

# DIN SAE SPEC 91571:2026-04 (E)

## Test methods for LiDAR Performance in adverse conditions; Text in English

---

Inhalt	Seite
Foreword .....	7
Introduction.....	9
1 Scope.....	12
2 Normative references .....	12
3 Terms and definitions.....	12
4 Symbols and Abbreviations .....	15
5 Specification of LiDAR sensors in adverse conditions.....	16
5.1 General.....	16
5.2 Evaluation on the Point Cloud Level.....	16
5.2.1 Targets Used .....	17
5.2.2 Reference Data .....	17
5.2.3 Evaluation Input .....	17
5.2.4 Evaluation Metrics .....	18
5.3 Evaluation on the Object Level.....	19
5.3.1 General.....	19
5.3.2 Targets Used .....	19
5.3.3 Reference Data .....	20
5.3.4 Evaluation Input .....	21
5.3.5 Evaluation Metrics .....	21
5.4 Sensor Mounting.....	23
6 Adverse Weather Test Methods.....	24
6.1 General.....	24
6.2 Weather Conditions .....	24
6.2.1 General.....	24
6.2.2 Dry Weather (Reference).....	25
6.2.3 Rain .....	25
6.2.4 Wet Road .....	26
6.2.5 Fog.....	27
6.3 Evaluation on the Point Cloud Level.....	28
6.3.1 Multi-Domain Test (MDT).....	28
6.4 Evaluation on the Object Level.....	30
6.4.1 General.....	30
6.4.2 Car-to-Car Rear stationary (CCRs) .....	30
6.4.3 Car-to-Car Rear moving (CCRm) .....	32
6.4.4 Car-to-Pedestrian Longitudinal Adult (CPLA).....	34
6.4.5 Car-to-Bicyclist Longitudinal Adult (CBLA) .....	36
6.4.6 Car-to-Motorcyclist Rear Stationary (CMRs) .....	38
6.4.7 Detection of small objects on the road (CSO) .....	40
7 Contamination Test Methods.....	42
7.1 General.....	42
7.2 Contamination Conditions.....	43
7.2.1 General.....	43
7.2.2 Reference .....	43
7.2.3 Dust/Mud on SuT.....	43
7.2.4 Mist on SuT .....	44

7.2.5	Frost/Ice on SuT .....	44
7.2.6	Road Spray in Transmission Medium.....	46
7.2.7	Dust in Transmission Medium.....	47
7.3	Evaluation on the Point Cloud Level .....	48
7.3.1	General .....	48
7.3.2	Multi-Domain Test (MDT) .....	49
7.4	Evaluation on the Object Level.....	51
7.4.1	General .....	51
7.4.2	Car-to-Car Rear stationary (CCRs) .....	52
7.4.3	Car-to-Car Rear moving (CCRm).....	54
7.4.4	Car-to-Pedestrian Longitudinal Adult (CPLA).....	56
7.4.5	Car-to-Bicyclist Longitudinal Adult (CBLA) .....	57
7.4.6	Car-to-Motorcyclist Rear Stationary (CMRs).....	59
7.4.7	Detection of small objects on the road (CSO) .....	61
8	Interference Test Methods .....	63
8.1	General .....	63
8.2	General Conditions .....	64
8.3	Evaluation on Point Cloud Level.....	65
8.3.1	General .....	65
8.3.2	Direct Interference - 1.....	65
8.3.3	Indirect Interference - 1 .....	67
8.3.4	Indirect Interference - 2 .....	69
8.3.5	Indirect Interference - 3 .....	70
8.3.6	Direct Interference - 2.....	72
8.4	Evaluation on Object Level.....	74
8.4.1	General .....	74
8.4.2	Parallel and Oncoming Traffic .....	74
8.4.3	Parallel Traffic .....	76
8.4.4	Traffic Jam .....	78
8.4.5	Intersection .....	80
9	Sensor Cleaning Test Methods .....	82
9.1	General .....	82
9.2	De-icing System Performance Test.....	83
9.2.1	General .....	83
9.2.2	Test Conditions .....	83
9.2.3	Test Setup .....	84
9.2.4	Test Procedure.....	85
9.2.5	Evaluation.....	85
9.3	Cleaning System Performance Test.....	86
9.3.1	General .....	86
9.3.2	Test Conditions .....	86
9.3.3	Test Setup .....	86
9.3.4	Test Procedure.....	86
9.3.5	Evaluation.....	87
10	Documentation.....	88
Annex A (informative)	Example Weather Testing Facilities.....	89
A.1	Rain Chambers .....	89
A.2	Fog Chambers .....	91
Annex B (informative)	Checklist for tests according to this document.....	93
Bibliography	.....	94

## Figures

Figure 1 — Overview of global standardisation activities.....	10
Figure 2 — Clustering using histogram method .....	14
Figure 3 — Example of reference and SuT bounding boxes.....	22
Figure 4 — Example of sensor mounting areas on passenger car.....	23
Figure 5 — Measurement points for rainfall/fog parameter measurements (top view) .....	26
Figure 6 —DIN SAE SPEC 91471 Multi-Domain Test with a weather chamber .....	28
Figure 7 — CCRs scenario according to Euro NCAP AEB Car-to-Car Systems Test protocol v4.3:2023-12 with adverse weather.....	30
Figure 8 — CCRm scenario according to Euro NCAP AEB Car-to-Car Systems Test protocol v4.3:2023-12 with adverse weather.....	32
Figure 9 — CPLA scenario as per Euro NCAP AEB/LSS VRU Systems test protocol v4.5:2023-12 with adverse weather .....	34
Figure 10 — CBLA scenario as per Euro NCAP AEB/LSS VRU Systems test protocol v4.5:2023-12 with adverse weather .....	36
Figure 11 — CMRs scenario as per Euro NCAP AEB/LSS VRU Systems test protocol .....	38
Figure 12 — Scenario for detection of small objects on the road.....	40
Figure 13 — Climate chamber setup for frost on SuT surface .....	45
Figure 14 — Illustration of side view of road spray plume .....	46
Figure 15 — Illustration of road spray covering the target in SuT azimuth-elevation plane .....	47
Figure 16 — DIN SAE SPEC 91471 Multi-Domain test with a dust chamber .....	49
Figure 17 — Illustration of DIN SAE SPEC 91471 Multi-Domain test with SuT placed in a climate chamber .....	49
Figure 18 — Illustration of DIN SAE SPEC 91471 Multi-Domain test for road spray test .....	50
Figure 19 — CCRs scenario according to Euro NCAP AEB Car-to-Car System Test protocol v4.3:2023-12 for road spray test.....	52
Figure 20 — CCRm scenario according to Euro NCAP AEB Car-to-Car Car Systems Test protocol v4.3:2023-12 for road spray test.....	54
Figure 21 — CMRs scenario as per Euro NCAP AEB/LSS VRU Systems test protocol v4.5:2023-12 for road spray test.....	60
Figure 22 — Scenario for detection of small objects on the road.....	62
Figure 23 — Direct interference — 1 test .....	66
Figure 24 — Indirect interference — 1 test.....	67
Figure 25 — Indirect interference — 2 test.....	69

Figure 26 — Indirect interference — 3 test.....	71
Figure 27 — Direct interference — 2 test .....	73
Figure 28 — Parallel and oncoming traffic test .....	75
Figure 29 — Parallel traffic test .....	77
Figure 30 — Traffic jam test.....	78
Figure 31 — Intersection test .....	80
Figure 32 — Phases for data recording for cleaning performance evaluation .....	83
Figure 33 — De-icing system performance evaluation setup.....	83
Figure 34 — SuT orientations for de-icing/cleaning performance evaluation.....	85

## Tables

Table 1 — Simplified geometry targets for evaluation on point cloud level (DIN SAE SPEC 91471:2023-05).....	17
Table 2 — New IDs for KPIs from DIN SAE SPEC 91471:2023-05, 7.2 .....	18
Table 3 — List of real-world targets for evaluation on object level (Euro NCAP).....	19
Table 4 — Proposed small objects for object level tests .....	19
Table 5 — Variations for the CCRs scenario as per Euro NCAP AEB Car-to-Car Systems Test protocol v4.3:2023-12.....	31
Table 6 — Variations for the CCRm scenario as per Euro NCAP AEB Car-to-Car Systems Test protocol v4.3:2023-12.....	33
Table 7 — Variations for the CPLA scenario as per Euro NCAP AEB/LSS VRU Systems Test protocol v4.5:2023-12.....	35
Table 8 — Variations for the CBLA scenario as per Euro NCAP AEB/LSS VRU System Test protocol v4.5:2023-12.....	37
Table 9 — Variations for the CMRs scenario as per Euro NCAP AEB/LSS VRU System Test protocol v4.5:2023-12.....	39
Table 10 — Variations for the CSO scenario as per Euro NCAP AEB Car-to-Car test protocol .....	41
Table 11 — Overview of tests and contamination conditions.....	43
Table 12 — Road spray modes for testing .....	47
Table 13 — Variations for the CCRs scenario as per Euro NCAP AEB Car-to-Car System Test protocol v4.3:2023-12.....	53
Table 14 — Variations for the CCRm scenario as per Euro NCAP AEB Car-to-Car Systems Test protocol v4.3:2023-12.....	55

<b>Table 15 — Variations for the CPLA scenario as per Euro NCAP AEB/LSS VRU Systems Test protocol v4.5:2023-12.....</b>	<b>57</b>
<b>Table 16 — Variations for the CBLA scenario as per Euro NCAP AEB/LSS VRU Systems Test protocol v4.5:2023-12.....</b>	<b>59</b>
<b>Table 17 — Variations for the CMRs scenario as per Euro NCAP AEB/LSS VRU Systems Test protocol v4.5:2023-12.....</b>	<b>61</b>
<b>Table 18 — Variations for the CSO scenario.....</b>	<b>63</b>
<b>Table 19 — Victim/interferer combinations .....</b>	<b>64</b>
<b>Table 20 — Variations for direct interference — 1 test .....</b>	<b>66</b>
<b>Table 21 — Variations for indirect interference tests .....</b>	<b>68</b>
<b>Table 22 — Variations for direct interference — 2 test .....</b>	<b>74</b>
<b>Table 23 — Variations for parallel and oncoming test.....</b>	<b>76</b>
<b>Table 24 — Variations for parallel and oncoming test.....</b>	<b>77</b>
<b>Table 25 — Variations for parallel and oncoming test.....</b>	<b>79</b>
<b>Table 26 — Variations for parallel and oncoming test.....</b>	<b>81</b>
<b>Table A.1 — List of known rain chamber facilities.....</b>	<b>89</b>
<b>Table A.2 — List of known fog chamber facilities.....</b>	<b>91</b>
<b>Table B.1 — Example checklist for overview of conducted tests .....</b>	<b>93</b>