Application Note C

Distance Applications Using the Doppler Radar Non-Contact Speed Sensor

Measuring distance using the Delta DRS1000 Non-Contact Speed Sensor is an excellent application if one remembers one important fact. The Delta DRS1000 cannot measure speeds below 0.5 miles per hour (0.8 km/h). Therefore any distances travelled at speeds below 0.5 miles per hour will not be measured.

If the sensor is mounted on a vehicle and is pointed straight ahead (parallel to the ground), the offset angle is zero. If the sensor could get its signal reflected back, at a zero offset angle, the output of the sensor would be 100 pulses per second for every mile per hour of speed measured. If the vehicle travels one mile, the total number of pulses outputted by the sensor will be 360,000 regardless of the speed at which it was travelled. I will give you two examples that will explain why the total number of pulses outputted in one mile does not change regardless of speed.

At one mile per hour, the sensor will output 100 pulses per second. In one hour, the vehicle will travel one mile. So, outputting 100 pulses per second for one hour, the total number of pulses outputted will be 100 times the number of seconds in an hour. Or, 100 times 3,600 which is a total of 360,000 pulses.

If the vehicle travels twice as fast, that is to say 2 miles per hour, the output of the sensor is twice as much. It is 200 pulses per second. At twice the speed, the vehicle will travel the one mile distance in half the time. Seeing it will be outputting twice as many pulses in half the time, at the end of one mile, the same number of total pulses will be outputted. In either example, the total number of pulses outputted in one mile will be 360,000. In fact, in all cases, at any speed, as long as the offset angle is zero, the total number of pulses outputted in one mile will be 360,000.

The sensor calculates how fast the target is moving towards the sensor by measuring the difference between the transmitted signal and the signal reflected back from the target. When the sensor is mounted on a vehicle, the sensor must be pointed down towards the ground to measure true ground speed. Seeing the ground is not moving directly towards the sensor, one must make a correction for the offset angle and the cosine error. It is difficult to accurately measure the offset angle of the sensor with a protractor. Even if you could accurately measure the offset angle, it would not take into consideration the profile of the beam being transmitted.

The sensor transmits a conical beam with a 12º angle. Think of it like the beam of a flashlight. If one points a flashlight towards the ground at an angle, the beam does not light up the ground with a perfect circle. It will be more like an oval. If the sensor is mounted precisely at a 30º offset angle, the reflected signal returning to the sensor will be weighted at slightly more than 30º.

Therefore the best way to calibrate for the offset angle is to travel a known distance and count the total number of pulses outputted. For example, if one travels one mile and the total number of pulses outputted is 309,600, this is 14% less than 360,000. This is 14% less than what the sensor would have outputted with a zero offset angle. Therefore, the sensor is not outputting 100 pulses per second for every mile per hour of speed measured. It is outputting 14% less - or 86 pulses per second for every mile per hour of actual ground speed.

One's accuracy with the speed sensor is largely determined by how accurately one can calibrate the sensor in the field. If one calibrates the sensor by counting the total number of pulses outputted in one mile of travel, an error of one count will equal an error of 0.015 feet when measuring distance. If the sensor is corrected for the offset angle as described above, most other sources of error are minimized or averaged out. For instance, vibrations or bumps encountered by the vehicle will be filtered out over time because they generate noise fluctuations in the data which will average out when the counts are summed.

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