Speed Run Design Considerations

Theory of operation

Speed Trap systems are designed around the concept of measuring time for a travelled distance. The 'Trap' is generally a set distance of 66 feet or 20 meters with a sensor at the start of the trap and a sensor at the end of the trap. Time is measured starting when the first beam is tripped until the second beam is tripped. Speed is a calculation of the trap distance divided by the measured time. Time is actually a measurement of the number of ticks of the clock, known as 'tick count'. The tick count multiplied by the clock rate equals the amount of time in seconds between beam trips. Needless to say, the higher the tick count, the higher the speed resolution of the calculated speed.

The two main speed trap design items effecting speed resolution is the clock rate of the trap timing and the length of the trap. Increase the clock rate increases the tick count for any given speed. Increase the trap length and the vehicle takes longer to get through the trap, thus, causing the tick count to be higher for the same speed.

The technique of calculating speed

To put speed into perspective, a difference between a vehicle moving at 50.00mph (80.47kph) and a vehicle moving at 50.01mph (80.48kph) is the faster speed moves about a 1/5 of an inch (0.44cm) farther each second.

At 50mph (80.47kmph) and a 66ft trap (20mtr) , a vehicle trips the first beam and 0.9 seconds later, trips the second beam. The resulting number of ticks of the clock during the 0.9 seconds equals the tick count. If the tick count were off by 1 tick less, the calculated speed would be 49.99mph (80.46kph). If the tick count were off by 1 more, the calculated speed would be 50.01mph (80.48kph). Speed resolution would be 0.01mph (0.01kph), the difference of the calculated speed for the tick count variance of 1. With a 0.01mph (0.01kph) speed resolution, there are 100 possible speeds for any 1mph (1kph), that is, 100.00 or 100.01 or 100.02, etc.

The downside of calculated speeds

As the speed increases, the time in trap decreases reducing tick count to calculate the higher speed.

At 200mph (321.87kph) and a 66ft trap (20mtr) , a vehicle trips the first beam and 0.225 seconds later, trips the second beam. If the tick count were off by 1 tick less, the calculated speed would be 200.18mph (322.16kph). If the tick count were off by 1 more, the calculated speed would be 199.82mph (321.58kph). Speed resolution would be 0.18mph (0.29kph), the difference of the calculated speed for the tick count variance of 1. With a 0.18mph (0.29kph) speed resolution, there are fewer possible speeds for any 1mph (1kph).

At 200mph with the given trap length and clock rate, calculated speeds possible are 200.00mph, 200.18mph, 200.36mph, etc. 321.87kph, 322.16kph, 322,45kph, etc. Calculated speeds form a list of possibilities known as 'buckets'. With the standard trap length and clock rate, there are 5 possible calculated speeds between 200.00mph and 201.00mph, 3 possible calculated speeds between 321.00kph and 322.00kph. Since speed is a calculation from trap length and measured time, the higher the speed, the fewer the number of calculated speeds available. The fewer the number of buckets, the higher the probability of duplicate speeds occurring in large speed run events.

Increase the number of buckets, decrease duplicate speeds

To increase the number of calculated speed buckets at higher speeds, the tick count must be increased. Tick count can be increased by increasing the clock speed of the tick count. Tick count can also be increased by increasing the trap length. Doubling the clock rate, doubles the tick count, and doubles the number of calculated speed buckets for the higher speeds. In the example above, the result of the increased clock rate provides calculated speed buckets of 200.00mph, 200.09mph, 200.18mph, etc 321.87kph, 322.01kph, 322.16kph, etc. Doubling the trap length to 132 feet (40 meter) has the same doubling effect of calculated speed buckets. Double the clock rate and double the trap length has a cumulative effect with a 4x increase in the number of calculated speed buckets at the higher speeds.

Speed trap placement

Since trap speed is an average velocity while in the trap, calculated speed is closest to vehicle speed at the mid-point of the trap length. A 66 foot (20 meter) trap will measure a calculated speed at the 33 feet (10 meter) point of the trap. When increasing the trap to 132 foot (40 meter), the first sensor could be placed before the official finish line and the second sensor placed an equal distance after the official finish line. The calculated speed will be reflective of the vehicle speed at the center of the trap where the official finish line is drawn on the track

Questions? Contact RaceAmerica at (408) 988-6188 or online at http://www.raceamerica.com