SpeedPod
Correlation with EZSpeed

1. Introduction

SpeedPod is among the newest generation of devices to capture door characteristics such as minimum closing speed. This latest addition to the EZ Metrology product line has been held to the highest standards. SpeedPod incorporates nearly a decade of improvements and suggestions collected from users around the world.

EZMetrology understands the requirement of data consistency and continuity when customers consider migrating to the SpeedPod platform.

This document has been created to assure users of a seamless migration to the SpeedPod platform by illustrating the strong correlation between measurements collected with EZSpeed and SpeedPod.

2. Procedure

EZSpeed and SpeedPod are simultaneously placed on the same car door according to standard installation procedures. When the door is slammed, the readings from both gauges are recorded concurrently. The door is slammed multiple times from relatively low speeds (500mm/sec) all the way to higher speeds (1500mm/sec). For each closing event, the displayed value shown on the EZSpeed screen is compared to the displayed value on the SpeedPod screen.

The population consists of the following variables:

- 4 different doors; two front and two rear doors
- 30 measurements per trial

Therefore, the population size of the study consists of 120 samples collected between approximately 500 and 1500 mm/sec. All data is collected with one operator and one car.

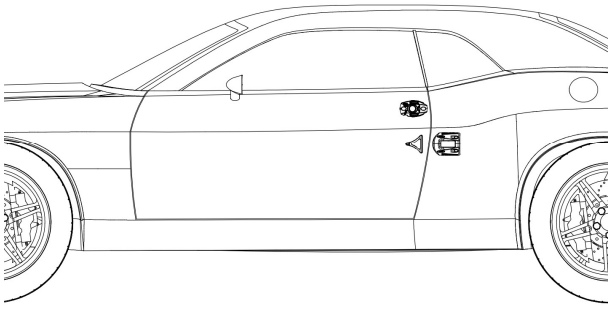

Image 1: Mounting example of SpeedPod right above EZSpeed.

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The relative difference between the EZSpeed and SpeedPod values is calculated for each measurement and expressed as a percentage. For each data set, the average difference for all samples as well as the minimum and maximum values are determined.

Graphically, the readings are plotted in a scatter graph with EZSpeed data on the x-axis and SpeedPod data on the y-axis. In line with classic regression methods, the correlation between the two data sets can be evaluated based on R^2 and the slope of the best fit trendline where R^2 provides the level of variance in the best fit trendline for the graphed data set. For ideal linear regression indicating a perfect level of correlation, R^2 and the slope are both equal to 1

3. Equipment Used

The EZSpeed and SpeedPod units used for correlation testing were assembled, tested, and calibrated per standard EZMetrology procedures.

4. Target Correlation

To evaluate the correlation between EZSpeed and SpeedPod, it is important to highlight the individual gauge performances to establish a target correlation value.

Per EZSpeed specifications, the accuracy of all devices is 5%. As documented in the calibration certificate, EZSpeed gauges typically measure approximately 3% deviation from the international standard.

Per SpeedPod specifications, the accuracy of all devices is 1.5%. As documented in the calibration certificate, SpeedPod gauges typically measure approximately 0.5% deviation from the international standard.

Thus, the combined population uncertainty would be 5.4% or an expected experimental value of about 3%. For a correlation study between gauges where the total uncertainly remains less than 3%, one can therefore conclude that the uncertainty from the gauge-to-gauge correlation is insignificant relative to the uncertainty of the individual gauge.

Correlation Value < 3%

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5. Configuration

SpeedPod has enhanced capabilities to be configured by the user including door radius and speed angle - the angle at which the momentary speed is recorded.

These SpeedPod values need to be configured to correspond to EZSpeed measurement principles. Standard values are a door radius of 1 meter and a speed angle of 5 degrees. To best match the EZSpeed readings, the door radius must be adjusted in the profile for the actual door, and the speed angle should be set to 4 degrees.

If the settings are not adjusted, slightly higher deviations could be observed in the higher speed measurement range.

6. Results

In Section 8, all individual tests are listed and the evaluation per door is graphed. For the evaluations of Front Door A, Front Door B, Rear Door A, and Rear Door B, the R^2 values obtained from linear regression are 0.9989, 0.9989, 0.9935, 0.9992, respectively.

For the population where results for all four doors are combined into one single data set, the total linear regression is represented in Figure 1.

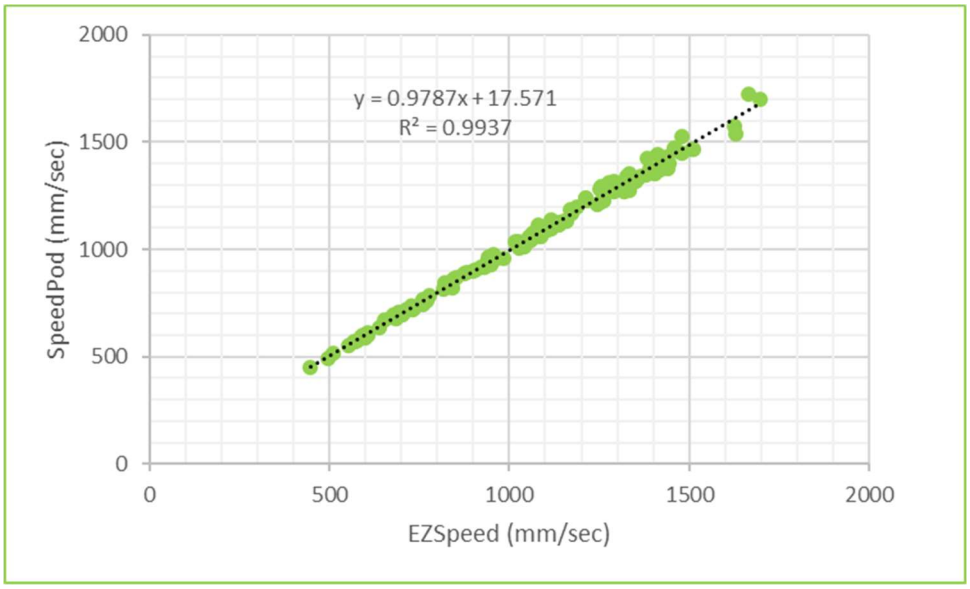

Figure 1 : Correlation Graph, All Samples, EZSpeed vs SpeedPod

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For all 120 samples combined, the full population has the following characteristics:

- Average Deviation: 0.3%
- Max Difference: +3.5%
- Min Difference: -5.5%
- R^2 Value: 0.9937
- Correlation Slope: 0.978% or 2.13% difference

7. Conclusion

The measurements collected from EZSpeed and SpeedPod have a correlation R^2 of 0.9937 and slope difference of 2.13%.

This value is well within the expected deviation due to individual gauge uncertainty, 3%.

Therefore, the difference between the two gauges is limited by the individual EZSpeed gauge uncertainty and not the correlation uncertainty between the two devices.

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8. DATA

8.1. TRIAL 1: FRONT DOOR A

Sample (#)	EZSpeed (mm/sec)	SpeedPod (mm/sec)	Difference (%)
1	845	865	2.4%
2	677	694	2.5%
3	654	670	2.4%
4	569	569	0.0%
5	821	847	3.2%
6	759	770	1.4%
7	940	964	2.6%
8	1217	1228	0.9%
9	1116	1137	1.9%
10	1082	1114	3.0%
11	1016	1039	2.3%
12	1252	1283	2.5%
13	1478	1524	3.1%
14	1335	1354	1.4%
15	1413	1441	2.0%
16	1696	1699	0.2%
17	1457	1474	1.2%
18	1213	1240	2.2%
19	1263	1288	2.0%
20	1170	1183	1.1%
21	1022	1035	1.3%
22	1020	1025	0.5%
23	955	977	2.3%
24	854	870	1.9%
25	777	787	1.3%
26	607	614	1.2%
27	447	448	0.2%
28	674	685	1.6%
29	510	514	0.8%
30	1286	1301	1.2%
		Average	1.7%
		2 Sigme (95%)	1.7%
		Max	3.2%
		Min	0.0%

Table 1 : Comparison of EZSpeed and SpeedPod Data: Front Door A, 30 Test Samples

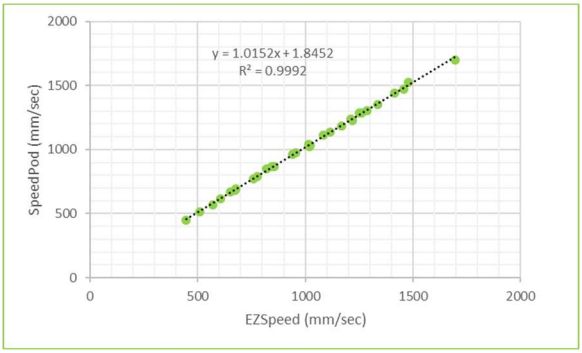

Figure 2 : Front Door A, Correlation Graph

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8.2. TRIAL 2: FRONT DOOR B

Sample (#)	EZSpeed (mm/sec)	SpeedPod (mm/sec)	Difference (%)
1	906	906	0.0%
2	764	755	-1.2%
3	593	597	0.7%
4	939	938	-0.1%
5	590	592	0.3%
6	715	718	0.4%
7	694	706	1.7%
8	729	739	1.4%
9	759	760	0.1%
10	880	892	1.4%
11	1116	1098	-1.6%
12	1151	1133	-1.6%
13	874	888	1.6%
14	1022	1036	1.4%
15	1065	1077	1.1%
16	1276	1310	2.7%
17	1254	1291	3.0%
18	1325	1340	1.1%
19	1666	1725	3.5%
20	1292	1320	2.2%
21	1187	1198	0.9%
22	1383	1427	3.2%
23	1481	1451	-2.0%
24	1307	1290	-1.3%
25	1379	1349	-2.2%
26	1427	1420	-0.5%
27	1625	1573	-3.2%
28	1445	1403	-2.9%
29	1214	1238	2.0%
30	1037	1033	-0.4%
		Average	0.4%
		2 Sigme (95%)	3.6%
		Max	3.5%
		Min	-3.2%

Table 2 : Comparison of EZSpeed and SpeedPod Data: Front Door B, 30 Test Samples

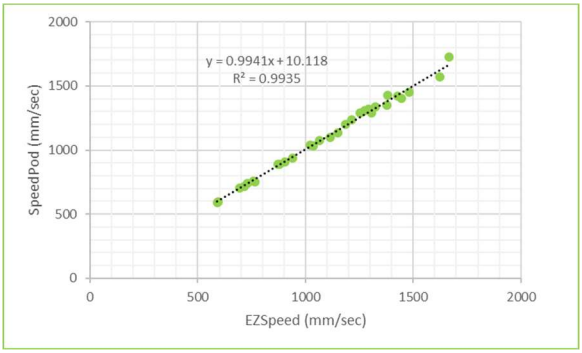

Figure 3 : Front Door B, Correlation Graph

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8.3. TRIAL 3: REAR DOOR A

Sample (#)	EZSpeed (mm/sec)	SpeedPod (mm/sec)	Difference (%)
1	734	723	-1.5%
2	703	695	-1.1%
3	553	551	-0.4%
4	730	722	-1.1%
5	601	590	-1.8%
6	842	823	-2.3%
7	1043	1010	-3.2%
8	983	958	-2.5%
9	1256	1219	-2.9%
10	1089	1062	-2.5%
11	1138	1113	-2.2%
12	1258	1236	-1.7%
13	1243	1207	-2.9%
14	1320	1271	-3.7%
15	1442	1374	-4.7%
16	1404	1355	-3.5%
17	1159	1134	-2.2%
18	1332	1274	-4.4%
19	1507	1465	-2.8%
20	1416	1374	-3.0%
21	1629	1539	-5.5%
22	1418	1373	-3.2%
23	1327	1289	-2.9%
24	1104	1089	-1.4%
25	1026	1007	-1.9%
26	949	931	-1.9%
27	930	914	-1.7%
28	684	676	-1.2%
29	772	759	-1.7%
30	572	569	-0.5%
		Average	-2.4%
		2 Sigme (95%)	2.4%
		Max	-0.4%
		Min	-5.5%

Table 3 : Comparison of EZSpeed and SpeedPod Data: Rear Door A, 30 Test Samples

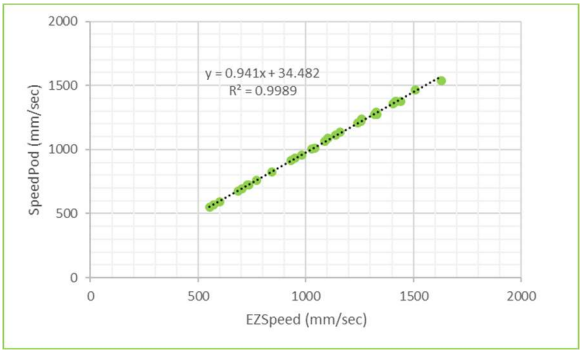

Figure 4 : Rear Door A, Correlation Graph

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8.4. TRIAL 4: REAR DOOR B

Sample (#)	EZSpeed (mm/sec)	SpeedPod (mm/sec)	Difference (%)
1	578	574	-0.7%
2	603	606	0.5%
3	719	721	0.3%
4	940	948	0.9%
5	760	742	-2.4%
6	919	919	0.0%
7	817	817	0.0%
8	960	951	-0.9%
9	1136	1124	-1.1%
10	1059	1041	-1.7%
11	1082	1060	-2.0%
12	1390	1358	-2.3%
13	1172	1168	-0.3%
14	1291	1270	-1.6%
15	1366	1341	-1.8%
16	1436	1432	-0.3%
17	1390	1375	-1.1%
18	1261	1228	-2.6%
19	1510	1468	-2.8%
20	1353	1318	-2.6%
21	1472	1456	-1.1%
22	1355	1331	-1.8%
23	1057	1052	-0.5%
24	1143	1127	-1.4%
25	1057	1061	0.4%
26	900	897	-0.3%
27	837	836	-0.1%
28	605	601	-0.7%
29	639	635	-0.6%
30	498	493	-1.0%
		Average	-1.0%
		2 Sigme (95%)	2.0%
		Max	0.9%
		Min	-2.8%

Table 4 : Comparison of EZSpeed and SpeedPod Data: Rear Door B, 30 Test Samples

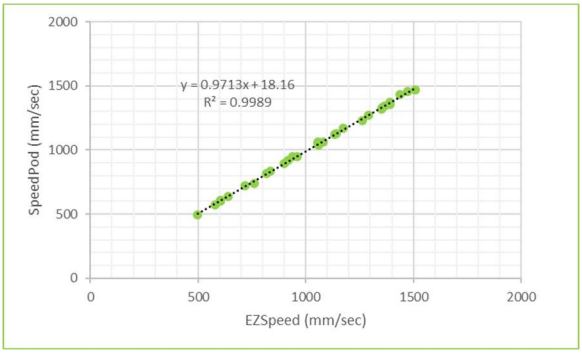

Figure 5 : Rear Door B, Correlation Graph

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