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ROAD TRAFFIC

Average speed control

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Abstract

Average speed control (ASC) was introduced in Switzerland by the competent traffic authority, the Federal Roads Office (FEDRO), for a test phase at the beginning of 2010. As the competent partner for verification of technical aspects involved in speed measurement for type approvals as well as the responsible organization for periodic checks, the traffic laboratory at METAS became involved in this project at an early stage. Currently, fixed as well as mobile versions of this type of instrument have been approved and are subject to annual verifications, as are all other types of speed measuring devices.

1 Birth of the system

Average speed control (ASC), which is also known as “section control” or “point-to-point control”, is a system which measures the average speed of vehicles between two points located a fixed distance apart. The entry gate identifies each passing vehicle so that the average speed can be subsequently calculated when the vehicle passes through the exit gate. If the driver exceeds a set speed limit (see Figure 1, red car), information about the vehicle is saved and photos are taken at a third gate where the vehicle is flashed. Then, the violation information is transmitted to the police. Otherwise (see Figure 1, green car), the data is immediately deleted to ensure compliance with data protection laws.

European countries that have implemented ASC (I, A, NL, GB) have already recorded a marked reduction in the number of accidents and speeding violations. Their experience has also shown that this new system leads to improved traffic flow and regularity compared to classic systems. The ASC system prevents the “accordion effect” – a dangerous phenomenon observed around fixed radar systems due to drivers adjusting their behavior because of the radar.

At the start of the test phase in 2010, the Federal Roads Office launched a major study with the aim of evaluating the impact of ASC on the behavior of drivers and overall traffic safety in Switzerland. Two sites were chosen for these tests: a fixed version with a length of 1.7 km on the A2 highway near the Arisdorf tunnel (Canton of Basel Landschaft) and a mobile version with a length of 7.4 km on the A9 between Aigle and Bex (Canton of Vaud). Based on these results, the decision was made to approve this system in Switzerland in 2011. For its part, METAS issued type approval certificates for the fixed version on 16 December 2011 and the mobile version on 8 May 2012. Interim approval was granted for the first year. As no problems were detected during the initial period, final approval was granted. Thanks to their METAS approval, these instruments may be used for official speed measurements.

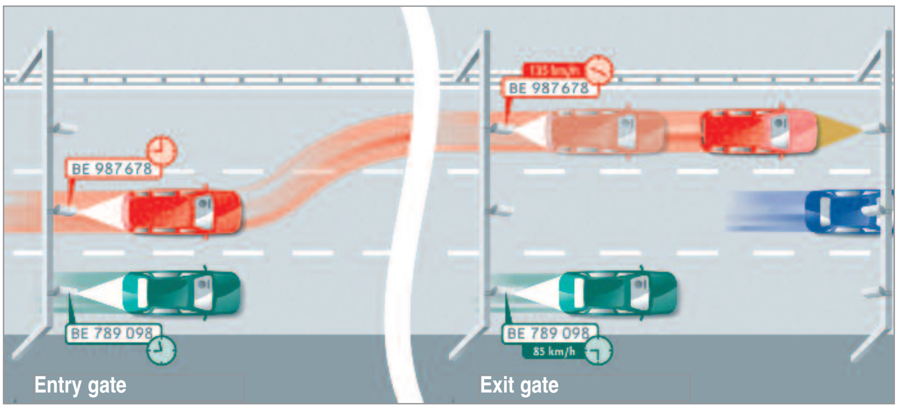

Figure 1 The time it takes to travel from the entry gate to the exit gate divided by the distance (here: 45 km) is equal to the vehicle’s average speed. The third gate is used to flash the speeding vehicles (here: red vehicle).

2 Basic principle of the speed measurement

The speed measurement is based on a simple principle: the distance travelled by the vehicle is divided by the time required to travel the distance, yielding the average speed. The distance between the two gates is either measured directly by METAS (fixed version) or by means of GPS units arranged in each gate (mobile version). The time measurement is handled on a common basis between the two gates for the fixed version. For the mobile version, there is a time server in each gate which is synchronized using GPS.

Figure 2 ASC gate on the A2 highway at the entrance to the Arisdorf tunnel

3 Critical measurement issues in the approval process

In the fixed version, the distance represents a set parameter that is measured by METAS. Here, the time base is the same in any installation. In comparison, the mobile version is more challenging since each gate is individually responsible for determining its own position and timing information. In both cases, there are uncertainties that apply to the distance as well as the time.

At each gate (see Figure 2), the vehicle's position is detected in order to take a picture that can be used to identify the vehicle with a timestamp. In the fixed version, a lane-based system is used while the mobile version simultaneously monitors all of the lanes. The detection point thus introduces another uncertainty which must be taken into account.

As with all official speed measurements in Switzerland, a safety margin is respected in the ASC system to ensure that drivers cannot be cited due to measurement errors. Along with other margins, this safety margin is defined in an Ordinance of the Federal Roads Office [1]. The values of the safety margin are as follows:

- 5 km/h for measured speeds up to 100 km/h;
- 6 km/h from 101 km/h to 150 km/h; and
- 7 km/h starting at 151 km/h.

4 Measurement and verification of the distance

The traffic laboratory at METAS has several types of references that can be used to verify the distance measurement. The highest precision involves measurement with a Global Navigation Satellite System (GNSS). Positions can be determined with a measurement uncertainty of ± 2 cm (k = 2).

For measurements that involve long distances, such as on highways, or if numerous bridges or tunnels prevent continuous reception of the satellite signals, another type of reference must be used. For example, this is the case with the fixed system at the Arisdorf tunnel since nearly the entire section is in the tunnel. In this case, the chosen reference instrument is an optical correlator from the company Corrsys [2]. This instrument enables measurement of the distance based on the perceived movement of the road surface (see Figure 3). Calibrated by METAS, it has a measurement uncertainty of better than ± 0.2 % (k = 2) for distances greater than 200 m.

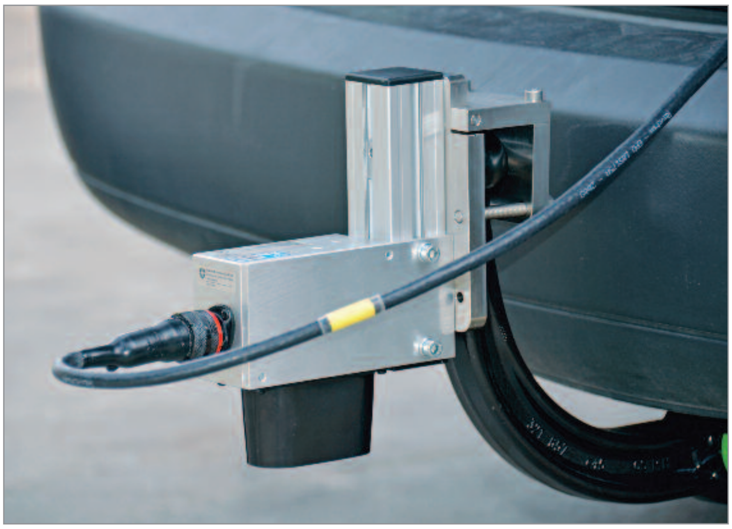
Figure 3 Optical correlator mounted on the METAS vehicle

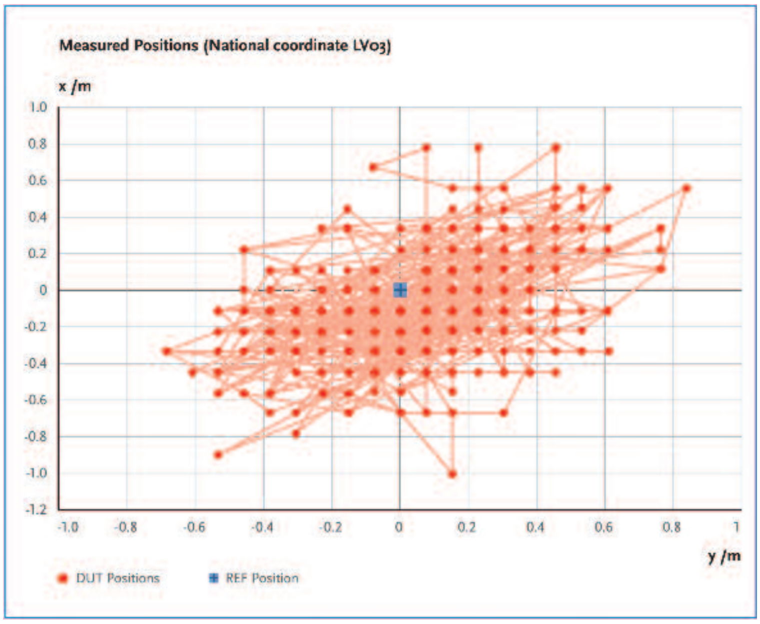

Figure 4 Example of a measurement with 9 satellites, an HDOP of 0.8 and EGNOS. The blue point in the centre corresponds to the METAS reference while the cloud of red points at different positions were generated by the gate's GPS as a function of its uncertainty. The instrument's uncertainty under these conditions is ± 0.9 m (*k* = 3).

In the case of the fixed version of the ASC system, the distance is measured with the optical correlator and the measured value is then configured in the speed measurement system. In this manner, the distance represents a constant value that is stipulated directly by METAS and cannot be modified by the user.

In the mobile version, the distance is calculated automatically by the gates based on the satellite position data. Since the precision of the position data is highly dependent on the reception quality, a number of tests were carried out during type approval by METAS with the aid of tools such as its GNSS measuring system [3]. This made it possible to control the reception parameters so as to ensure defined quality for the distance calculation. In particular, these parameters involve the number of satellites, the dilution of precision (HDOP), the DGPS correction (in our case with EGNOS [4]) and the measurement time for calculation of the average value of the received positions. This makes it possible to ensure a maximum deviation for the position of ± 2.5 m (*k* = 3, without averaging of the position) per gate, and thus ± 5 m for the total distance (see Figure 4). Obviously, if the gates are moved or if the GPS reception deteriorates past the limits stipulated by METAS, the instrument will halt the speed measurements until proper operation has been restored. Faulty system states of this sort were the subject of specific tests during the type approval process.

5 Measurement and verification of the timing information

The time measurement is dependent primarily on the internal clock (in case the GPS synchronization is lost), the timing delay for transmission of information through the system, and the delay to snap a photo once the trigger signal is received.

In order to take into account all of the possible deviations, the timing information is verified using the METAS test vehicle which is photographed by the gates. The vehicle is equipped with an infrared digital reference chronometer (resolution 0.1 ms, time base ± 10 ppm) to allow direct time read-out from the photos. This approach accounts for the various delays associated with the instrument. For control purposes, the time between the two gates specified by the ASC system is compared to the time output by the METAS chronometer.

6 Measurement and verification of the speed

In order to verify that the speed calculation process is handled correctly, a speed measurement is performed.

Figure 5 Photo of the METAS vehicle taken by a gate with zoom of the chronometer

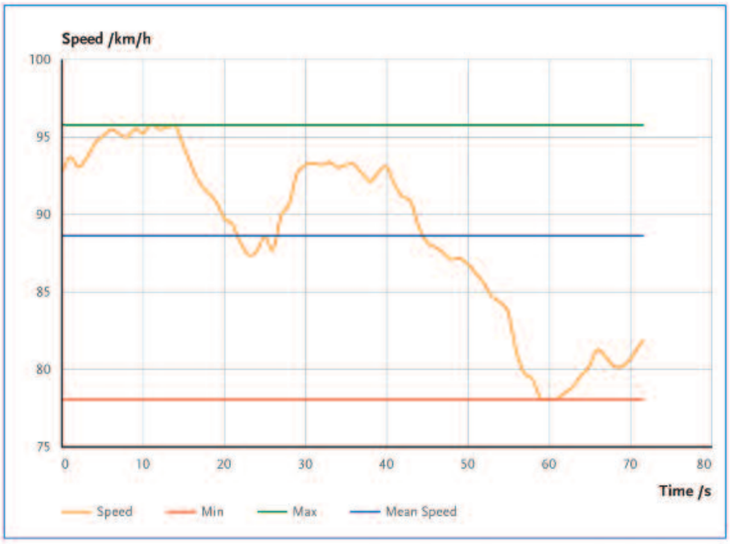

Figure 6 Plot of the reference speed of the METAS vehicle between the gates

The METAS test vehicle constantly measures and records its own speed between the two gates. The average speed (see Figure 6) is then compared with the speed reported by the ASC system.

7 Other checks made during the verification

These various measurements represent only part of the verification process. All of the system components as well as the associated programs are checked to ensure they have not been exchanged or modified and that the versions approved by METAS are used. The photographic documentation is also inspected. For example, at the Arisdorf site the traffic signs are photographed at the time of each violation. Similarly, the digital signature of the photographs and the encryption of the violation data are checked.

8 Guaranteeing the quality of the speed measurement

Thanks to the many tests carried out during the type approval process along with monitoring of all instruments during annual verifications, the speed measurement results produced by the ASC instruments as well as the vehicle attribution for the speeding infractions are guaranteed to be correct.

The vast experience of the METAS traffic laboratory in the domain of verification of all types of speed measuring instruments, combined with its world unique measurement capabilities, means that manufacturers, clients and drivers can trust that speeding infractions issued on the basis of these instruments are correct.

References

[1] Ordinance of the Federal Roads Office of 22 May 2008 to the Road Traffic Controls Ordinance (RTCO-FEDRO), Classified Compilation of Federal Legislation 741.013.1; Article 8, Item f.

[2] www.corrsys-datron.com

[3] Damien Lachat: Étalonnage des récepteurs de mesures par satellites, METinfo, vol. 17, no. 1, pp. 26-29, 2010

[4] www.egnos-portal.eu

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