GMH Engineering
336 Mountain Way Drive
Orem, UT 84058, U.S.A.
Telephone: (801) 225-8970
Email: info@gmheng.com

Application Note 1001

Using Non-Contact Speed Sensing to Measure Vehicle Ground Speed

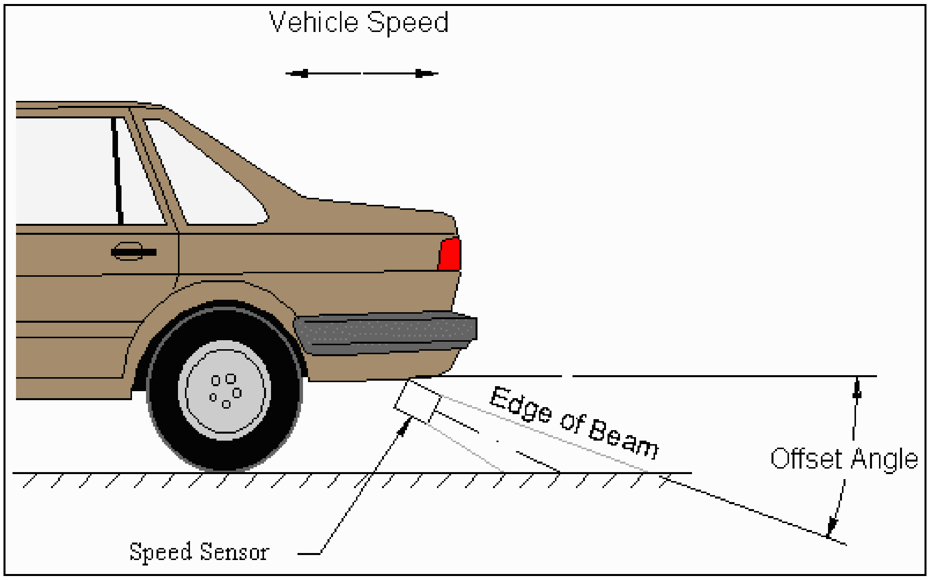

Figure 1. **Measuring Vehicle Ground Speed** (not to scale)

Measuring vehicle ground speed is a straight-forward application of the Delta Non-Contact Speed Sensor. As shown in Figure One, the sensor can be mounted on a vehicle, pointed toward the ground and used to measure the speed of the vehicle relative to the ground. The sensor may be pointed either forward or backward.

An advantage of using a non-contact speed sensor over other methods such as measuring wheel rotation is that the speed measurement is not affected by such factors as wheel slip, allowing a better measurement of true ground speed.

The data in the graph to the right clearly show such features as gear shifting, acceleration, coasting and braking. In this test, the vehicle was driven over an asphalt surface, but the sensor may be used on any surface that will reflect the transmitted signal back to the sensor such as gravel, dirt, ice, etc.

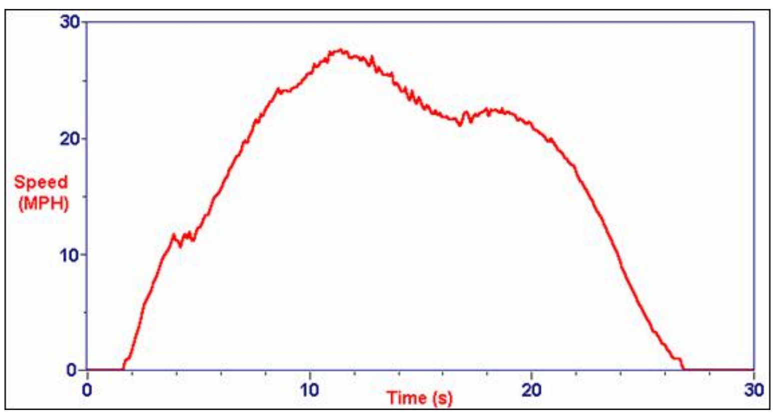

Figure 2. **Vehicle Ground Speed** (miles per hour)

Offset Angle

The offset angle shown in Figure One is the *nominal* offset angle. This is the angle between the center axis of the radar beam and the horizontal in the vertical plane. Because of factors involving geometry and relative strengths of the return signal from the ground ahead of and behind the center axis of the radar beam, the *effective* offset angle will differ from the nominal and requires a correction.

Table One shows the results of testing conducted to determine the effective offset angles using the speed sensor on vehicles driven over asphalt. To use the table, replace the *nominal* offset angle actually used by the corresponding *effective* offset angle when correcting for the offset angle. (See Application Note 1000, Fundamentals of Non-Contact Speed Measurement Using Doppler Radar.) For convenience, the cosine of the *effective* offset angle is also given in the table.

Nominal Offset Angle (degrees)	Effective Offset Angle (degrees)	Cosine Effective Offset Angle		Nominal Offset Angle (Degrees)	Effective Offset Angle (Degrees)	Cosine Effective Offset Angle
20	24.12	0.9127		33	34.47	0.8245
21	24.82	0.9076		34	35.34	0.8157
22	25.54	0.9023		35	36.22	0.8068
23	26.28	0.8966		36	37.11	0.7975
24	27.04	0.8907		37	38.00	0.7880
25	27.82	0.8844		38	38.90	0.7782
26	28.61	0.8779		39	39.80	0.7682
27	29.41	0.8711		40	40.71	0.7580
28	30.23	0.8640		41	41.63	0.7475
29	31.05	0.8567		42	42.54	0.7368
30	31.89	0.8490		43	43.47	0.7258
31	32.74	0.8411		44	44.39	0.7146
32	33.60	0.8329		45	45.32	0.7031

Table One - **Effective Offset Angles on Asphalt**

The particular choice of nominal offset angle involves a tradeoff between several factors. Placing the sensor at a steeper angle increases signal strength and reduces the field of view of the sensor so that it does not see non-targets such as other vehicles. On the other hand, a steeper angle also increases sensitivity of the sensor to vertical motions and may introduce more variation in the vehicle ground speed measurement because of pitching of the vehicle on its suspension.

The accuracy of the speed measurement using this method of offset angle correction depends on the accuracy to which the offset angle is known. For instance, with a 30º offset angle, a 1º uncertainty in offset angle can cause a 1 - 2% uncertainty in the speed measurement. If greater accuracy is required, the sensor can be calibrated by other methods such as distance comparison achieved by recording the number of pulses received from the sensor while the vehicles travels over a fixed distance.

The sensor should be aligned parallel to the direction of vehicle travel so that there is no horizontal offset angle. It is also important to consider factors such as suspension pitching, vibration, and dust or water spray when choosing a mounting location for the sensor. For example, a forward-pointing sensor may be indicated for applications where dust or water spray is expected at the rear of the vehicle which might interfere with the radar beam. The sensor should be mounted on a rigid location located away from engine vibration. Some suspension pitching is evident in Figure Two, where the vehicle under test was, in fact, driven over bumps and had a stiff suspension. These effects could be removed, if desired, by post-processing to smooth the data. If these factors are taken into consideration, however, measurements of vehicle ground speed can be made for a wide variety of applications.

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