

MetTalk on OIML R 91 Traffic speed meters, 09.09.2026

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Introduction to SLM

- At the moment the SLM is accredited calibration laboratory for road speed meters
- I was a head of laboratory for more than 10 years
- SLM was performing initial and subsequent verification of road speed meters in Slovakia for more than 10 years



Introduction to legislation of Slovakia

- Law of metrology 157/2018 Z.z.
- Technical regulation for measuring instruments 161/2019 Z.z. and its annex 1 and 34
- Initial and subsequent verification can be done just by Slovenský metrologický ústav which is the national metrology institute of Slovakia.
- Period of reverification is 1 year
- Type approval is mandatory, and can be performed only by Slovenský metrologický ústav.
- Verification required only for meters used by police during road traffic checks
- Repair and installation has to be performed by registered subjects, that must prove their competency



- List of approved measuring instruments
- <https://www.normoff.gov.sk/typovky/TSK/?zt=&om=162&tm=&v=#>
- Approved instruments include:
 - Doppler-radar based speed meters
 - Range-finding based speed meters
 - Average speed meters
 - Fixed-distance speed meters
 - Image based speed meters (video used just for detection of same speed as ego speed)
 - Across-the-road speed meters
 - Moving speed meters



Major requirements

- All instruments must provide photographic evidence with the data included.
 - The risks from wrong alignment are minimised by user checking the evidence, if the vehicle is in correct location or completely visible,
- Instrument cannot measure outside of its measurement range working conditions of temperature and voltage or must mark these measurements
- Instrument must guarantee when used according to the user manual assignment of measured data to the evidence material
 - This is considered as a responsibility of the manufacturer, due to complex nature of the systems it is impossible to systematically test all scenarios. This is also indirectly testing during terrain tests
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Chapter 5 tests		
Dynamic performance test	Included	
Speed linearity test	Included	
Distance linearity test	Not included	distance measurements outside of legal metrology control. However during type testing the complete range of distances or angles should be tested for accuracy at speed measurement
Angle linearity test	Not included	angle measurements outside of legal metrology control. However during type testing the complete range of distances or angles should be tested for accuracy at speed measurement

Chapter 7 tests		
Doppler-radar based speed meters	Included in 1.2a	
the carrier frequency or interval of modulated frequencies;	5.3.2.1	
the antenna pattern test to determine beam width and secondary beams and angles of the measurement beam;	5.3.2.2	
equivalent isotropic radiated power (EIRP)	Not included	Does not affect accuracy directly
minimum and maximum of distance measurement, if applicable	Documentation analysis	
accuracy of angle measurement, if applicable; and	5.3.2.4	
accuracy of the aiming device, if applicable.	Not included	Responsibility of user and registered bodies for installation

Range-finding based speed meters	Included in 1.2b	
that vehicle shape does not significantly affect the speed measurement;	Not included	tested by terrain tests
pulse repetition rate or another characteristic of the time intervals between the pulses;	Not included	Indirectly tested by simulation
the beam width, secondary beams, if applicable;	Documentation analysis	
relevant characteristics of the field of view (divergence, etc.); and	Documentation analysis	
the exit angle of the measurement beam, if applicable.	Documentation analysis	

Average speed meters	Included in 1.2c	
the robustness of the time synchronisation mechanism;	Not included	tested by terrain tests
that the MPE for time measurement is fulfilled when vehicle detection and image recording are included;	Not included	tested by terrain tests
maximum size of detection field, even at varying speeds; and	Documentation analysis	
minimum distance between entry and exit points.	Documentation analysis	

Fixed-distance speed meters	Included in 1.2c	
accuracy of trigger point; and	Not included	tested by terrain tests
minimum and maximum distance between trigger points	Documentation analysis	

Image based speed meters	Included only partly by 1.2d (video used just for detection of same speed as ego speed)	
accuracy of trigger point;	Not included	tested by terrain tests
minimum and maximum distance between trigger points; and	Not included	tested by terrain tests
minimum illumination and maximum fog density.	Not included	tested by terrain tests

Across-the-road speed meters	Included	
accuracy of the aiming device, if applicable; and	Not included	Responsibility of user and registered bodies for installation
influence of the curve radius of target trajectory.	Not included	Responsibility of user and registered bodies for installation

Across-the-road speed meters		Included	
accuracy of the aiming device, if applicable; and		Not included	Responsibility of user and registered bodies for installation
influence of the curve radius of target trajectory.		Not included	Responsibility of user and registered bodies for installation
Moving speed meters		Included	
Moving metrological field test		5.3.6.1	
Metrological field test of the ego speed meter		5.3.6.2	



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Software evaluation

Are included, however only in small part – identification and security

Tests of influence quantities and disturbances

Already implement in the same or stricter level			
Test	Slovakia legislation	OIML D11	Note
Cold test	5.3.7.3	Table 7	equal
Cyclic damp heat test	5.3.7.5	Table 9	equal, only condensing applied
Resistance to water testing	5.3.7.6	Table 10	equal, not optional
Resistance to dust testing	5.3.7.7	Table 13	equal, not optional
Random vibrations	5.3.7.8	Table 15	we require everything for M3
Static deviations in supply voltage	5.3.7.10	Table 19,21,22, 40, 41	we require the range specified by manufacturer, or by mains standards
AC mains voltage dips, short interruptions and voltage variations	5.3.7.11	Table 23, 24	equal, DC mains not included
Burst transients	5.3.7.12	Table 27, 29	equal
Radio frequency immunity – conducted	5.3.7.15	Table 32	equal with 20V
Electrical transient conduction via lines other than supply lines from external 12 V and 24 V road vehicle batteries	5.3.7.19	Table 43	equal

Tests of influence quantities and disturbances

Implemented, however higher level or further testing should be added			
Test	Slovakia legislation	OIML D11	Note
Electrical transient conduction along supply lines of external 12 V and 24 V road vehicle batteries	5.3.7.18	Table 42	small differences in pulses, due to changes in the standards
Radio frequency immunity – radiated	5.3.7.16	Table 35, 36, 37, 38, 39	equal but only until 3 GHz, no close proximity
Power frequency magnetic field	5.3.7.14	Table 31	only level 4 required
Resistance test to extreme storage temperatures	5.3.7.2	Table 6 and 7	equal, maximum required operating temperature is 40 °C
Dry heat test	5.3.7.4	Table 6	equal, maximum required operating temperature is 40 °C
Surges	5.3.7.13	Table 28, 30	No significant fault after is evaluated
Electrostatic discharge	5.3.7.17	Table 39	No significant fault after is evaluated
Mechanical shock test	5.3.7.9	Table 17, 18	we require everything for 50 mm, more stricter testing should be applied for handheld devices

Tests of influence quantities and disturbances

No risk in Slovakia			
Test	Slovakia legislation	OIML D11	Note
Atmospheric pressure	Not included	Table 11 and 12	Not expected to be a influence quantity
Salt mist	Not included	Table 14	Not expected in geographic location of Slovakia
Not included and should be included in the future			
Test	Slovakia legislation	OIML D11	Note
Ripple on DC mains power	Not included	Table 20	EN 61000-4-17
AC mains frequency harmonics	Not included	Table 25	EN 61000-4-13
VLF and LF disturbances on AC mains	Not included	Table 26	EN 61000-4-19
Conducted, common mode disturbances in the frequency range 2 kHz to 150 kHz	Not included	Table 33, 34	EN 61000-4-19
Battery voltage variations during cranking	Not included	Table 44	ISO 16750
Load dump tests	Not included	Table 45	ISO 16750



Challenges of testing of disturbances

- Laboratory equipment is usually complicated to transport to EMC, climatic or mechanical laboratories.
- Setting up this equipment can be a challenge in new conditions.
- Protection of equipment against influence quantities and disturbances should be applied, or the simulator should be proved immune against it
- In some case the simulator must be used in non standard operating angles, so new brackets and adapters are necessary
- Even though the EMC radiated field is not extreme, the operator should not be inside of the chamber during the tests, special operating modes are necessary to externally trigger the measurement or continually perform the measurements
- External displays, EMC proof cameras can be helpful.
- Some cables will need to be prolonged for the tests, if specific cable is required it should be used. For conducted tests usually 2 m long cable is acceptable, for radiated tests if you want to take the simulator or its part outside of the chamber it can be more than 10 m, which usually is not standard



Challenges of testing of disturbances

- Alignment of antennas and transducers are much more complicated, new mechanisms should be created
- EMC tests, climatic tests and mechanical tests should always be conducted with accuracy tests (during or after). Standard EMC tests focused on functionality or safety are not considered acceptable.
- Only one influence conditions should be applied at one time, so no other influence quantities are simulated (change of speed, different distances, etc.)
- Since some systems can have a large number of cables, care should be taken for their routing (tested lengths), termination and shielding if required.
- All cables intended for normal operation should be tested
- The results during or after disturbance have no correlation, so testing at lab after disturbances usually has little value. Most devices recover after disturbances and fail just in narrow band or just one test.
- For all tests every measurement transducer should be tested, for example doppler + ego speed etc.

Challenges of testing of disturbances



Challenges of testing of disturbances



- Complete system for laboratory tests of radar, laser and other road speed meters.
- Designed by SLM, now operated by Slovenský metrologický ústav



GNSS based system with external display, designed and developed in house
Calibration using length and time measuring instruments





Challenges of terrain tests

- GNSS systems must first of all be operated safely. Safety has higher priority than performing the tests. Operator of GNSS cannot be a driver etc.
- To be practical and reliable, GNSS system must use carrier frequency doppler shift based velocity measurements not position based measurements.
- GNSS systems can be affected by obstacles (bridges, tunnels, dense tree cover, electric lines)
- GNSS systems can be sensitive to quality of roads (bumps, curves etc.). It is not possible to use it in extreme conditions.
- GNSS systems from our experience should be used always with other systems to be reliable (inercial systems, cruise control systems),
- GNSS systems should be traceable calibrated in terrain.
- Uncertainty better than 0,6 km/h is possible only in certain cases not at all conditions.
- GNSS systems should be used at stable speed, indication of systems can have unpredictable delays under dynamic conditions.



Challenges of terrain tests

GNSS systems are usually much better for practical use than other systems. Since they can be easily installed in vehicle, in some cases even inside without influence from the weather.

GNSS system doesn't require labour intensive installation.

GNSS systems do not create risks of something falling off from the car during traffic.

GNSS systems can be easily scaled for multiple operations, since they can work on off the shelf parts

GNSS systems require a certain number of satellites to be visible, however minimum number of satellites does not provide acceptable uncertainty.

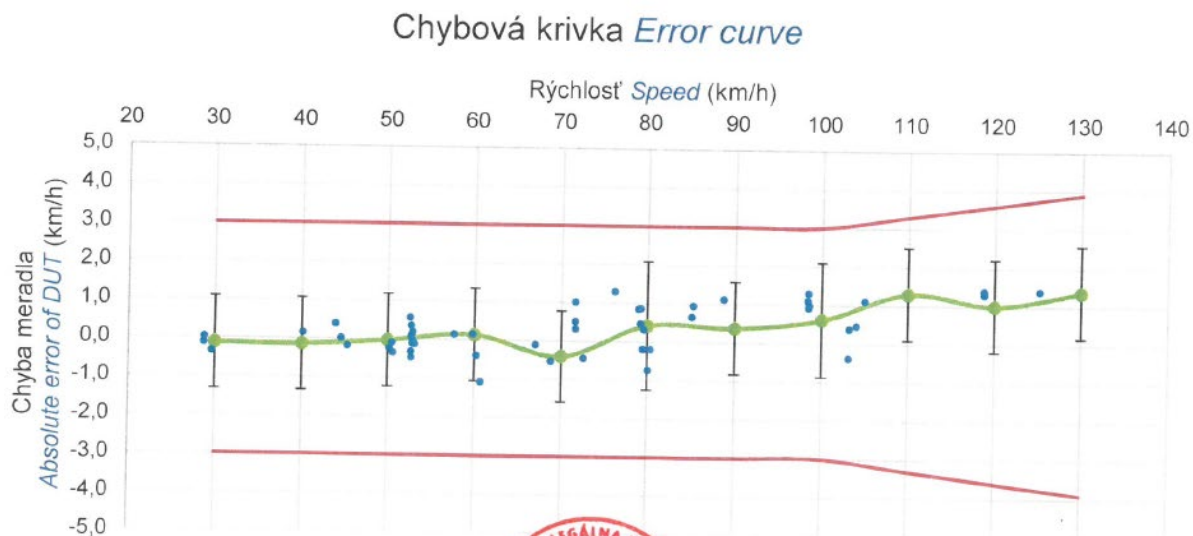
GNSS systems are a great tool, however if not operated with extensive knowledge and practical experience they can be misleading.

Since 500 measurements are quite a lot it is practical to combine the system with external display, so you have evidence material for every measurement conducted by DUT, pairing of data can be complicated and lead to complications.

Sunlight and reflections can be a problem in this case.

Data presentation and analysis of terrain tests

- Presentation and analysis of data can be challenging when performing terrain tests with large number of measurements:
 - evaluation of outliers and not acceptable measurements
 - statistical analysis of data is necessary - OIML R91-2 4.7





Test site selection

- **No terrain test can be performed for all conditions** – If something cannot be tested in the field and creates a risk, simulation or documentation evaluation should be considered
- Conditions should reflect usual conditions, not extreme conditions, rationale: there is no reason to build a road just for type testing. **Extreme conditions can still be limited by type approval.**
- **If installation is required**, the installation should be done according to all manufacturer requirements, this can lead to limitations (requirements for poles, overhangs, concrete work etc.)
- **If operated manually**, operators must be trained, so they do not add false readings or other problems



Test site selection

- **With traffic or no traffic?**
- Both have its own pros and cons.
- Due to practical reasons road without traffic is preferred option, since it will be faster and without unexpected influences or failed measurements because of „obstacles“
- Road with traffic will always generate smaller range of testing – safety and „obstacles“
- Rationale : From basic metrology perspective, complete range should be tested for type approval. It is not possible to test for every situation that somebody can think off.
- It is possible to perform simulated traffic experiments, however this can lead to extremely expensive testing, and simulating conditions that happen only rarely in the field.
 - Dense conditions usually are applicable for low speed where usually there is no speed regulation
 - At higher speed the surrounding traffic is much less dense
 - Multiple parallel vehicles can happen, however for most instruments types it is not relevant to test them.
 - For doppler meters parallel vehicles should be considered at least to some extent, however from our narrow experience this testing lead to measurements that were not evaluated by the meter as valid measurements.

Test site selection

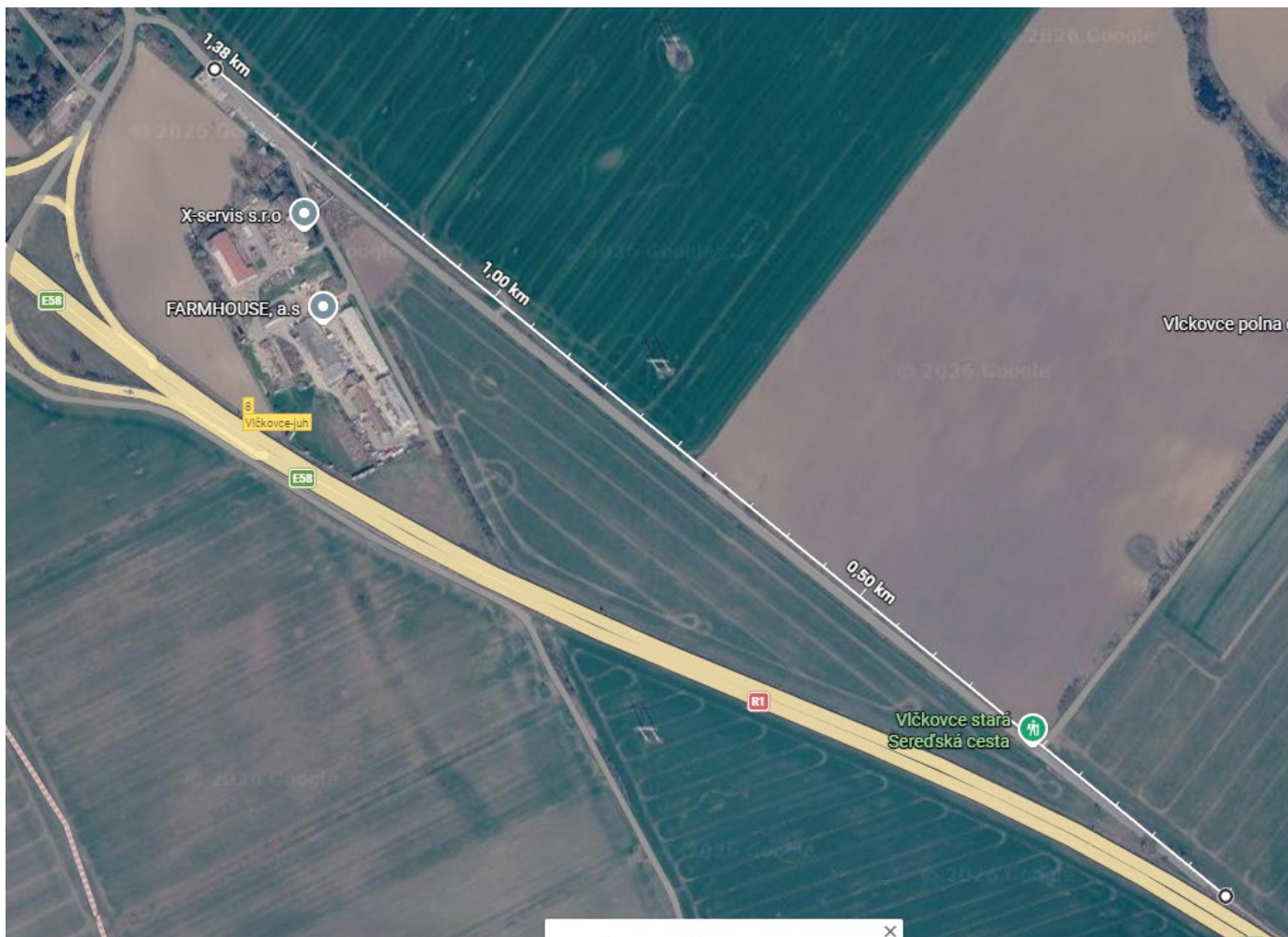
	Traffic	No traffic
Safety	Higher risk	Lower risk
Non valid readings	Higher risk	Lower risk
Testing time	Higher	Lower
Evaluation of traffic influence	Yes	Limited
Range of measurements	Limited by traffic and safety	Limited by safety
Risk of other influence factors and disturbances	Higher	Lower



Test site selection

- Road must be without major damages or safety risks, that can affect the uncertainty or safety
- Care should be take to planning of braking distances, acceleration and speed stabilisation and place where the meter is installed and operated.
- Both directions should be tested if applicable,
- The test site should be choosen to allow at least range from minimum up to maximum allowable speed at a country, or maximum of range of the meter
- Possibly this could lead to one site for low speeds (for example premises of lab that is performing the test – larger parking area etc.) and higher speed range (highway, dead-end road, racetrack)
- Highway and racetrack usually have the same issue that turnaround time can be extremely long, and can lead to delays

Test site selection





Specific challenges

National safety – Software examination is linked to the meter itself, however the meter used in systems of police or other national bodies can be a risk for national safety (data can be leaked, meter can be used as a gateway to network etc.).

This information is not directly linked with OIML R91, however my point is that will probably be a lot of changes to the software that will have to be approved by both approval bodies.

Cyber security requires immediate actions if vulnerability is identified. The question is if the meter can be used, until the new software version is approved for metrology.

There are still ongoing discussions about this topic also for other meters.



- Thank you for your attention
- Questions?