Auto Service

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# Test Report
# No.: 76123843-3
## Blind Spot Information System for the Detection of Bicycles
## With selected test cases following
## UN ECE-R151
## of 13.01.2020

This test report covers the evaluation of a blind spot information system for motor vehicles according to the version of UN-ECE R151, ECE/TRANS/505/Rev.3/Add.150 of 13.01.2020 plus Amendment 1 of 05.11.2020, Amendment 2 of 02.07.2021 and Amendment 3 of 30.08.2022.

The blind spot information system (BSIS) is a system that informs the driver of a possible collision with a bicycle near side.

| | |
|---|---|
| System 1 under Test (Yellow): | - Shield + 52-degree look back / AWS4_4.18.11_3.4.1_0.1<br>- Shield + 150-degree BSIS look front / AWS4_4.20.5_RC7_v8.2.24 |
| System 2 under Test (White): | - Shield + 150-degree BSIS / AWS4_4.20.5_RC7_v8.2.24<br>- Shield + 150-degree MOIS / AWS4_4.20.5_RC7_v8.2.24 |

Test vehicle: Ford Transit Mk7

Munich, 19.12.2022_____

Date, Signature

Dipl.-Ing. (FH) Robert Matawa

Lead Engineer Testing HAD
Business Unit Automotive

## Index

## 0. Summary

TÜV SÜD tested the Mobileye Systems:

| | Hardware: | Software: |
|---|---|---|
| System 1 under Test (Yellow): | Camera 1: Shield + 52 degree look back | Camera 1: AWS4_4.18.11_3.4.1_0.1 |
| | Camera 2: Shield + 150-degree look front | Camera 2: AWS4_4.20.5_RC7_v8.2.24 |
| System 2 under Test (White): | Camera 1: Shield + 150-degree BSIS | Camera 1: AWS4_4.20.5_RC7_v8.2.24 |
| | Camera 2: Shield + 150-degree MOIS | Camera 2: AWS4_4.20.5_RC7_v8.2.24 |

according to the version of UN-ECE R151, ECE/TRANS/505/Rev.3/Add.150 of 13.01.2020 plus Amendment 1 of 05.11.2020, Amendment 2 of 02.07.2021 and Amendment 3 of 30.08.2022, a directive to regulate the type-approval of vehicles equipped with a blind spot information system for motor vehicles.

TÜV SÜD tested the Mobileye System in a Ford Transit Mk7 using an advanced metrology system. The motion of the test vehicle was real time monitored, using an IMU/GNSS based tool chain developed to meet the requirements regarding precision for the testing of automated vehicle functions and compared to ground truth, respectively the digital map of the proving ground used during the test.

Following the test matrix in the UN-ECE R151, ECE/TRANS/505/Rev.3/Add.150 of 13.01.2020 plus Amendment 1 of 05.11.2020, Amendment 2 of 02.07.2021 and Amendment 3 of 30.08.2022, TÜV SÜD tested all paragraphs that can be applied to a Standalone Technical Unit.

**Findings:**

System 1 (“yellow”), adopted to the geometry of the Ford Transit Mk7 as tested by TÜV Süd

is in line with the requirements of the regulation *)

System 2 (“white”), adopted to the geometry of the Ford Transit Mk7 as tested by TÜV Süd

is potentially in line with the requirements of the regulation*) **)

*) Applicable paragraphs 6.5 and 6.6 of the regulation ECE/TRANS/505/Rev.3/Add.150 of 13.01.2020 plus Amendment 1 of 05.11.2020, Amendment 2 of 02.07.2021 and Amendment 3 of 30.08.2022.

**) System 2 (“white”) showed nonconformities in single tests which could be sorted out by the Mobileye Team on site by system adjustments. System 2 can meet the requirements in an OEM setup in case Mobileye conducts proper application and set up work.

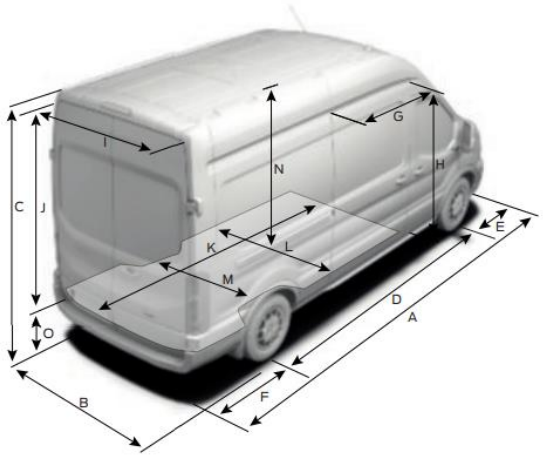
# 1. General information / Vehicle information

| | |
|---|---|
| **Test date:** | 01.08.2022 to 05.08.2022 |
| **Test track/Route:** | Proving ground Airport, Mnichovo Hradiště, CZ |
| **Weather conditions:** | Partly cloudy and sunny, dry |
| **Air temperature:** | 25 to 35°C |
| **Road surface material:** | Concrete |

| | |
|---|---|
| **Vehicle:** | Ford Transit Mk7 |

| | |
|---|---|
| **System 1 Hardware:** | Camera 1: Shield + 52 degree look back<br>Camera 2: Shield + 150-degree look front |
| **System 1 Software:** | Camera 1: AWS4_4.18.11_3.4.1_0.1<br>Camera 2: AWS4_4.20.5_RC7_v8.2.24 |
| **System 2 Hardware:** | Camera 1: Shield + 150-degree BSIS<br>Camera 2: Shield + 150-degree MOIS |
| **System 2 Software:** | Camera 1: AWS4_4.20.5_RC7_v8.2.24<br>Camera 2: AWS4_4.20.5_RC7_v8.2.24 |

**Vehicle dimensions:**




| | | |
|---|---|---|
| **A** | Fahrzeuglänge | 6.704 |
| **B** | Fahrzeugbreite mit Spiegeln | 2.474 |
| | Fahrzeugbreite mit angeklappten Spiegeln | 2.112 |
| | Fahrzeugbreite ohne Spiegel (Einzelbereifung) | 2.059 |
| | Fahrzeugbreite ohne Spiegel (Zwillingsbereifung) | 2.126 |
| **C** | Fahrzeughöhe* | 2.778–2.680 |
| **D** | Radstand | 3.750 |
| **E** | Überhang vorn | 1.023 |
| **F** | Überhang hinten | 1.931 |
| **G** | Schiebetür Öffnungsweite | 1.300 |
| **H** | Schiebetür Öffnungshöhe | 1.600 |
| **I** | Hecktür Öffnungsweite | 1.565 |

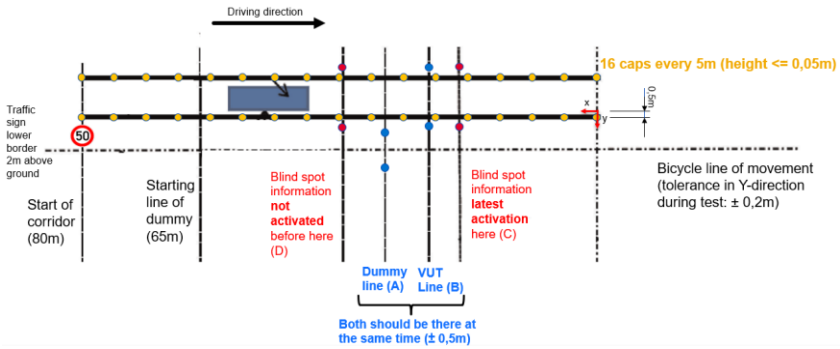
| | | |
|---|---|---|
| **J** | Hecktür Öffnungshöhe | 1.887 |
| **K** | Maximale Laderaumlänge am Boden (ohne/mit Vinylboden "Easy Clean") | 4.217/ 4.168 |
| | Maximale Laderaumlänge in 1,2m Höhe | 4.073 |
| **L** | Maximale Laderaumbreite | 1.784 |
| **M** | Laderaum zwischen Radhäusern (Einzelbereifung) | 1.392 |
| | Laderaum zwischen Radhäusern (Zwillingsbereifung) | 1.154 |
| **N** | Maximale Laderaumhöhe | 2.025 |
| **O** | Beladehöhe* | 677–608 |
| **P** | Max. Laderaumvolumen (m³) | 15,1 |
| | Laderaumvolumen (VDA) (m³) | 14,1 |

# 2. Blind Spot Information Dynamic Test

## 2.1. Overview (according to Chapter 6.5 of R151)

Seven Tests where a bicycle target moves along a parallel line to the vehicle under test (VUT).

The area of focus on the right side of the vehicle.




The point of interest [POI] are as follows:

- VUT: Most front right
- Bicycle: Most front of centerline and 250mm to the lef

**1st Remark: As permitted by the regulation, the starting point of the dummy was moved 5m backwards (70m). Therefore, the corridor was extended to 85m. (See 6.5.6 of R151)**

**2nd Remark: In the original table (R151 Appendix 1 Table 1) there is an error for test case 2 for the value of $d_d$. According to the formulas of R151 Annex 3 this value was changed from to 32,1m.**

Following tests were performed to evaluate the systems performance.

*Table 1Based on regulation document ***)*

| Test Name | 2_1 | 2_2 | 2_3 | 2_4 | 2_5 | 2_6 | 2_7 |
|---|---|---|---|---|---|---|---|
| $v_{Bicycle}$ [km/h] | 20 | 20 | 20 | 10 | 10 | 20 | 20 |
| $v_{Truck}$ [km/h] | 10 | 10 | 20 | 20 | 10 | 10 | 10 |
| $d_{Lateral}$ [m] | 1.25 | 1.25 | 1.25 | 4.25 | 4.25 | 4.25 | 4.25 |
| $d_a$ [m] | 44.4 | 44.4 | 44.4 | 22.2 | 22.2 | 44.4 | 44.4 |
| $d_b$ [m] | 15.8 | 22.0 | 38.3 | 43.5 | 19.8 | 14.7 | 17.7 |
| $d_c$ [m] | 15.0 | 15.0 | 38.3 (15.0) | 15.0 | 19.8 (15.0) | 15.0 | 15.0 |
| $d_d$ [m] | 26.1 | 32.3 (32.1) | 65 (37.2) | 43.2 | 65 (32.1) | 26.1 | 29.1 |

***) The table reflects the values from the regulation of 13.01.2020. The values in brackets are the corrected values calculated by correctly applying the indicated formulas, since no single exception can be found to explain the values in the table.

## 2.2. Test Run Validation

This table shows the validation check of each test run.

| Run | 2_1_15 | 2_2_4 | 2_3_7 | 2_4_1 | 2_5_1 | 2_6_13 | 2_7_2 |
|---|---|---|---|---|---|---|---|
| SyncX Truck [m] | 16.29 | 22.34 | 37.92 | 43.89 | 19.43 | 14.95 | 17.64 |
| SyncX Dummy [m] | 44.43 | 44.44 | 44.26 | 22.24 | 22.36 | 44.17 | 44.85 |
| Sync | OK | OK | OK | OK | OK | OK | OK |
| Speed Truck | OK | OK | OK | OK | OK | OK | OK |
| Speed Dummy | OK | OK | OK | OK | OK | OK | OK |
| Lateral Displac-ement Dummy | OK | OK | OK | OK | OK | OK | OK |
| Valid | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

## 2.3. System Performance

The results of the tests are shown in the table below.

| Run | 2_1_15 | 2_2_4 | 2_3_7 | 2_4_1 | 2_5_1 | 2_6_13 | 2_7_2 |
|---|---|---|---|---|---|---|---|
| System 1 (Yellow) meets requirements | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| System 2 (White) meets requirements | No1,2 | Yes | Yes | Yes | Yes | No1,2 | Yes |

1: Information signal too late. (After truck's reference point is at 15m)
2: Testing acc. to regulation rated as not passed. The nonconformity was addressed by the Mobileye Team on site by readjusting the system.

**System 1 has passed the verification.**
**System 2 has not passed the verification.**

After the test campain, Mobileye reconfigured the software and failed tests were repeated.

| Run | 3_1_X | 3_2_X | 3_3_X | 3_4_X | 3_5_X | 3_6_X | 3_7_X |
|---|---|---|---|---|---|---|---|
| System 2 (White) can meet the requirements after reconfiguration | Yes | / | / | / | / | Yes | / |

Mobileye demonstrated the performance of System 2 in several testruns after the initial testcampain to the satisfaction of the TÜV Süd experts. TÜV Süd is convinced, that both systems 1 and 2 can fulfil the requirements of the regulation including the amendments in an OEM setting.

On request of TÜV Süd, Mobileye made the following statement after having been asked for reasons behind the initial test result for system 2 (white system):

**********

**MOBILEYE WARNINGS STRATEGIES FOR WHITE SYSTEM**

Based on the regulation the Dc point are described as a step function when:

- Vehicle speed lower of 5 km/h the Dc should be 2 m or TTC= 1.4 sec
- Vehicle speed lower of 10 km/h but higher of 5 Km/h the Dc should be 5 m
- Vehicle speed higher of 10 km/h but lower of 25 km/h the Dc should be 15 m

- Vehicle speed higher of 25 km/h the Dc should be 15+(vehicle speed-25) *0.82

**Hysteresis**

To make the system more understandable for the driver Mobileye implement different layer of warnings based on vehicle speed.
The resulted Dc based on the regulation around the 10km/h can be change by 300%, this case can confuse the driver!

Therefore, to make the system more robust for the driver perspective we implement a hysteresis function, that mitigate the fluctuation in Dc. This is done by detecting whether the driver is accelerating or decelerating.

**Warnings in driving straight scenario**

To make the warning efficient as possible in road situation we decide to create a warning based on Last point of information with a tolerance of 10% before the LPI and on the longitudinal distance and 1 % on the lateral separation (max of 4.30m).

When the vehicle drive straight Mobileye provide an information warning (yellow) when the maximum separation are 4.25 meters, and the longitudinal warnings are based on Dc and speed.

**Warning in turning manoeuvre scenario**

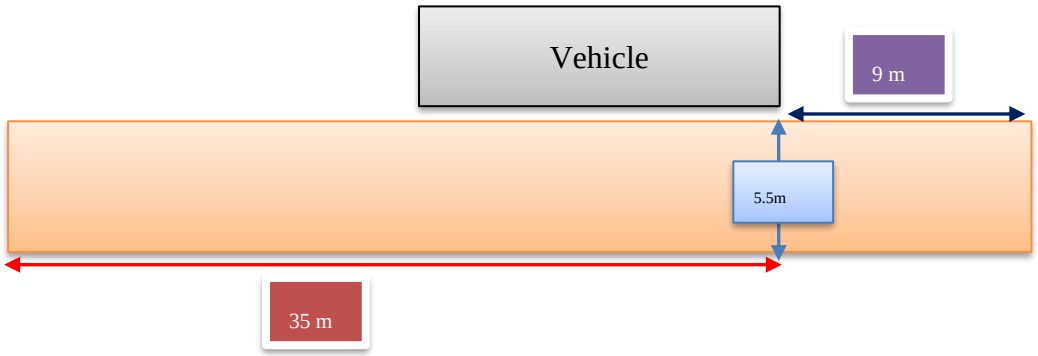
If turnings was detected, we define 2 new warnings:

1- Information warnings (yellow)when the lateral septation is 6 m but the longitudinal is vehicle length +50%
2- Imminent warnings (red alert) when we calculate if the impact point can be on the side of the vehicle when TTC is up to 3 sec

**Mobileye Warnings strategies for yellow system**

The strategies of this system were to create an information warning:

- When driving speed is higher of 5 km/h – the warning is provided if the VRU is positioned in within the boundaries of the area defined as:
  - 9 m front of the corner vehicle
  - 35 meters behind the corner of the vehicle
  - Lateral separation up to 5.5 meters.




- When driving speed is lower of 5 km/h - the warnings are provided according to the statistic test.

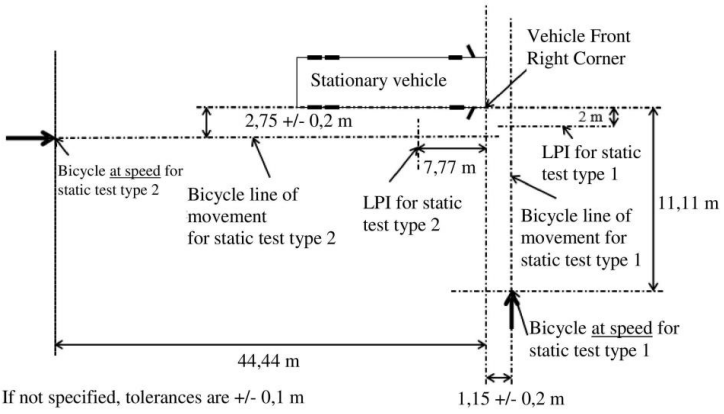
**********

# 3. Blind Spot Information Static Test

## 3.1. Overview (according to Chapter 6.6 of R151)

Two tests:

1. a bicycle target moves along a parallel line to the VUT
2. crosses in front of the vehicle under test




The point of interest [POI] are as follows:

- VUT: Most front right
- Bicycle: Most front of centerline (for crossing) and most front of centerline and 250mm to the left (for moving parallel to VUT)

The speed of the bicycle when moving along a parallel line to the VUT is 20km/h.
The speed of the bicycle when crossing in front of the VUT is 5km/h.

## 3.2. Test Run Validation

This table shows the validation check of each test run.

| Run | 3_3 | 4_1 |
|---|---|---|
| Dummy Speed | OK | OK |
| Lateral Displacement Dummy | OK | OK |

## 3.3. System Performance

The results of the tests are shown in the table below.

| Run | 3_3 | 4_1 |
|---|---|---|
| System 1 (**Yellow**) meets requirements | Yes | Yes |
| System 2 (**White**) meets requirements | Yes | Yes |

**System 1 has passed the verification.**
**System 2 has passed the verification.**

# Annex A

## Abbreviation list

| | |
|---|---|
| **MOIS** | **Moving Off Information System** |
| **LPI** | **Last Point of Interest** |
| **POI** | **Point of Interest** |
| **VUT** | **Vehicle Under Test** |

# Annex B

## List of the measurement equipment used

1. iMAR iREF-GNSS-PRO base station

- Providing the reference position
- Positioned 1x on the proving ground

2. SATELLINE-3AS Serial Modem


- Sending or receiving the correction data for the RTK mode
- Used 1x at the GNSS base station to transmit correction data
- Used in VUT/VRU to receive correction data for the positioning systems

3. Mikrotik Metal 52 AC AP WLAN Mesh Network

- Provide a network on the proving ground
  to transfer data between vehicles in real-time (position)
- Used in VUT/VRU and several devices on the proving ground
  to ensure communication coverage during the tests

4. iMAR iNAT-FSSG-1 Fibre-Optic-Inertial-Measurement-Unit

- High precision, dynamic fiber gyro position measurement system
  with 3-axis acceleration sensors and GNSS support
- Used in VUT for permanent position recording

5. 4active systems VRU targets

- Child pedestrian articulated (ISO 19206-2:2018)
- Bicycle pedestrian articulated- (ISO (CD) 19206-4)

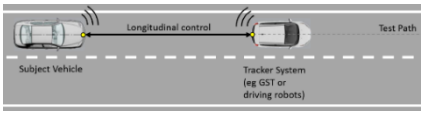
6. ABD SP05-i7-Flex-0

- Used in VUT for synchronization with VRU

7. ABD MKII GST

- Used to mount the VRU-Dummies and move them on the proving ground

8. ABD SP7004-i4-Synchro




- Used to sync the activities of dynamic objects on the proving ground

9. ABD RC Controller Software

- Used to control the ABD-equipment

10. IMAR iXCOM-CMD Software


- Used to control the iMAR-equipment

11. DEWESOFT Sirius / Krypton

- Used to record digital / analog channels in time and frequency domain
- Used to prepare, execute tests and postprocess data

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