Calculation on SP'
    - *The controller can perform any custom calculations by calling a SFPGM during the loop calculation. This is used for manipulating SP and/or PV values and is called in AUTO or CASCADE mode immediately before loop calculation takes place.*
- In the Special Function Program menu:
  - Create a new 'Restricted' SFPGM of program type 'Restricted' and insert this logic:

```
SFP1
*       WRITE SETPOINT VALUE INTO LOOP SETPOINT
*
*       AS AN UNSCALED INTEGER
MATH    LSP1 := V1000
*
*       OR
*
*       AS AN FLOATING POINT VALUE
MATH    LSP1. := V2000.
*
```

Now your setpoint will always be the value of V1000 or V2000. respectively; and these registers could hold the value of setpoints coming from an HMI for example.

Bumpless Transfer and Loop Output

For a sensitive process there is one other Loop attribute that could create an issue.

When the Loop is placed into AUTOMATIC mode it starts controlling where it was last operating.

For example, if the Loop is running in AUTOMATIC mode and controlling a pump at 50%.

Then you place the Loop in MANUAL mode (due to some issue) and set the pump to 25% via a manual potentiometer (which is connected to a PLC analog input).

When you put the Loop into AUTOMATIC mode it will start controlling at 50% and work its way to the setpoint. Depending on Loop tuning and your process, this bump may not be tolerated well.

For a smooth transition, we need to write an appropriate value to the Loop Output (LMN) while the Loop is in MANUAL mode. Using our pump example above, if we take the manual potentiometer value from the analog input (WX500 for example) and write that to the loop output then the transition will be smooth.

In an existing or new 'Cyclic' SFPGM write the value from an analog input that has the manual potentiometer wired to it:

```
SFP3
00001   *          LOOP 1:
                   WRITE MANUAL POTENTIOMETER VALUE (WX500) TO LOOP OUTPUT (LMN1)
                   WHEN LOOP IS IN MANUAL MODE
                        LOOP MODE FROM EXISTING LADDER LOGIC:
                             C100 = 0 LOOP IN MANUAL MODE
                             C100 = 1 LOOP IN AUTOMATIC MODE
00002   *
00003   IF         C100 = 0
00004   MATH       LMN1 := WX500
00005   ENDIF
00006   *
```

From the example above, now when the Loop is put into AUTOMATIC mode, the Loop output will start controlling at 25% and work its way to achieving setpoint.

Other points of linear process feedback could be used in place of this potentiometer signal.

For example, the speed feedback signal from a VFD, or the flow signal from a flow meter monitoring a pump could be used.

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