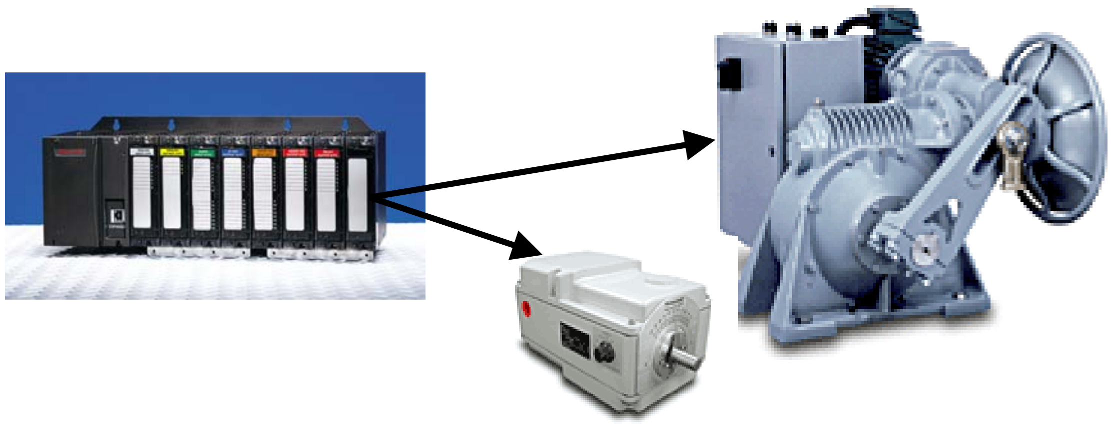
Honeywell

HC900 Hybrid Controller

When you need more than just discrete control

Product Note - Positional Proportional Output



Background:

Many processes under control today have requirements that are best satisfied using energy regulating devices that are directly connected to electromechanical motor actuators. Electromechanical actuators have been in use in industry for control system regulation for more than 50 years, and there is a large installed base of these devices. Many control system upgrade projects focus on the electronic hardware located in the control room, but fail to include motor actuators in the project, particularly if they are functioning acceptably. Although newer “Smart” actuators can offer numerous maintenance and asset management advantages, they are often overlooked when upgrade projects are planned.

The motor actuator used for regulation uses a bi-directional motor that holds its last position when deactivated. Many actuators use a position sensing device to provide a signal to the control system of the actual actuator position. One of the most common sensors used for this function, because of its low cost, simple design and rugged performance, is a variable resistor or slidewire. Since the slidewire is a passive electronic device, one of the requirements of the control system is to provide an excitation voltage in order to obtain a position output signal. Although the slidewire is a cost effective and rugged device, it does have a mechanical attribute that is subject to wear over time. For this reason, some actuator suppliers offer electronic position sensors that can supply a voltage or current without the dependency on wear component hardware. For these devices, control systems typically only require a high level analog measurement capability and an algorithm to position the motor. Algorithms used to position actuators with feedback sensors do not have a standard terminology for their identification but a few of the most common names used are: Position Proportional Outputs (PPO), Position Adjusting Type (PAT), and Motor Positioner (MP). Honeywell uses the PPO terminology.

When knowing the actual motor position in a control system is not important, many actuators are supplied without a position sensor. The control systems used to regulate these actuators depend on a special algorithm that simulates an internal feedback to substitute for the actual feedback signal. The most commonly recognized algorithm for this type of control is the “Three-Position-Step” algorithm.

Both the Position Proportional Output (PPO) and the Three Position Step Control (TPSC) can provide excellent process control when properly engineered into the control system.

Problem Statement:

Many first time application engineers approach position proportional control as a very simple task. Just measure the analog signal representing position, compare it to the desired position, and if the value is lower than required, turn a digital output ON to increase the position, and if the value is too high, turn the decreasing output ON. To keep the motor from oscillating, add some dead-band, or said another way, compromise position accuracy to improve motor life. This is typically not more than a few program statements in a PLC.

Before putting the system on-line the following problems must be addressed:

1. The passive slidewire position sensor of the actuator requires electrical excitation, (typically DC power source with a voltage low enough not to cause the resistive element to heat up or burn out). If the controller does not provide this voltage, an external power supply must be used.

Once on-line, other problems surface:

2. Once the slidewire is powered and the actuator is moved to its 0% and 100% travel limits based on the setting of the motor limit switches, a common observation is that the limit switches stop the motor before the slidewire contact reaches its 0% and 100% voltage limits. If the power supply used to excite the slidewire was 5 volts, the feedback voltage measured between 0% and 100% may typically be between ~0.3V and ~4.8V. A measurement of feedback based on a 5V span would have an error of 0.5V or a 10% error. To correct this error the actual span value of the feedback signal as measured on a 5V analog input range must be re-spanned to have 0.3V and 4.8V represent 0% and 100% travel of the motor.

3. Once the feedback is addressed, positioning the motor becomes the next issue. If a simple compare algorithm is used to determine when to increase or decrease the motor, an oscillation of the motor is guaranteed. This is because it takes time to measure the analog feedback, process the compare function, and turn an output OFF. During this time the motor is still moving. When the motor is finally deactivated, it will have already passed the compare point that initiated the action to turn off. The amount of overshoot is based on the algorithm processing time and motor speed. Also, if the update rate of the algorithm is not consistent or varies with processor loading, the amount of overshoot will also vary.

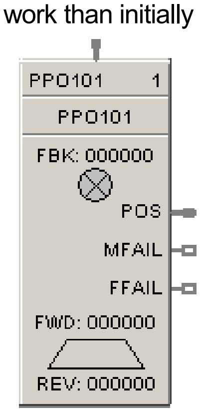
   To avoid this overshoot condition, a timed output approach is typically used to position the motor. With this approach, if a 15 second motor is at its 0% position and a new request comes in for a 50% position, the output algorithm would turn ON its output for 7.5 seconds. This feature adds a new complexity, to measure the time for full scale motor travel and use this value in the output algorithm calculation.

4. Another variable that must be considered is the amount of motor over-travel that may occur after power to the motor is removed. To minimize this condition, many actuators employ a gearing or braking system, but it can seldom be reduced to zero. To optimize control of this variable, a combination of timed pulses and a dead-band are typically used.

When fully implemented the final program often requires significantly more work than initially planned.

The Solution:

The HC900 "Position Proportional Output" (PPO)



The HC900 Position Proportional Output is designed to provide optimum actuator position control with a minimum of setup complexity. From a standard analog input range for feedback slidewire measurements to a fully automatic feedback calibration feature, the HC900 PPO algorithm excels. Once on-line, the PPO algorithm provides additional benefits with a scaled output of the actual motor position that may be used on displays or integrated into the control strategy, and diagnostics routines that run in the background that detect actuator problems. The following are a few of the HC900 PPO algorithm highlights and benefits.

1. Standard analog ranges embedded in the PPO algorithm to measure slidewire resistances between 100 and 1000 ohms. (No external power supply required. Uses a simple 3-wire connection to the standard universal AI module.) Voltage ranges of 0 to 5V, 0 to 1V, and current ranges 0 to 20mA , 4 to 20mA are also supported for feedback inputs.

2. Flexibility to use any type of digital output module with the PPO algorithm, AC, DC or Relay. (No special output modules or incompatible voltages.)

3. Complete actuator control setup from a single PPO function block including analog input hardware and range, digital output hardware, actuator feedback scaling and motor speed, actuator sensitivity (dead-band). (Easy to setup, easy to troubleshoot.)

4. Fully automatic feedback signal calibration. Scales the actual feedback signal values to represent 0 to 100% output and calculates motor speed. (The easy choice for easy to use.)

5. Semi-automatic feedback calibration (user initiated step-by-step process) and manual feedback calibration (user manually moves the motor) also supported. (Offers flexibility when required.)

6. User entered dead-band support for values from 0.5% to +/- 5.0%. Ideal for actuators without braking action.

7. Input scaling support is included to allow reverse scaling for heating/cooling applications using Duplex control (0 to 50, 50 to 0).

8. User entered output limit values supported. For users who want to limit actual actuator travel to values less than 0 and 100%.

9. Actuator position output pin provided for displays or connection to other function blocks.

10. Feedback failure detect output pin provided. Digital output turns ON if the algorithm detects a failed slidewire.

11. Automatically defaults to Three-Position–Step control on feedback failure.

12. Fault output pin turns ON upon detection of a failed or stalled motor.

The HC900 controller can support up 64 PPO algorithms, or two for each PID loop. The algorithms also execute independently from the PID algorithms, allowing them to accept setpoint signals from other sources. For example, a single manually entered variable from an OI overview display could be used to set the position of multiple actuators simultaneously. Another application might connect two actuators to the same PID algorithm with the actuators operating in series, applying unique input scaling to each actuator. These are only a few examples of the control flexibility afforded users with the HC900 PPO algorithm.

How to Order:

The PPO algorithm is offered in the HC900 controller at no additional cost in CPU versions 900C51-0011, 900C52-0011, 900C31-0011, 900C32-0011 and later versions. If direct slidewire measurements are required, analog input module 900A01-0002 is required. This module is a direct replacement for module 900A01-0001 in all applications.

Use the HC900 PPO algorithm in retrofit applications and in new applications when accurate positioning of drive actuators is required.

Typical Position Proportional Configuration and Wiring: