PID Modifications for Unreliable Communications

Standard PID with Unreliable Communications

$$Output = K_P\left[e(t) + K_I\int e(t)d(t) + K_D\frac{de(t)}{dt}\right]$$

$where\ K_p,\ K_I,\ K_D$ are the proportional, integral and derivative gains, respectively

- Lost Inputs
  - The integral part increases linearly
  - Upon communication reestablishment, a spike from the derivative part
- Lost Outputs
  - The actuator gets a bump

Modified PID for Wireless – PIDPLUS

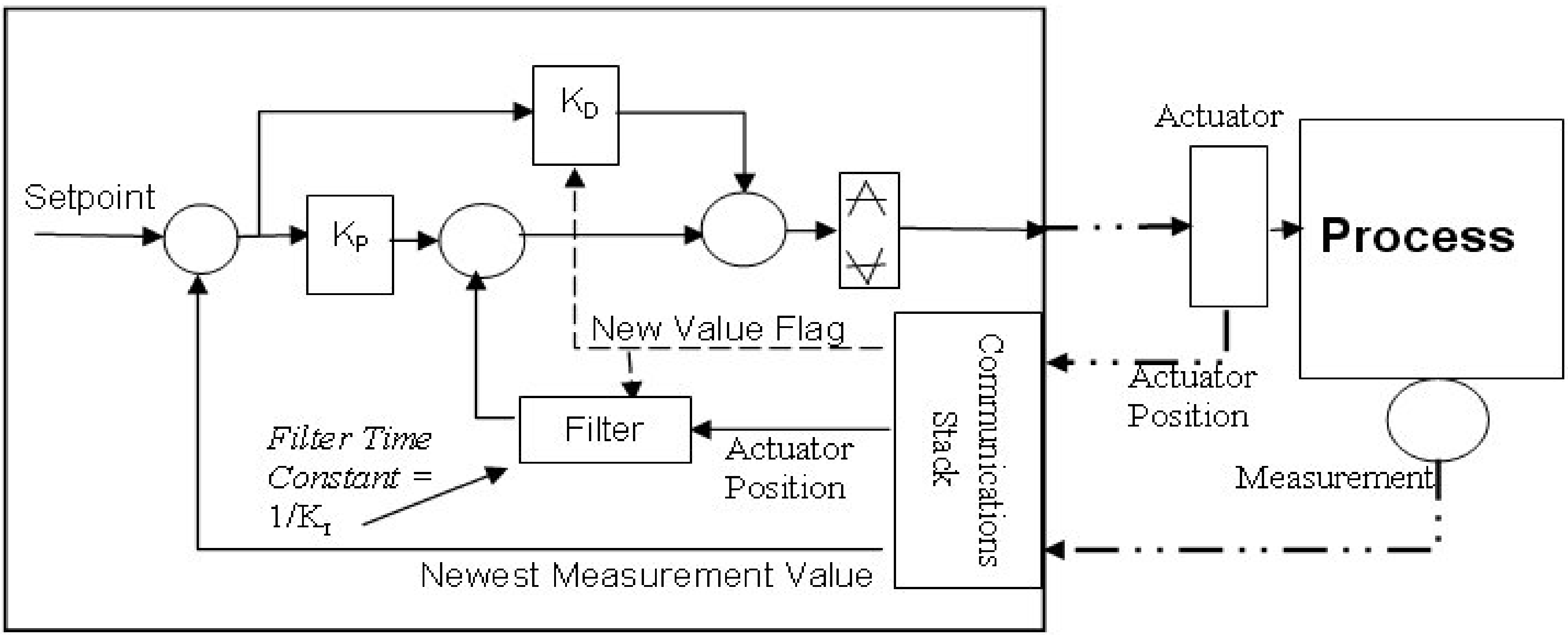


Figure 5. The enhanced PID algorithm application

Integral Contribution – Calculated only on arrival of new measurement update

$$F_N = F_{N-1} + \left(O_{N-1} - F_{N-1}\right) * \left(1 - e^{\frac{-\Delta T}{T_{Reset}}}\right)$$

$$\text{where} \quad F_N = \textit{New filter output}$$

$$F_{N-1} = \textit{Filter output for last execution}$$

$$O_{N-1} = \textit{Controller output for last execution}$$

$$\Delta T = \textit{Elapsed time since a new value was communicated}$$

Note: Controller output in the equation above s based on the actuator position feedback supplied by BKCAL_IN

Derivative Contribution – Calculated only on arrival of new measurement update

$$O_D = K_D \bullet \frac{e_N - e_{N-1}}{\Delta T}$$

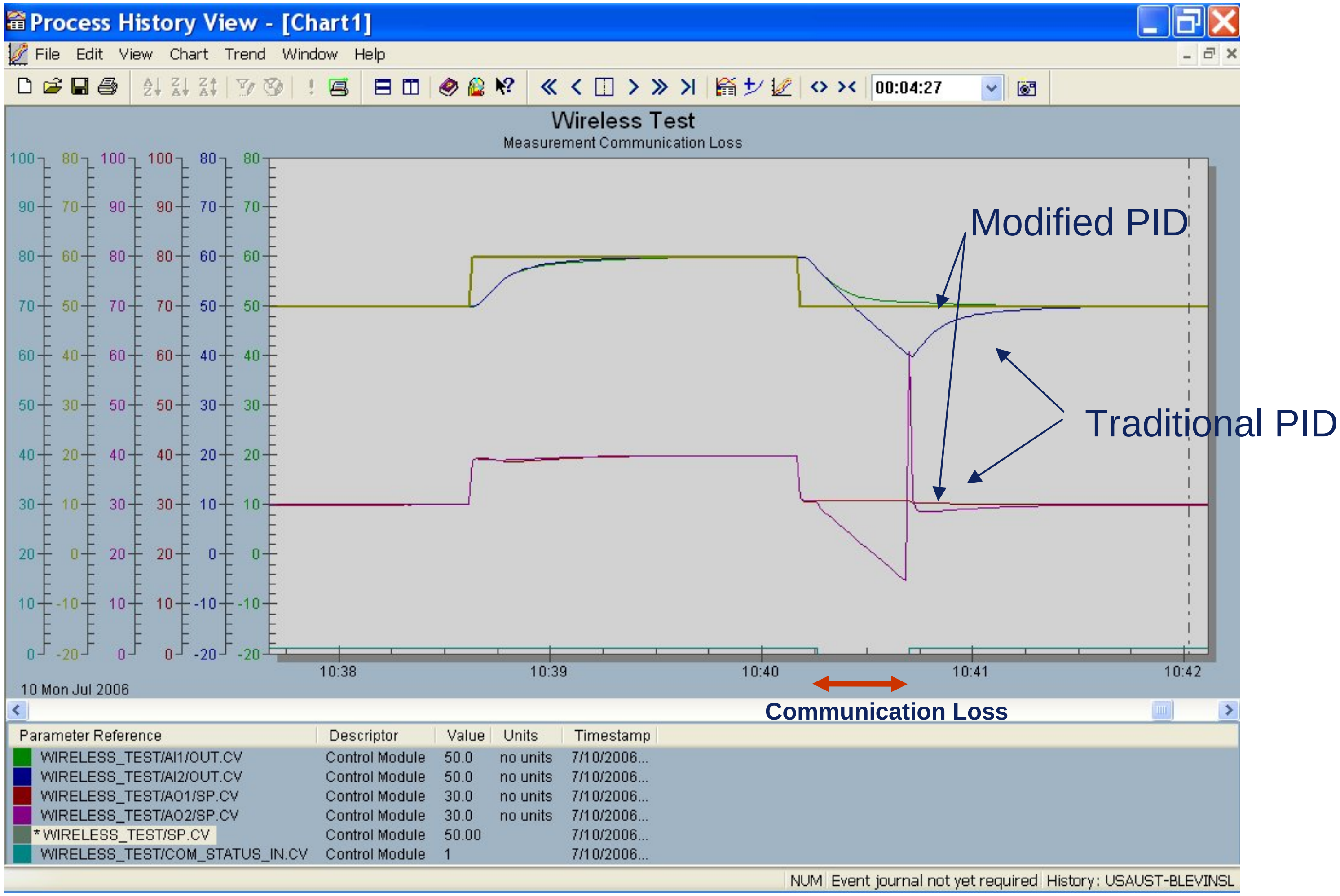
where e_N = current error

e_{N-1} = last error

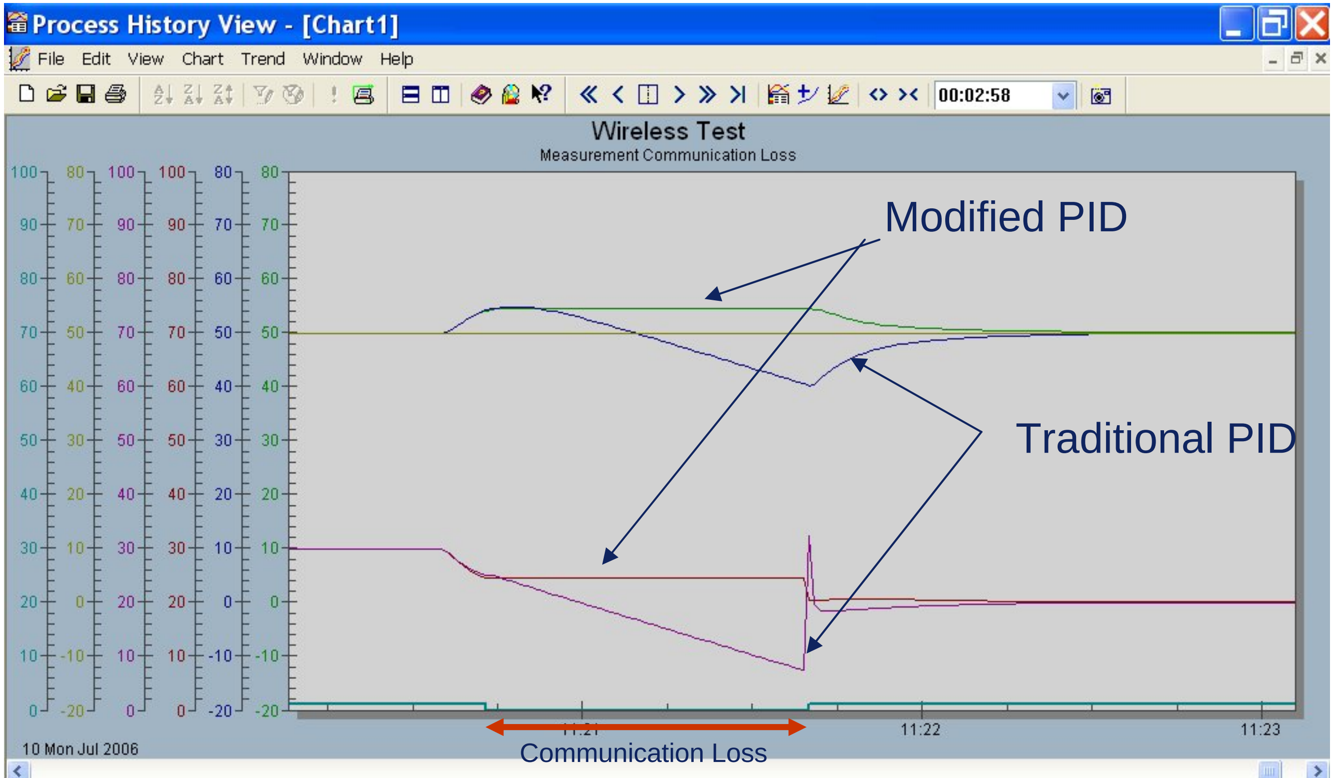
ΔT = Elapsed time since a new value was communicated

O_D = controller derivative term

Measurement Communication Loss – During Setpoint Change



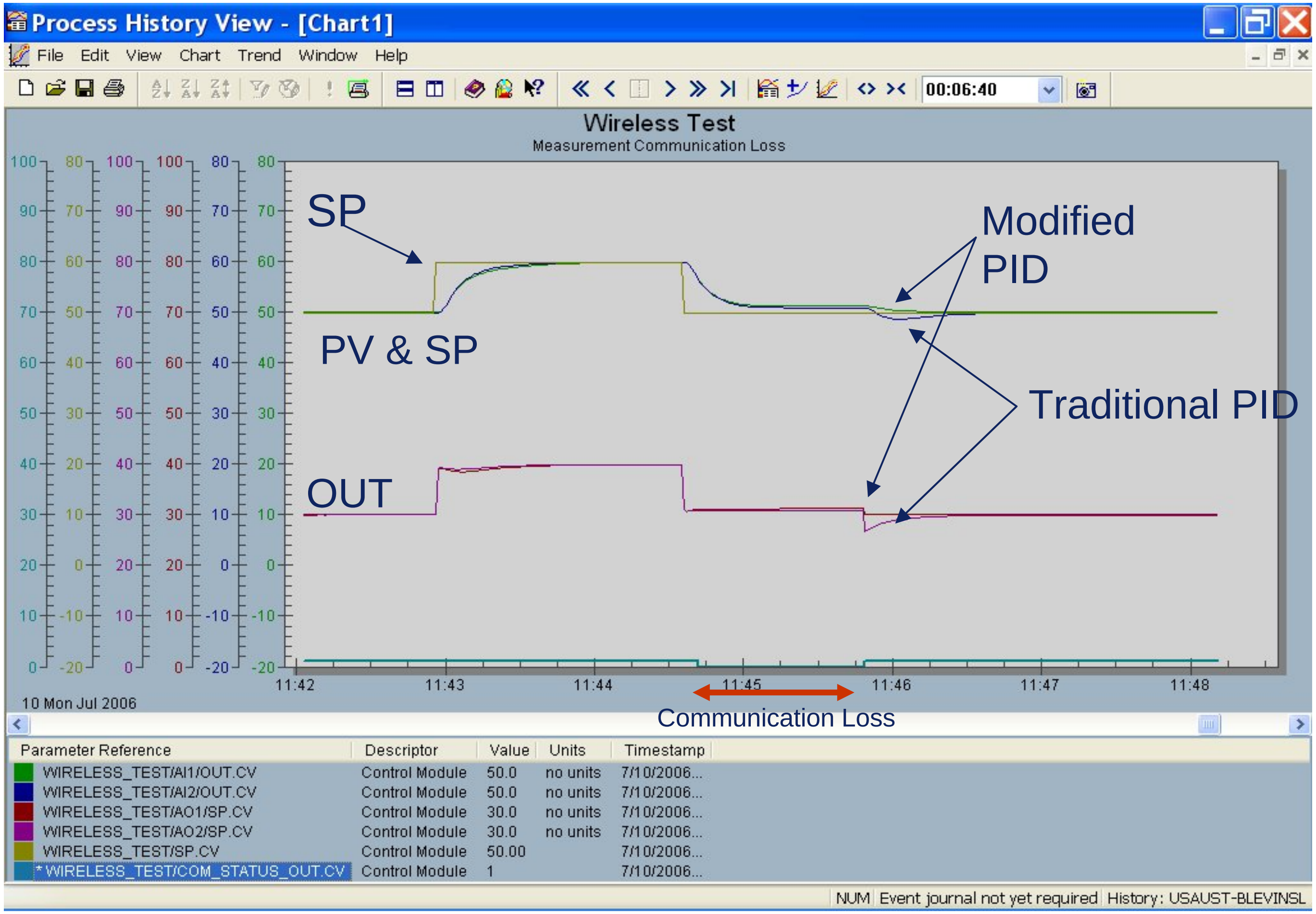
Measurement Communication Loss – During Process Disturbance



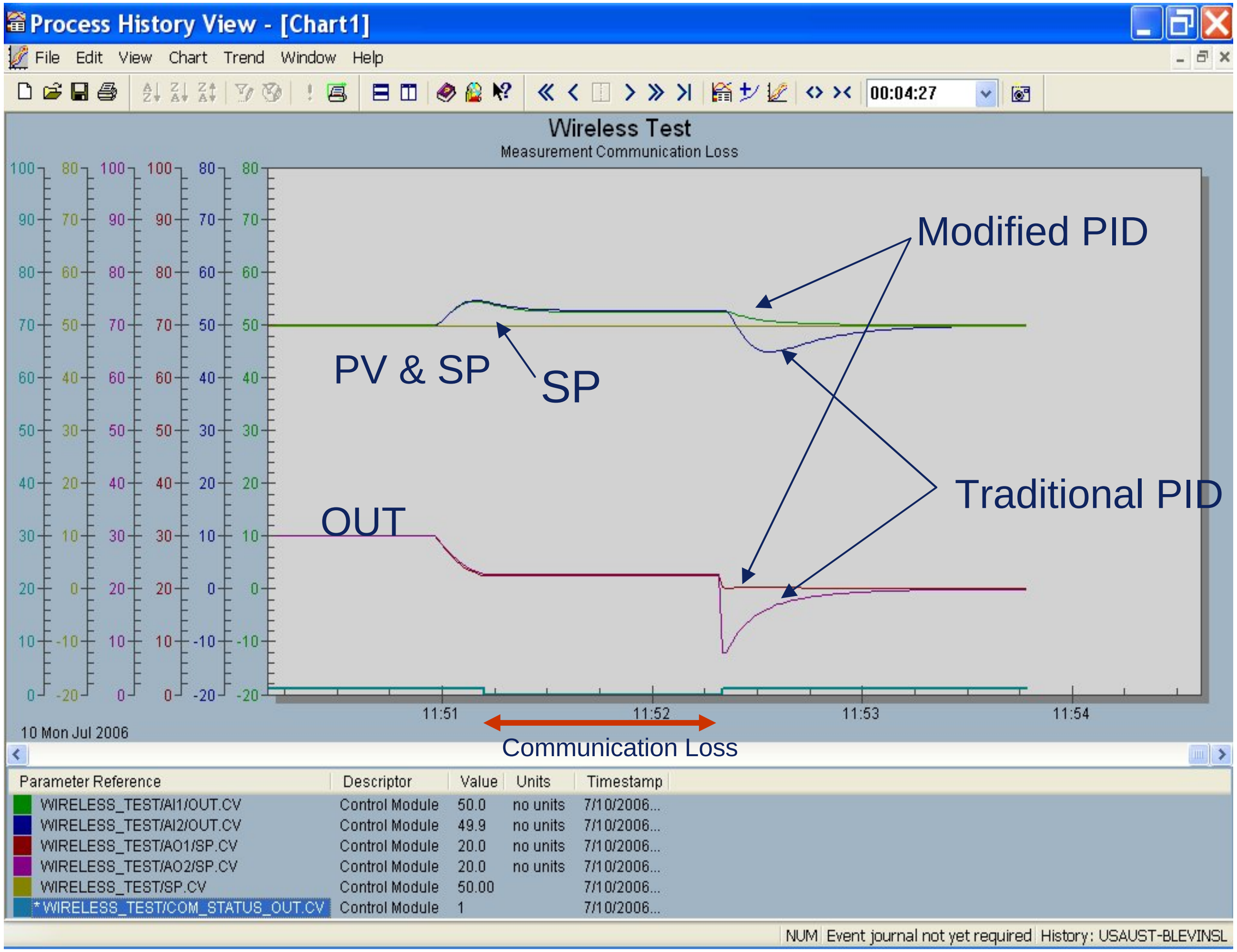
Parameter Reference	Descriptor	Value	Units	Timestamp
WIRELESS_TEST/AI1/OUT.CV	Control Module	50.0	no units	7/10/2006...
WIRELESS_TEST/AI2/OUT.CV	Control Module	50.0	no units	7/10/2006...
WIRELESS_TEST/AO1/SP.CV	Control Module	30.0	no units	7/10/2006...
WIRELESS_TEST/AO2/SP.CV	Control Module	30.0	no units	7/10/2006...
WIRELESS_TEST/SP.CV	Control Module	50.00		7/10/2006...
*WIRELESS_TEST/COM_STATUS_IN.CV	Control Module	1		7/10/2006...

NUM | Event journal not yet required | History: USAUST-BLEVINSL

Actuator Communication Loss – During Setpoint Change



Actuator Communication Loss – During Process Disturbance



Test Results

Scenarios / IAE / PIDs	Unreliable Inputs: Setpoint Change	Unreliable Inputs: Process Disturbance	Unreliable Outputs: Setpoint Change	Unreliable Outputs: Process Disturbance
PID	372	366	196	388
PIDPLUS	169	333	190	267