Servo System Startup

The purpose of these instructions is to help you safely set up your motion control system. It assumes the components you are using are compatible. Use these procedures in conjunction with your hardware user guides.

--- DO NOT CONNECT THE MOTOR TO MECHANICS UNTIL INSTRUCTED TO DO SO.   ---

Do not proceed without securing the motor to a table or other sturdy surface. For smaller motors affix the motor to a table top by means of a "C" clamp using a piece of wood between the clamp and motor case. This will prevent the motor from injuring personnel and/or damaging equipment in the event the motor becomes unstable. Be careful not to damage the outer casing and be aware of the excessive heat a servo motor can produce.

Test motor/amplifier setup (without the controller)

1) Limit the current in the amplifier to approximately 10% of the continuous rated current. If the peak current is limited separately, limit it also to approximately 10%.
2) Wire the motor to the amplifier only.
   a) for brushless motors with Hall sensors, also wire the Hall sensors. This procedure is a little trying at times, as there are six distinct wiring combinations to try. Three do not work at all. Two almost seem like they could work, but will have some wierd discontinuties. One will be right. To find this one, make a little truth table. Apply power, and try the most obvious wiring (ie. 1-2-3 connected to U-V-W or something similar). Record the results. For the second try, shift two sensor wires over one position and the third back to the now-empty first position. Try again. One more shift gives the third try. To get to the other three, simply swap two sensor wires, and run through the sequence again.
   b) for resolver feedback systems, the resolver provides both commutation to the amplifier, and position feedback to the controller. Wire the resolver to the amplifier according to the user guide, as there are not well established standards for resolver feedback like there are with encoders.
3) Check the stability of the current loop by applying power to the amplifier. The motor shaft should not move, but it may rotate slightly. If it rotates, the balance is off. If the motor "runs away" (moves at a high rate of speed spontaneously), cut power to the amplifier immediately as the balance is way off. Adjust it appropriately to stop the shaft (usually with the offset potentiometer on the amplifier). If you have a digital amplifier, you may have to disable the limit switches. If the amplifier detects a fault, check wiring and installation instructions in the user guide.

Verify encoder operation

1) Turn off the amplifier.
2) Power up the controller.
3) Enter the controller's software on your PC and establish communication with the controller. If you have a stand-alone controller, this requires that your PC and controller be configured for the same communication signals, i.e. RS232, 9600 baud, com port, etc.
4) Wire the encoder to controller only.
   a) for resolver feedback systems, the resolver wires directly into the amplifier, and then the encoder-equivalent output from the amplifier goes to the controller. Sometimes the controller is packaged inside the amplifier, in which case this last wiring is done internally for you.
5) To test operation, turn the motor shaft by hand. You should be able to read the change in encoder counts both in the positive and negative directions in either the servo software setup procedure or by querying the position from the terminal window (using the controller's programming language).

Connecting Grounds

The rule is: when circuits share a ground there should only be one ground wire between the circuits.
In general, connect all logic and analog grounds to logic and analog commons when available. Connect high voltage grounds, shields, etc. to earth ground.
Be careful not to create any ground loops. Ask if you need help here.

Closing the velocity & position loops

1) Turn off the amplifier.
2) Wire command wires and enable circuit from controller to amplifier.
3) Turn on power to controller, but keep the amplifier off.

4) Set all servo gains to 0. Set the following error for 1/4 revolution, and set an "off on error" condition so that the amplifier will be disabled if the motor becomes unstable. Turn on and enable the amplifier.

5) If the motor runs away, the polarity of the encoder is opposite of the command signals:

    a) For single ended encoders switch Ch.A and Ch.B.

    b) For differential encoders switch Ch.A and Ch.A-. Do not invert Ch.B.

    c) Some amplifiers have two reference inputs; positive and negative. Switching between the two will also invert the polarity of the position loop.

6) Increase the velocity loop (derivative) gain to the point at which a resistive torque is evident at the motor shaft (it should feel like there is water in the motor). Next, set the proportional gain to approximately 10% of this value.

Tuning a PID loop

1) Start by turning the derivative gain up slowly. Keep bumping the value up until the motor starts to vibrate, then decrease the gain to the point at which the vibration stops. Feel the motor shaft while you do this, so you can feel how the gain value is affecting the motor.

2) Repeat the above procedure with the proportional gain.

3) If your system requires an integral gain (usually for steady state error or for vertical axes), add it in slowly as it decreases stability.

4) Once your motor is stable and well tuned you can start testing your programming skills.

Connecting to the mechanics

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