

EPID Record

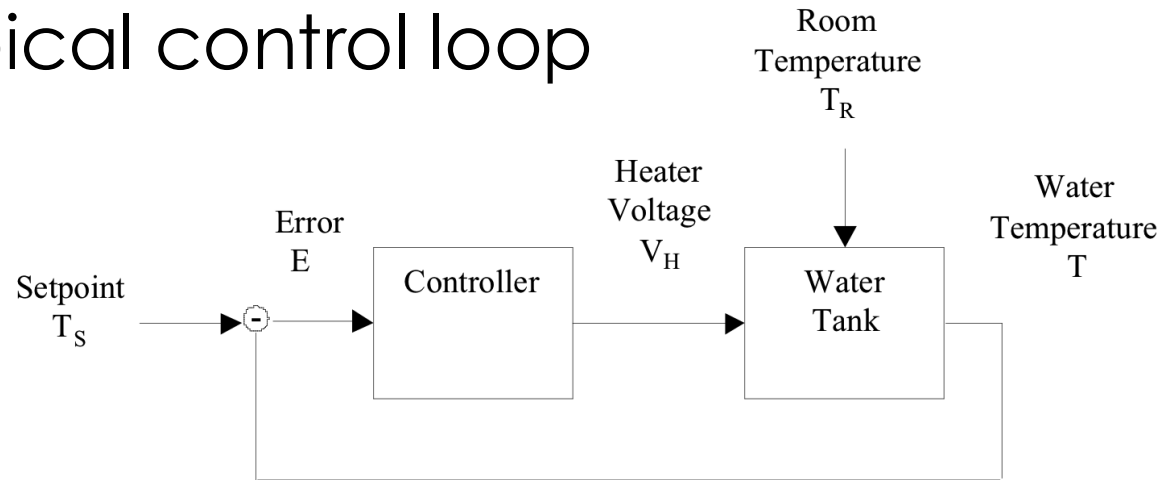
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PID Control: Old but still prevalent

- Typical control loop



- PID Controller

$$O(n) = K_P E(n) + K_I \sum_i E(i) dT + K_D [E(n) - E(n-1)] / dT$$

- Update period dT
- Error readings $E(n)$
- Output $O(n)$
- Proportional Gain K_P , Integral K_I , Derivative K_D

Basic Recipe

1. Increase K_P until system oscillates, back off a little
2. Increase K_I to eliminate residual error
3. Maybe use K_D to dampen overshoot

See also “Ziegler-Nichols” and many control system theory books

Why does EPICS base not include a PID record?

- How to define?

- a) P, I, D gains with

- $$O(n) = K_P E(n) + K_I \sum_i E(i) dT + K_D [E(n) - E(n-1)] / dT?$$

- b) K_p applied to all terms?

- $$O(n) = K_P (E(n) + K_I \sum_i E(i) dT + K_D [E(n) - E(n-1)] / dT) ?$$

- c) P gain K_p , Integration time $T_i = K_p / K_i$, Derivative time $T_d = K_d / K_p$?

- Avoid integral windup?

- a) Limit $\text{abs}(\text{error sum}) < \text{max}$

- b) Reset error sum whenever setpoint changes

- Start over for new setpoint

- c) Reset error sum when error > "Integration Zone"

- Only use K_i to fine-tune once error is small, within IZone

➔ Collection of CALC records, original PID record,
"Controlled" CPID record, "Enhanced" EPID record

EPID Record

Included in APS synApps “std” module

- VAL is the setpoint
- INP reads current value
- Error sum limited to [DRV_L, DRV_H]
- Applies K_P , K_I , K_D gains as $output = K_P (err + K_I \text{ sum} + K_D \text{ diff})$
- FBON=1 to enable feedback
- Output is limited to [DRV_L, DRV_H]
- Writes to OUTL

About the example

Showing EPID record now as follow-up to PID-using-CALC

.. but EPID record is not included in EPICS base, i.e., unknown to the “softloc” we used so far!

Usage of “makeBaseApp.pl” to create IOCs with additional modules will be detailed later

Example

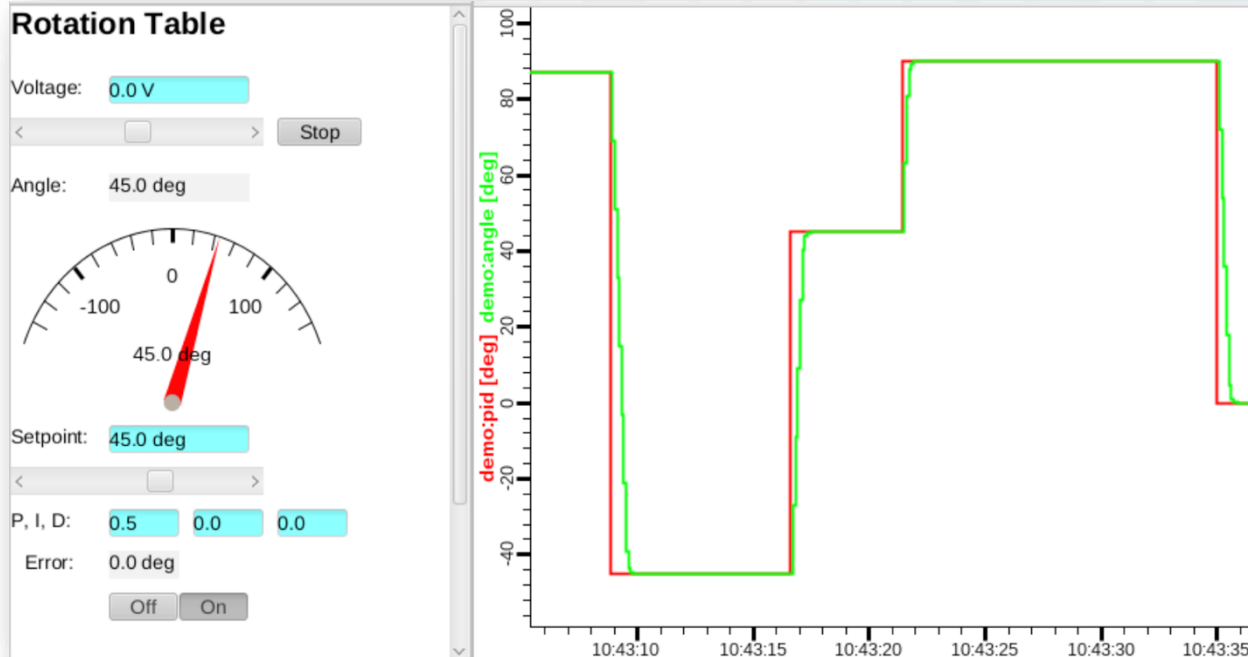
```
record(epid, "$(S):pid")
{
  field(DESC, "PID controller")
  field(EGU, "deg")
  field(PREC, "1")
  field(SCAN, ".1 second")
  field(INP, "$(S):angle")
  field(KP, "0.5")
  field(DRVL, "-12")
  field(DRVH, "12")
  field(OUTL, "$(S):voltage PP")
}
```

IOC

```
cd /ics/examples/02b_epid
cat pidApp/Db/rotation_control.db
cd iocBoot/iocpid
./st.cmd
```

Display

In CSS, File/Open /ics/examples/02b_epid/rotation_control.bob
Turn feedback "On", change setpoint, tweak P, I, D



'EPID' Record

Currently the preferred EPICS PID record

For more, see

- <https://github.com/epics-modules/std>
- <https://github.com/epics-modules/std/blob/master/docs/epidRecord.md>