APPENDIX A – GM CONTROL VALVE MODEL

The GM control valve model recreates the dynamic response of a typical control valve. The model allows the user to easily set the actuator and valve dynamics and is convenient for use in simulated loops. It is implemented as a composite template library block named “ACTUATOR”. The user wires the output of an analog output block in percent to the “SIGNAL_IN” input of the composite block and wires the “TRIM_POSITION” output of the composite block in percent to a process or positioner simulation block input.

The control valve model consists of two models. The first model for actuator shaft position is the input for a second model of actual valve trim position. The actuator shaft position simulates the dynamics of the actuator pressure response by the use of the filter, dead time, and rate limiting blocks shown in Figure A-1. The trim position simulates the effect of valve stem and trim friction and backlash by the setting of a resolution and dead band, respectively, for the calc block named “VALVE_STICKTION” in Figure A-1.

The model of actuator shaft position simulates the rate limited second order response and a pre-stroke dead time of the actuator. The pre-stroke dead time is the amount of time it takes for the fill or exhaust flow to change the actuator pressure enough to cause the actuator shaft to start to change. The pre-stroke dead time is normally negligible (less than 0.2 second) except for extremely large actuator volumes associated with large valves and high pressure drop valves. Once the shaft moves, the rate limiting is set by the slewing rate or stroking time (time to stroke 100%). A nominal stroking time for small actuators is 5 seconds, which corresponds to a slewing rate of 20% per second.

The pre-stroke dead time and stroking time is proportional to the actuator volume and inversely proportional to the effectively flow coefficient of the accessories (positioner or booster) including any restrictions from solenoid valves and actuator connection sizes. The exhaust and fill flow coefficients of the accessories are normally different so the pre-stroke dead time and slewing rate depend upon the direction of the change in signal.

The actuator model also facilitates the setting of two time lags. These lags are usually about 1 second for small volume actuators. As the stroking time increases, these time lags also increase. For diaphragm actuators, these time lags can be approximated as ¼ of the stroking time.

The actuator shaft position is an input to the concise expression in the calc block shown in Figure A-2. The output of the expression is trim position. In the expression, if the absolute difference between shaft and trim position (NEW_DELTA) minus an offset set by backlash is less than the resolution limit, the trim does not move (the trim sticks). The trim moves (the trim slips) if the difference in shaft and trim position exceeds half of the dead band plus the resolution. The new trim position is the old trim position plus the slip, which is the sum of the difference between shaft and trim position plus the offset. If the trim moves, the offset is updated to be equal to half of the dead band with a sign based on the direction of the change in trim position.

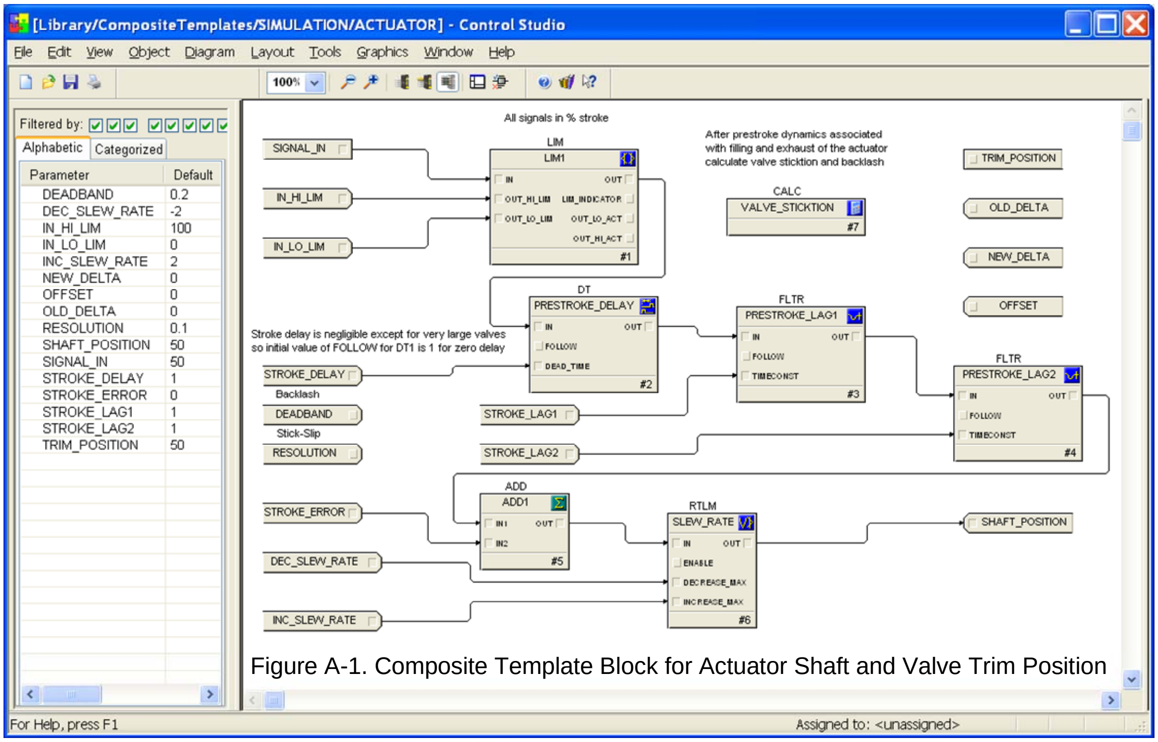

Figure A-1. Composite Template Block for Actuator Shaft and Valve Trim Position

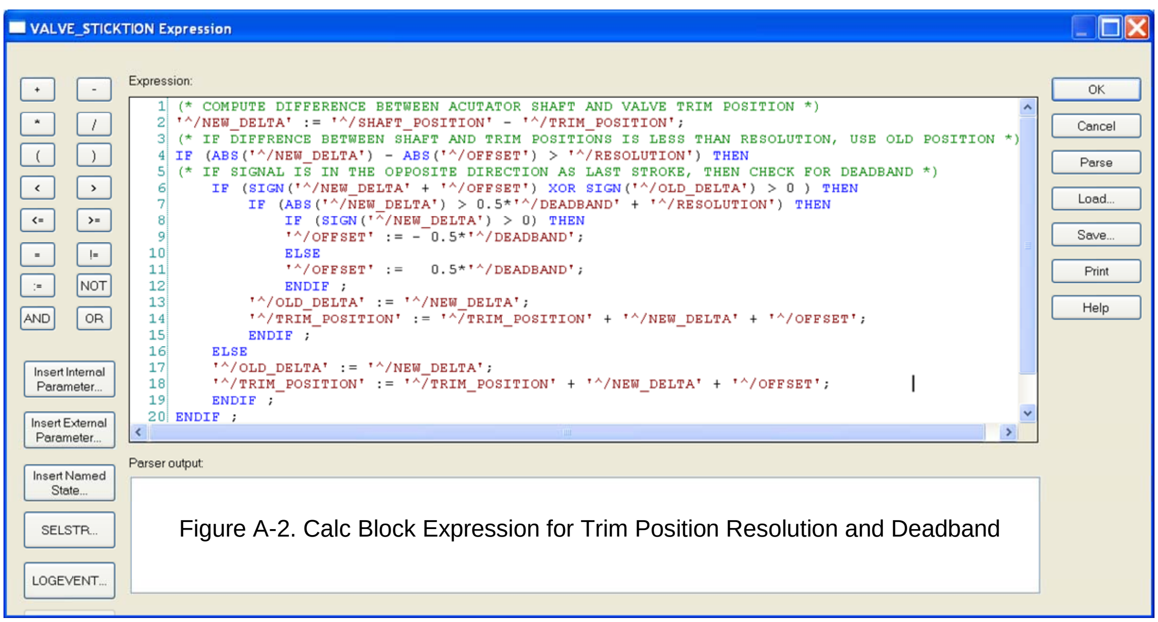

Figure A-2. Calc Block Expression for Trim Position Resolution and Deadband