PID-Servo Howto

Rev 2
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Initialization

Currently the AMC "DX15C08" motor controller is supported. As this is a standardized "CANOpen" interface, other servo controllers supporting this standard are easily supported in the future. The AMC DC201E series will be supported soon, Maxxon also sells CANOpen motor controllers. Plans for the Chip-EC to drive PID Servo H-Bridges directly are also in the works. Suport for Stack-EC's to drive CANOpen PID Servos is also planned.

The DX15C08 controller can be used either with an encoder or analog feedback loop. If encoders are used, an analog feedback pot can be used as an absolute position sensor for no-movement homing. Note that with this controller, the CAN power must not come on after the logic power.

When Chip-EC 1 boots, it scans the IEC bus for PID servo controllers.
Since digital motor controllers take a few seconds to boot, the CEC can be programmed to wait for a delay, up to 25 seconds, before scanning the IEC bus and subsequently connecting to the CC. Use "Set EC Delay" on the Overdrive EC page for this.

Currently a maximum of 12 motor controllers are supported, a larger number will be supported in the near future (contact Concept Overdrive Inc. for details).

If controllers use encoders for feedback the Chip-EC will perform a "homing" sequence on each controller. The servo will not move at all during homing if you have an absolute position sensor, like an analog pot. Note that the polarity of the voltage of an analog pot must be correct to use it as an absolute position sensor. If polarity is reversed, the servo will home by the correct amount, in the wrong direction.

EC Channel Allocation

There are 12 Output Devices per Chip-EC. These are allocated sequentially as may be seen on an freshly created, non-reordered, Outchan list in Overdrive. Be sure to assign the proper device type (“Rcservo”/Hydraulic/PIDservo, etc) to each OutDev.

At present the maximum number of PID Servos supported per CEC is 12. Only CEC 1 supports PID servos at present.

Each Output Channel ("OC") in the system is mapped 1:1 with an Output Device ("OD") of the same number. OD's represent the real world actuators which reside out at the ECs. Each OD has a type, like "RCServo" "Hydraulic" or "PID-Servo", which you can set on the OD tab on the OC page.

Since a Chip-EC can control up to 12 actuators, either of type RCservo or of type PID-Servo. You must choose which type of OD to use. If, say, OD1 of a given CEC is of type PID-Servo, no signal will be output on the CEC's RCServo pin 1.

Motor Controller Configuration

A digital PID servo controller must be tuned to the load it will drive. This process is beyond the scope of this documentation, but the manufacturer will have a guide for it. For the AMC "DX15C08", see the Digiflex Digital Servo Drive Startup Guide, included in this documentation. Its important to go through this process before moving motors through Overdrive. Note that you can tune motors for no load, then test them positionally with Overdrive.

Once you have established a set of gains in AMC Driveware, enter the following values into the OutDev tab in Overdrive: Position loop Proportional Gain, Position loop Velocity Feedback Gain, Current limit, Velocity Limit. Use the AMC Gain Converter utility on the desktop to convert the proportional gain to Overdrive gain units.

When an Overdrive "Ramp" operates on a servo, it changes three things : Proportional Gain, Velocity Feedback Gain, and Velocity Limit. When ramping down a servo, these parameters are lowered from normal value to zero, to stop the servo from moving, and vice versa.

If you intend to connect Driveware to a controller card to change and Store new configuration, you should first disconnect the EC and re-power the controller card. This avoids the Ramps setting the above parameters to 0. The servo will still function fine even if you Store when those parameters are zeroed, as Overdrive pushes the parameters into the controller card when the EC connects, and whenever they change on the OutDev tab.

Be sure to enable the servo by checking the "powered" checkbox.

Scaling

After tuning the PID loops through the manufacturer's process, it is necessary to set the scaling, or stroke of the servo. Set the scaling to go no farther than you need, so as to get the highest resolution, and smoothest movement, out of the servo. For the AMC "DX15C08", this is done in Driveware via Advanced_Functions->Interface_Units. An Overdrive Outchan position value is an "interface unit". Set "1 interface unit for Position = X mrev". Where you choose X mrevs based on how far you want the servo to travel.

Example:
The Overdrive outchan scale is 0-4095, motor has a 74:1 gearhead, desired travel is +/- 90 degrees off of Overdrive center scale.
Here, 74000 mrevs = 360 degrees, so 1 degree is 74000/360 = 205.55mrev
205.55mrev x 90deg = 18500mrev
Since this is an offset from center scale, divide this by half the Overdrive scale:
18500/2047= 9.037
So X = 9.037mrev.
Enter this value via Driveware, then Store the config into the driver card.
The motor's gearhead will now sweep +/- 90 degrees then the Overdrive OutChan is moved +/-2047 off of center scale.

After giving the servo a different stroke, you must also set a new scaling factor for the homing pot. See the next section.

Feedback

The AMC DX15C08 can be used with an encoder for position feedback, or with an analog feedback pot.

Position feedback polarity can be reversed from the Overdrive software OutDev tab, this may be necessary at first turn-on if the motor wiring is of a different polarity than the feedback. This has been tested using encoders, but has not been tested with analog feedback.

When using Encoders it is necessary to correct for turn-on position error.
In order to use an analog feedback pot as an absolute position sensor for Homing, a scaling factor must be established, namely the number of overdrive OutChan counts per Volt of the homing pot. This must be re-calibrated every time you change the extents of the stroke of the servo. Follow the procedure below:

. Make sure the controller itself is not storing a home offset :
Velocity_Mode->Command->Command_Selection->Command_Source->
Homing_Routine-> Homing_Parameters->Home_Position should be 0. After checking this, Be sure to restore the original mode before Storing:
Position_Mode->Command->Command_Selection->Command_Source->
Discrete_Points

. Mouse-drive the relevant OutChan to center scale (2047).

. Position the servo so it is roughly mechanically centered.

. Adjust the homing pot so it reads as close to 0.000 volts as possible. Attach a high resolution oscilloscope or voltmeter.

. Make sure the PID controller card has its Trigger_at_Val stored as 0 (see below).

. Turn on the controller card.

. Ramp up in Overdrive. If the motor moves off of zero Volts due to homing, Mouse-drive the Outchan so that the voltage on the pot is as close to 0.000 Volts as possible. Take up the backlash in any gearing, and travel the same direction in the next step.

. Mouse-drive the OutChan with the arrow keys, don't reverse direction at the end of the move, as this will allow position backlash.

. Stop when the voltage on the pot reads 1.000 volt, this must be very accurate, within a few millivolts.

. Record the difference between the OutChan starting position and ending position, this a measure of "Overdrive counts per Volt" of homing pot feedback.

. Repeat the previous four steps a total of four times, twice travelling upward on the OutChan scale, twice traveling downward. Average the four values. This averaged value is the final "Overdrive counts per Volt". Other servos with an identical stroke can also use this value.

. Enter this number into the "trigger at value" field of AMC Driveware : IO_Config->Dedicated_Outputs->Trigger_at_Val. Store the config into the controller card.

. The homing pot is now scaled to the servo stroke. The EC will use the homing pot to correct the turn-on position error.