MetroCount®
Traffic Data Specialists

Vehicle Speed Accuracy

MC5600 RSU

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Background

Measuring Vehicle Speed

The MetroCount 5600 Roadside Unit is a time-stamping traffic recorder. The unit contains two pneumatic sensors, and simply logs the time of detected air pulses. The resulting raw data stored in the unit has no concept of vehicles, providing MetroCount Traffic Executive's analysis software, MCReport, with unrestricted flexibility.

During data analysis, MCReport scans the axle stream extracting groups of axles that belong to a single vehicle. The speed of the vehicle is calculated from the first matching A and B sensor hits, using the simple formula:

$$speed = \frac{sensor\ spacing}{\left| time\ of\ \ first\ A\ hit - time\ of\ \ first\ B\ hit \right|}\ m/s$$

Measurement Uncertainty

Stating the accuracy of a measurement device is often not a simple task. In the case of measuring vehicle speed, uncertainty or error in measurement can be introduced from several sources. Many sources are independent of the Roadside Unit itself, and will vary from one survey site to the next.

There are two types of uncertainty in the measurement of individual vehicle speed:

- Random Errors, such as the inherent timing uncertainty of the Roadside Unit, or
- Systematic Errors, such as sensor length and spacing.

Random Errors occur in any physical measurement, usually due to the finite resolution of the measuring device. A large sample of measurements form a normal (bell-shaped) distribution around the true value. As the number of samples increases, the average value approaches the true value, and the average error approaches zero.

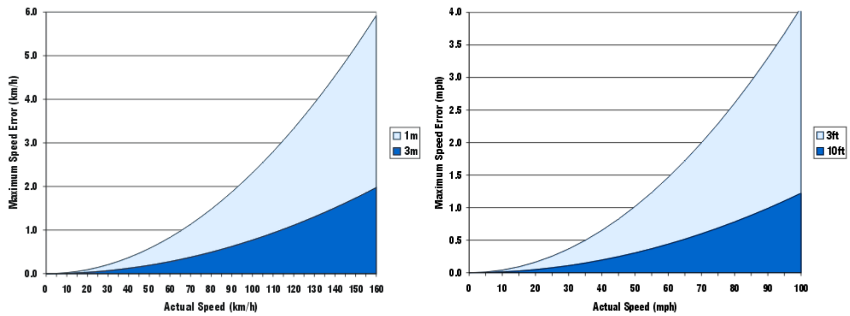
Systematic Errors contribute a fixed error or offset. Gross systematic errors can often be detected, and manually compensated for in the analysis software.

Random Error Sources

MetroCount 5600 Inherent Timing Resolution

Given an ideal sensor installation, the accuracy limiting factor for an individual vehicle is the inherent timing uncertainty of the Roadside Unit. Based on the speed calculation used, the maximum inherent error of an individual vehicle varies with the actual speed of the vehicle.

The MetroCount 5600 Roadside Unit time-stamps each sensor hit with a resolution of 833 microseconds. The graphs below show the effect of this uncertainty on the difference between calculated speed and true vehicle speed, for the given sensor spacings.



Inherent speed error (km/h and mph)

At slow vehicle speed, the 833 microseconds of uncertainty is only a very small percentage of the sensor traversal time (time between the first A and B sensor hits), giving a very small error. Similarly, increasing the sensor spacing increases the traversal time, thereby decreasing the effect of the timing uncertainty.

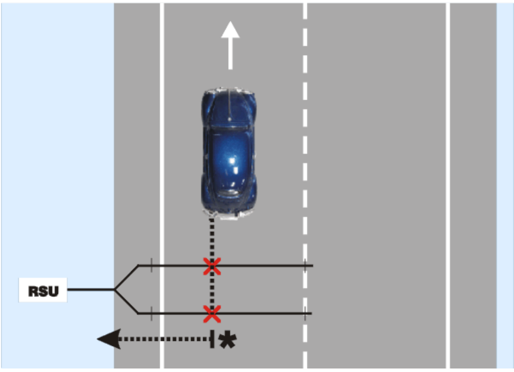
Note: An important point to note - the maximum error described above is for any single vehicle. However, for statistical calculations, as the number of vehicles in the sample increases, the average error will approach zero.

Systematic Error Sources

Given careful site selection and an ideal sensor installation, the combined effect of the systematic errors described below can be better than 1%.

Sensor Length

Air-pulses travel at the finite speed of sound in the sensors. Therefore a difference in sensor length, between where the vehicle wheel hits the sensor and the Roadside Unit, introduces an additional delay into one channel. The effect on calculated speed is asymmetrical - vehicles travelling in one direction will be too slow, and vehicles travelling in the other will be too fast.



***Sensor length from the wheel-hit to the Roadside Unit must be equal on both sensors**

Sensor Spacing

Precise sensor spacing is critical to accurate operation of the MetroCount Vehicle Classifier System. If the actual sensor spacing differs from that entered into the Roadside Unit when it was setup, the calculated speeds will be incorrect. This will also affect axle positions within the rest of the vehicle, and potentially cause classification errors.

The speed error produced is proportional to the error in the sensor spacing. For example, an actual spacing of 10% higher than entered into the Roadside Unit, will result in speed calculations 10% lower than actual vehicle speed.

Relative Sensor Angle

If the sensors are not parallel to each other, the calculated speed will vary depending on the position of the wheel-hit. For example, if the sensors are closer at the curbside, then the calculated speed will be faster for vehicles closer to the curb. Again, the percentage error is proportional to the percentage error in the spacing at the position of the wheel-hit.

Angle of Vehicle Incidence

Ideally, vehicles should be travelling perpendicular to the sensors. If vehicles cross at an angle, the increased time taken to traverse the sensors will result in a calculated speed less than the actual vehicle speed. An angle of incidence less than 10# gives a maximum error of 1%.

Calibration

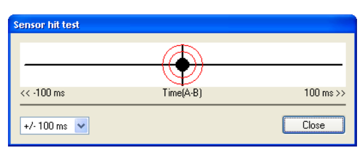
Survey Site

The MetroCount 5600 Vehicle Classifier System is designed to be a scientific instrument. The inherent accuracy, combined with a careful installation, provide an accuracy that is more than acceptable for behavioural and trend speed. However, for scenarios where instantaneous vehicle speed is of interest, the installation should be calibrated. Common site calibration methods include radar guns, or calibrated vehicle speedometers.

Roadside Unit

MCSetup's Sensor Hit Test provides a simple, but accurate performance test for the Roadside Unit. A short length of tube (approximately one metre) is attached to both sensors. The precise mid-point of the tube is then struck with a mallet. This should result in a simultaneous hit on both sensors. Any timing discrepancy, which may indicate a problem with the unit, can be easily identified.

Sensor Hit Test using a short length of tube



MCSetup's Sensor Hit Test

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