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

\[ F_N = F_{N-1} + (O_{N-1} - F_{N-1}) \left( 1 - e^{-\Delta T T_{reset}} \right) \]

where

- \( F_N \) = New filter output
- \( F_{N-1} \) = Filter output for last execution
- \( O_{N-1} \) = Controller output for last execution
- \( \Delta T \) = Elapsed time since a new value was communicated

Note: Controller output in the equation above is based on the actuator position feedback supplied by BKCAL_IN
Derivative Contribution – Calculated only on arrival of new measurement update

\[ O_D = K_D \cdot \frac{e_n - e_{n-1}}{\Delta T} \]

where 
\( e_n = \text{current error} \) 
\( e_{n-1} = \text{last error} \) 
\( \Delta T = \text{Elapsed time since a new value was communicated} \) 
\( O_D = \text{controller derivative term} \)
Measurement Communication Loss – During Setpoint Change

Traditional PID

Modified PID
Measurement Communication Loss – During Process Disturbance
Actuator Communication Loss – During Setpoint Change

Modified PID

Traditional PID

PID for Unreliable Communications
Actuator Communication Loss – During Process Disturbance

Traditional PID

Modified PID

PV & SP

SP

OUT
# Test Results

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