Easytork Control Valve White Paper

Introduction / Summary

The purpose of this white paper is to analyze positioner to valve stem repeatability using Easytork actuator with SIPART PS2 positioner.

Results Summary

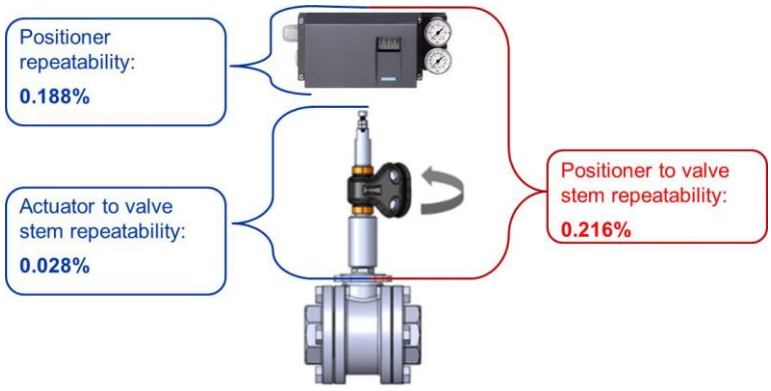
With 100% being full open (90°) and 0% being full close (0°) the following is the testing summary.

Total repeatability from valve stem to positioner measures 0.216%. The SIPART PS2 positioner itself had a measured repeatability of 0.188%. The difference of 0.028% repeatability is the sum of the repeatability of the actuator, valve connection hardware, and testing hardware.

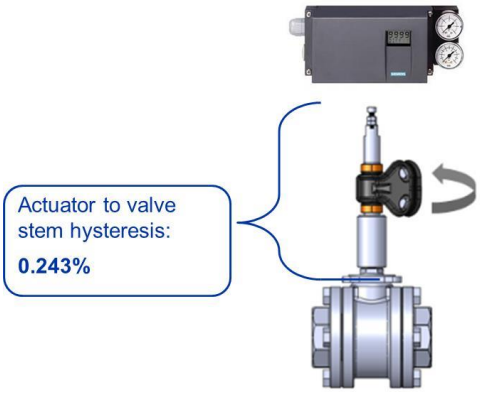
The total hysteresis in the actuator, valve connection hardware, and testing hardware is 0.243%.

Both repeatability and hysteresis can be further reduced through the removal of testing hardware, and non-custom parts such as cutaway bracket.

Repeatability



Hysteresis



Testing setup

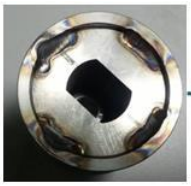
Easytork used an extended lower shaft, a custom drive insert welded into the extended lower shaft, a custom bracket with cutaway, and an arm extension that fully encapsulates the valve stem.

To measure the valve stem's angle of opening, the arm extension is free to move the full 90°. The custom bracket has a cutaway to not interfere with the free movement of the arm extension. The digital angle gauge takes measurements from 0 to 90° relative to a flat surface area and is placed on top of the arm extension.

The control valve package is laid sideways, so when the valve is 50% open, the arm extension will be parallel to the ground (for example the digital angle gauge will read 0°). When the valve is 0% open, the digital angle gauge measures the arm extension at +45° from the ground. And when the valve is 100% open, the digital angle gauge measures the arm extension at -45° from the ground. Easytork calibrated the digital angle gauge to be 0° at full close. Note, the digital angle gauge and the PS2 measurements start at independent base lines, one being the valve stem relative to a flat surface, and the other relative to the PS2.

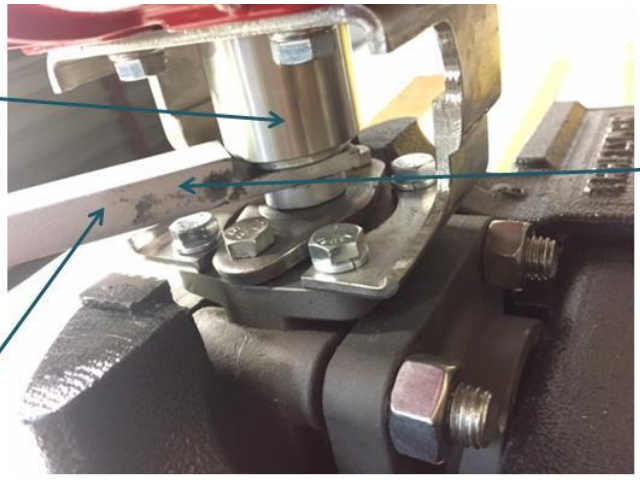
The PS2 conveys measurements as 0-100% open, whereas the digital angle gauge conveys measurements as 0° to 90°. The data on the digital angle gauge is converted from 0° to 90° to 0-100%.

Easytork alternated testing from 8 ma (25% open) to 12 ma (50% open) to 16 ma (75% open) to 12 ma (50% open), each time collecting data of the PS2 and valve stem at 12 ma (50% open). Easytork collected a total of 75 samples at 12 ma.



Drive insert welded into extended lower shaft

Arm extension from valve stem



Digital angle reader sits on top of arm extension

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Supporting Documentation – Repeatability Calculation

		Measurement			Repeatability For Repeatability Calc.	
Run #	Measured at 12ma	Positioner [1]	Stem Angle [1]		Positioner	Stem Angle
		0 - 100%	0° - 90°	0 - 100%	(Run # - Avg)^2	(Run # - Avg)^2
1	8 to 12ma	49.80%	44.10°	49.00%	0.000%	0.202%
2	16 to 12ma	49.80%	44.50°	49.44%	0.000%	0.000%
3	8 to 12ma	49.90%	44.40°	49.33%	0.007%	0.013%
4	16 to 12ma	49.90%	44.60°	49.56%	0.007%	0.011%
5	8 to 12ma	50.10%	44.60°	49.56%	0.080%	0.011%
6	16 to 12ma	49.85%	44.70°	49.67%	0.001%	0.047%
7	8 to 12ma	50.20%	44.50°	49.44%	0.146%	0.000%
8	16 to 12ma	49.90%	44.70°	49.67%	0.007%	0.047%
9	8 to 12ma	50.20%	44.60°	49.56%	0.146%	0.011%
10	16 to 12ma	49.90%	44.80°	49.78%	0.007%	0.108%
11	8 to 12ma	50.20%	44.70°	49.67%	0.146%	0.047%
12	16 to 12ma	49.90%	44.80°	49.78%	0.007%	0.108%
13	8 to 12ma	50.00%	44.70°	49.67%	0.033%	0.047%
14	16 to 12ma	49.90%	44.80°	49.78%	0.007%	0.108%
15	8 to 12ma	49.60%	44.20°	49.11%	0.048%	0.114%
16	16 to 12ma	49.80%	44.60°	49.56%	0.000%	0.011%
17	8 to 12ma	49.90%	44.20°	49.11%	0.007%	0.114%
18	16 to 12ma	49.90%	44.80°	49.78%	0.007%	0.108%
19	8 to 12ma	49.90%	44.40°	49.33%	0.007%	0.013%
20	16 to 12ma	49.80%	44.60°	49.56%	0.000%	0.011%
21	8 to 12ma	50.00%	44.30°	49.22%	0.033%	0.051%
22	16 to 12ma	49.70%	44.50°	49.44%	0.014%	0.000%
23	8 to 12ma	49.70%	44.30°	49.22%	0.014%	0.051%
24	16 to 12ma	49.80%	44.60°	49.56%	0.000%	0.011%
25	8 to 12ma	49.80%	44.50°	49.44%	0.000%	0.000%
26	16 to 12ma	49.90%	44.70°	49.67%	0.007%	0.047%
27	8 to 12ma	49.80%	44.40°	49.33%	0.000%	0.013%
28	16 to 12ma	49.80%	44.70°	49.67%	0.000%	0.047%
29	8 to 12ma	49.70%	44.30°	49.22%	0.014%	0.051%
30	16 to 12ma	49.80%	44.60°	49.56%	0.000%	0.011%
31	8 to 12ma	49.90%	44.50°	49.44%	0.007%	0.000%
32	16 to 12ma	49.80%	44.80°	49.78%	0.000%	0.108%
33	8 to 12ma	49.90%	44.60°	49.56%	0.007%	0.011%
34	16 to 12ma	49.80%	44.60°	49.56%	0.000%	0.011%
35	8 to 12ma	49.90%	44.70°	49.67%	0.007%	0.047%
36	16 to 12ma	49.70%	44.40°	49.33%	0.014%	0.013%
37	8 to 12ma	49.90%	44.60°	49.56%	0.007%	0.011%
38	16 to 12ma	49.00%	44.70°	49.67%	0.669%	0.047%
39	8 to 12ma	49.80%	44.40°	49.33%	0.000%	0.013%
40	16 to 12ma	49.80%	44.60°	49.56%	0.000%	0.011%
41	8 to 12ma	49.80%	44.10°	49.00%	0.000%	0.202%
42	16 to 12ma	49.70%	44.40°	49.33%	0.014%	0.013%
43	8 to 12ma	49.70%	44.30°	49.22%	0.014%	0.051%
44	16 to 12ma	49.80%	44.60°	49.56%	0.000%	0.011%
45	8 to 12ma	49.80%	44.10°	49.00%	0.000%	0.202%
46	16 to 12ma	49.70%	44.30°	49.22%	0.014%	0.051%
47	8 to 12ma	50.30%	44.80°	49.78%	0.232%	0.108%
48	16 to 12ma	49.90%	44.70°	49.67%	0.007%	0.047%
49	8 to 12ma	49.80%	44.40°	49.33%	0.000%	0.013%
50	16 to 12ma	49.80%	44.60°	49.56%	0.000%	0.011%
51	8 to 12ma	49.90%	44.50°	49.44%	0.007%	0.000%
52	16 to 12ma	49.80%	44.50°	49.44%	0.000%	0.000%
53	8 to 12ma	49.50%	44.20°	49.11%	0.101%	0.114%
54	16 to 12ma	49.90%	44.60°	49.56%	0.007%	0.011%
55	8 to 12ma	49.90%	44.70°	49.67%	0.007%	0.047%
56	16 to 12ma	49.90%	44.70°	49.67%	0.007%	0.047%
57	8 to 12ma	49.50%	44.10°	49.00%	0.101%	0.202%
58	16 to 12ma	49.80%	44.50°	49.44%	0.000%	0.000%
59	8 to 12ma	49.70%	44.30°	49.22%	0.014%	0.051%
60	16 to 12ma	49.50%	44.20°	49.11%	0.101%	0.114%
61	8 to 12ma	49.70%	44.40°	49.33%	0.014%	0.013%
62	16 to 12ma	49.90%	44.70°	49.67%	0.007%	0.047%
63	8 to 12ma	49.60%	44.40°	49.33%	0.048%	0.013%
64	16 to 12ma	49.70%	44.30°	49.22%	0.014%	0.051%
65	8 to 12ma	49.80%	44.50°	49.44%	0.000%	0.000%
66	16 to 12ma	49.60%	44.30°	49.22%	0.048%	0.051%
67	8 to 12ma	49.90%	44.70°	49.67%	0.007%	0.047%
68	16 to 12ma	49.70%	44.40°	49.33%	0.014%	0.013%
69	8 to 12ma	50.00%	44.50°	49.44%	0.033%	0.000%
70	16 to 12ma	49.90%	44.60°	49.56%	0.007%	0.011%
71	8 to 12ma	50.20%	44.80°	49.78%	0.146%	0.108%
72	16 to 12ma	49.50%	44.30°	49.22%	0.101%	0.051%
73	8 to 12ma	49.90%	44.40°	49.33%	0.007%	0.013%
74	16 to 12ma	49.80%	44.50°	49.44%	0.000%	0.000%
75	8 to 12ma	49.50%	44.30°	49.22%	0.101%	0.051%

	Positioner	Stem Angle
Unit of Measure.	0 - 100%	0 - 100%
Average	49.82%	49.45%
Sample Size	75	75
Repeatability	0.188%	0.216%
Actuator and Hardware Repeatability		0.028%

Note (1): Measurement based on different base line.
Note (2): Stem angle repeatability - positioner repeatability = hysteresis attributed to actuator and valve connection hardware

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Supporting Documentation – Hysteresis Calculation

Hysteresis

16 to 12 ma Measurement

Run #	Measured at 12ma	Positioner (1)	Stem Angle (1)	
		0 - 100%	0° - 90°	0 - 100%
2	16 to 12ma	49.80%	44.50°	49.44%
4	16 to 12ma	49.90%	44.60°	49.56%
6	16 to 12ma	49.85%	44.70°	49.67%
8	16 to 12ma	49.90%	44.70°	49.67%
10	16 to 12ma	49.90%	44.80°	49.78%
12	16 to 12ma	49.90%	44.80°	49.78%
14	16 to 12ma	49.90%	44.80°	49.78%
16	16 to 12ma	49.80%	44.60°	49.56%
18	16 to 12ma	49.90%	44.80°	49.78%
20	16 to 12ma	49.80%	44.60°	49.56%
22	16 to 12ma	49.70%	44.50°	49.44%
24	16 to 12ma	49.80%	44.60°	49.56%
26	16 to 12ma	49.90%	44.70°	49.67%
28	16 to 12ma	49.80%	44.70°	49.67%
30	16 to 12ma	49.80%	44.60°	49.56%
32	16 to 12ma	49.80%	44.80°	49.78%
34	16 to 12ma	49.80%	44.60°	49.56%
36	16 to 12ma	49.70%	44.40°	49.33%
38	16 to 12ma	49.00%	44.70°	49.67%
40	16 to 12ma	49.80%	44.60°	49.56%
42	16 to 12ma	49.70%	44.40°	49.33%
44	16 to 12ma	49.80%	44.60°	49.56%
46	16 to 12ma	49.70%	44.30°	49.22%
48	16 to 12ma	49.90%	44.70°	49.67%
50	16 to 12ma	49.80%	44.60°	49.56%
52	16 to 12ma	49.80%	44.50°	49.44%
54	16 to 12ma	49.90%	44.60°	49.56%
56	16 to 12ma	49.90%	44.70°	49.67%
58	16 to 12ma	49.80%	44.50°	49.44%
60	16 to 12ma	49.50%	44.20°	49.11%
62	16 to 12ma	49.90%	44.70°	49.67%
64	16 to 12ma	49.70%	44.30°	49.22%
66	16 to 12ma	49.60%	44.30°	49.22%
68	16 to 12ma	49.70%	44.40°	49.33%
70	16 to 12ma	49.90%	44.60°	49.56%
72	16 to 12ma	49.50%	44.30°	49.22%
74	16 to 12ma	49.80%	44.50°	49.44%

8 to 12 ma Measurement

Run #	Measured at 12ma	Positioner (1)	Stem Angle (1)	
		0 - 100%	0° - 90°	0 - 100%
1	8 to 12ma	49.80%	44.10°	49.00%
3	8 to 12ma	49.90%	44.40°	49.33%
5	8 to 12ma	50.10%	44.60°	49.56%
7	8 to 12ma	50.20%	44.50°	49.44%
9	8 to 12ma	50.20%	44.60°	49.56%
11	8 to 12ma	50.20%	44.70°	49.67%
13	8 to 12ma	50.00%	44.70°	49.67%
15	8 to 12ma	49.60%	44.20°	49.11%
17	8 to 12ma	49.90%	44.20°	49.11%
19	8 to 12ma	49.90%	44.40°	49.33%
21	8 to 12ma	50.00%	44.30°	49.22%
23	8 to 12ma	49.70%	44.30°	49.22%
25	8 to 12ma	49.80%	44.50°	49.44%
27	8 to 12ma	49.80%	44.40°	49.33%
29	8 to 12ma	49.70%	44.30°	49.22%
31	8 to 12ma	49.90%	44.50°	49.44%
33	8 to 12ma	49.90%	44.60°	49.56%
35	8 to 12ma	49.90%	44.70°	49.67%
37	8 to 12ma	49.90%	44.60°	49.56%
39	8 to 12ma	49.80%	44.40°	49.33%
41	8 to 12ma	49.80%	44.10°	49.00%
43	8 to 12ma	49.70%	44.30°	49.22%
45	8 to 12ma	49.80%	44.10°	49.00%
47	8 to 12ma	50.30%	44.80°	49.78%
49	8 to 12ma	49.80%	44.40°	49.33%
51	8 to 12ma	49.90%	44.50°	49.44%
53	8 to 12ma	49.50%	44.20°	49.11%
55	8 to 12ma	49.90%	44.70°	49.67%
57	8 to 12ma	49.50%	44.10°	49.00%
59	8 to 12ma	49.70%	44.30°	49.22%
61	8 to 12ma	49.70%	44.40°	49.33%
63	8 to 12ma	49.60%	44.40°	49.33%
65	8 to 12ma	49.80%	44.50°	49.44%
67	8 to 12ma	49.90%	44.70°	49.67%
69	8 to 12ma	50.00%	44.50°	49.44%
71	8 to 12ma	50.20%	44.80°	49.78%
73	8 to 12ma	49.90%	44.40°	49.33%
75	8 to 12ma	49.50%	44.30°	49.22%

	16-12ma	8-12ma	Difference
Positioner Average	49.77%	49.86%	-0.086%
Stem Angle Average	49.53%	49.37%	0.157%
Actuator hysteresis (3)			0.243%

Note (1): Measurement based on different base line.
Note (3): Stem angle average - positioner average = hysteresis attributed to actuator