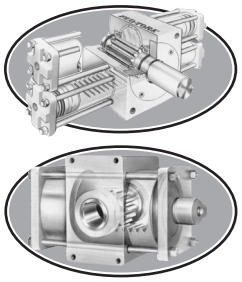
MOOG
FLO-TORK



Application Bulletin

AP 339
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ROBOTICS
SAMPLE ROBOTIC APPLICATION

ROBOTIC APPLICATION
AUTOMOTIVE PAINT SPRAYING SYSTEM

Robots are being used in critical environments to perform various functions in the painting sequence for automobiles. In this particular application the robot is controlling the opening and closing of individual car doors as the car proceeds down the assembly line. The actuator rotates the shoulder axis and through a mechanical linkage bends the elbow through a 90^0 motion. At the same time, another robot is spray painting the inside and outside of the doors.

THE ACTUATOR

Standard Model 3700-90-00-ET-MS13-RKD-N
Operating pressure: 1500 psi.
Displacement 2.23 cubic inches.
Flow rate / rotation speed: 45 gpm produces 1.25 rad/sec or 71.63^0/sec
Torque: 1850 lb-in. of torque at 1500 psi.
Cycle life requirements: Capable of multi-million cycles.
Backlash requirements: Less than 1/4 degree.

Major industries are using robots for increasing productivity in spray painting, pick and place, welding, multi-operations of tool changing, assembly of products in contaminated areas, and many more operations. Moog Flo-Tork's innovation and versatility offer the widest selection of styles, technology, and precise control for robots available from any single source. Moog Flo-Tork will continue to be the originator/innovator of rotary actuators as we move further into the era of the robot.

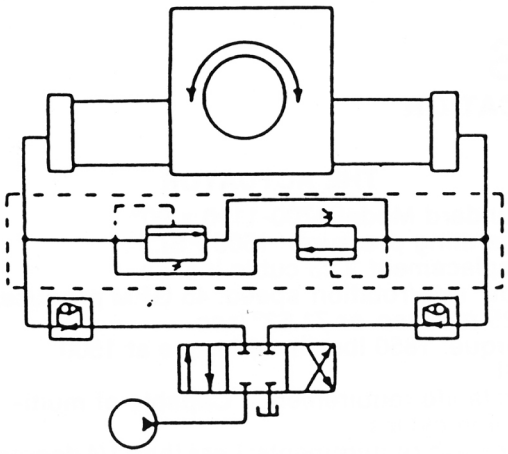
ROBOTIC TERMS

Roll Axis	Wrist Roll
Pitch Axis	Vertical Elevation (Elbow)
Yaw Axis	Base (Waist) Rotation
Response Flexibility	Positive Positioning
Controller Requirements	Accuracy to a controlled point
Manipulator	Finger Control Movement
Backlash	Uncontrolled shaft rotation allowed by clearance between rack & pinion teeth.
Overhung Loads	Radial or side load on the rotating shaft.
Breakaway	Pressure required to start rotary actuator in motion.
Rotational Speed	Cycle speed in degrees per second.
Hydraulic Leakage Problems	1) Internal leakage causing drift. Moog Flo-Tork rotary actuators have zero internal leakage. 2) Shaft seal leakage. Moog Flo-Tork rotary actuators have unpressurized gear cases, therefore no shaft seal leakage.

Moog Flo-Tork 1701 N. Main St. P.O. Box 68, Orrville, Ohio 44667-0068
PHONE: 330-682-0010 FAX: 330-683-6857

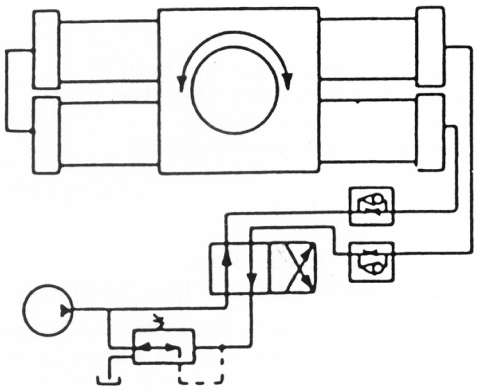
Examples of simple circuitry for controlling backlash between the pinion and rack teeth. (We suggest a meter-out circuit using two flow controls for the smoothest operation.)

NOTE: Standard Moog Flo-Tork hydraulic rack and pinion rotary actuators have backlash ranging from 1/5° for the model 600,000 to 1° maximum for the model 900. The normal backlash of Moog Flo-Tork rotary actuators is sufficiently small to satisfy the requirements of most applications.



ADJUSTABLE BACKLASH - MANUALLY CONTROLLED

The backlash control is accomplished by mechanically adjusting the rack bearing to move the rack teeth closer to the center line of the pinion. This reduces clearance between the rack and pinion teeth. Use the same circuit for single or double rack mode. Submit Application Specification Guide AP 301 for factory quotation.



ZERO BACKLASH - PRESSURE CONTROLLED

This is accomplished by applying hydraulic back pressure to one end of one rack while applying system pressure to the same end of the other rack. (A double rack unit is required.)

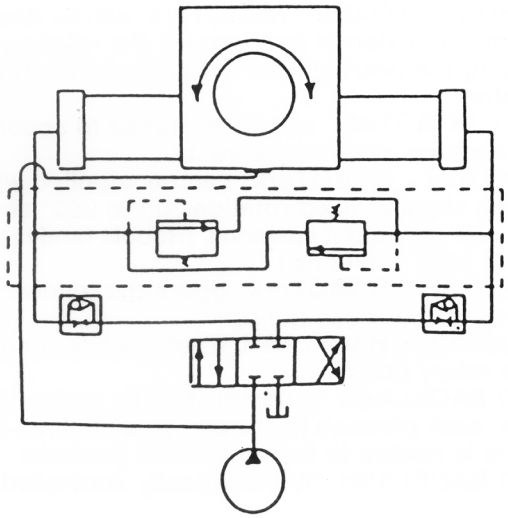
Be sure to size the rotary actuator based on torque produced by the actual differential pressure on one rack only.

EX. 3000 psi (system pressure) - 1000 psi (back pressure) = 2000 ΔP. Using a model 30,000 with double rack, this produces 10,000 lbs. in. of torque.

Model No. = Torque at 3000 psi
Model 300,000 = 10 lbs. in./psi

$$\frac{3000 - 1000}{2} = 10{,}000 \text{ lbs. in.}$$

Only one of two racks is used to develop torque while the other rack is back pressured to prevent pinion backlash; therefore, torque produced is one half normal torque of the actuator at the differential pressure.



ZERO BACKLASH - HYDROSTATICALLY CONTROLLED

This is accomplished by applying a force against the back of the rack using system pressure in a specifically designed hydraulic load cell.
Submit Application Specification Guide AP 301 for factory quotation.