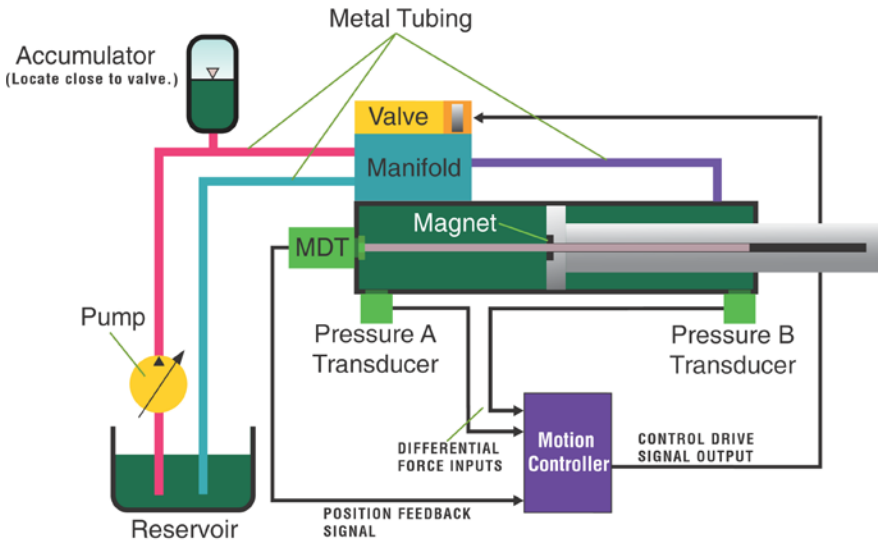
DOs and DON'Ts of Hydraulic Position Control System Design

Fluid power systems are capable of very high performance motion control. A well-designed closed-loop hydraulic actuator can position heavy loads to accuracies better than 0.0005". Fast, precise motion requires a controller with specialized fluid power capabilities, such as the easy-to-use RMC family from Delta Computer Systems, Inc. (www.deltamotion.com). However, a well-designed hydraulic system is equally important. This document provides a concise list of the considerations for high performance closed-loop hydraulic motion control systems.*

Diagram of a typical hydraulic system.



Note:
Pressure transducers are not required for position-only control.

DOs:

1. **Use Servo-Quality Valves**
   Use servo-quality valves or "proportional" valves with zero overlap spools and linear flow per input response. See DON'T #2.
2. **Place Valves on Cylinders**
   Mount valves on the end and on top of the cylinders. Keep the trapped volume of oil between the valve and the piston as small as possible. See DON'T #1.
3. **Use Accumulators**
   Use an accumulator, placed as close to the valves as reasonably possible. It should be sized at least 10 times larger than the change in the volume of oil.
4. **Pre-charge Accumulator**
   Pre charge the accumulator to 80% of system pressure. Any oil in the accumulator that is not being used reduces its effectiveness. The nitrogen bubble should be as large as possible as long as there is always some oil in the accumulator.
5. **Size Pump Correctly**
   Size the pump to the average oil flow plus 10%. There is no need to size the pump for peak load when using an accumulator.
6. **Size Cylinders Correctly**
   Use cylinders with a diameter large enough to get the desired acceleration / deceleration rates.
7. **Size Hydraulic Lines Correctly**
   Use adequate pressure and return lines with a minimum number of 45º and 90º joints.

*For an in-depth treatment of hydraulic design for high-performance motion control, refer to "Fluid Power Motion Control: A guide to Practical Design" written by Delta's Peter Nachtwey. Go to http://www.deltamotion.com/other/designguide/register.php to request your free copy.

8. **Size Valve Correctly**
   Valves should be sized large enough to allow the system to accelerate at the desired rate and the maximum desired speed. Remember that at high flow the pressure drop across the valve will be large and the pressure drop across the piston will drop, reducing the ability to accelerate.
9. **Use a Suitable Motion Controller**
   Hydraulic control requires parameters, transducer interfaces, and algorithms not available on motion controllers intended for motor control. Use Delta's RMC motion controllers for high performance control of hydraulic, electric and pneumatic systems.
10. **Use a Precision Position Feedback Transducer**
    Mount a magnetostrictive linear displacement transducer (MDT or LDT) in the hydraulic cylinder. Cylinders can be ordered so they are "MDT" ready. MDT's can be ordered with Start Stop, PWM, SSI, or analog outputs. (Analog is not recommended for best control because of susceptibility to noise, which can significantly reduce resolution.)

DON'Ts:

1. **Flexible Hose between Valve and Cylinder**
   Do not use flexible hose between the valve and the cylinder. THIS IS VERY IMPORTANT! Flexible hose between the valve and cylinder will result in difficult tuning and poor control. See DO #2.
2. **Overlapped Spools**
   Do not use valves with overlapped (closed-center) spools. ALSO VERY IMPORTANT! See DO #1. When an overlapped spool shifts from one side to another to change direction of the motion, the system will come to a stop with a thud, leading to difficult tuning and poor control around critical zero point. With a zero-lapped spool, the system very smoothly transitions between opposite directions of control.
3. **Separate Valve Amplifier**
   Avoid valves with separate amplifiers unless you are able to set up the amplifier properly. Many valves have the electronics built in the valve and are set up by the factory.
4. **Run Wires in Same Raceways**
   Do not run the high current Pulse Width Modulated signal, from the amplifier to the valve, in the same conduit or raceway as the wires from the position feedback transducer. See DON'T #3.
5. **Go Half-way on Closed-loop Control**
   Some people are scared of closed-loop motion control, so they put two different valves on their system – one for open-loop control, and one for closed loop control, along with plumbing to switch between the two. This makes a very complicated system, requiring more plumbing and programming and maintenance than a simple closed-loop system. Closed-loop control is simple and easy. Attend a Delta training course to learn more about hydraulic motion controllers!
6. **Counter-balance Valves**
   Do not use counter-balance valves. They counteract the motion controller. If you need to have a safety valve to keep a vertical load from falling, use a blocking valve between the valve and the cylinder. Close the valve when you need the load to be stopped. Open it when you want motion control.

About Delta's RMC Motion Controllers

Delta's motion controllers provide precise closed-loop position, velocity, pressure, force, and position-pressure or position-force control for electric, hydraulic, and pneumatic applications.

- RMC100 Series (2-8 axes)
  Delta's multi-axis motion controllers—possibly the most versatile pre-programmed motion controllers on earth—use them for all your motion needs! The RMC100 Series includes the flagship RMC100/101 controllers and the new RMC150/151 controllers.


RMC100/101


RMC150/151

- RMC70 Series(1-2 axes)
  Even more value for one and two-axis applications.


RMC70

A stand-alone motion controller frees up space in the PLC (in the program, processing power, and rack), and the motion control is done at the loop time of the RMC, which is typically much faster than the PLC. The RMCs also have superior plotting and diagnostic capabilities

All of Delta's legacy products are still serviced and available for sale to support existing designs.

Benefits of Delta's RMC Series Motion Controllers include:

- **High Performance:** Features such as synchronized moves, splines, position-pressure or position-force control, and fast user programs provide higher throughput, improved quality, and reduced machine wear and breakage through optimized control.
- **Communication Connectivity:** Support for numerous industrial standards provide efficient communications to the PLC of your choice. Communication options include EtherNet, serial RS-232/485, Profibus , discrete I/O, and Modbus Plus.
- **Transducer Connectivity:** The very versatile RMC family connects to virtually all industrial feedback transducers.
- **Quick to Set Up and Optimize:** Delta's command-driven programming, graphing tools, and new Tuning Wizard literally reduce project implementation time from weeks to days.
- **Responsive Support:** Bring us your challenges. We strive to be the industry leaders in responsive support and training, before, during and after the sale on legacy as well as newer products.

Summary: Maximize ROI and minimize lifecycle costs. Look to Delta for innovative technology, great products, responsive service, and lasting value.

Learn More

To learn more about Delta's motion controllers, visit www.deltamotion.com, or call 360-254-8688 to schedule a half-hour phone demo of an RMC.

You can also download the RMCTools software from Delta's website, and connect to a live RMC via the web.