

Report

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Comparison of RDE evaluation software

TÜV NORD Mobilität GmbH und Co. KG, Essen



Institut für Fahrzeugtechnik und Mobilität
Drivetrain / Emissions
Passenger cars / Motorcycles
Adlerstr. 7
45307 Essen, Germany

Customer:
Sensors Europe GmbH
Feldheiderstraße 60
40699 Erkrath, Germany

Table of contents

Table of contents	2
1. Object of examination	3
2. Calculation input settings	3
2.1. Diesel car.....	3
2.2. Gasoline car.....	4
3. Results.....	5
3.1. Trip Requirements and Dynamic.....	5
3.1.1. Trip Requirements and Dynamic Diesel	5
3.1.2. Trip Requirements and Dynamic Gasoline.....	6
3.2. MAW results	6
3.2.1. MAW results Diesel.....	6
3.2.2. MAW results Gasoline	7
3.3. Power Binning Results.....	8
3.3.1. Power Binning results Diesel	8
3.3.2. Power Binning results Gasoline	9
4. Conclusion.....	10

1. Object of examination

The purpose of examination is a comparison of the Real Driving Emissions (RDE) evaluation software SENSOR Tech-CT LDV Package 2 B17 with Emroad V5_90_B5, CLEAR 2.0 Build 116 and TÜV Nord calculation. SENSOR Tech-CT LDV Package 2 B17 was developed by Sensors, Inc., 6812 State Road, Saline, Michigan 48176, USA, to meet the requirements of COMMISSION REGULATION (EU) No 2016/427 and No 2016/646.

2. Calculation input settings

Two datasets, one of a Diesel passenger car and one of a Gasoline passenger car, are calculated with all software named above.

Cold start is excluded for all emission calculations.

Moving Averaging Window (MAW) and Power Binning calculation of SENSOR Tech-CT LDV Package 2 B17 is run with Vehicle Speed Smoothing checkbox activated.

MAW calculation direction is always backwards.

All other possible settings in the programs are selected by default to meet requirements of COMMISSION REGULATION (EU) No 2016/427 and No 2016/646.

Electronic Control Unit (ECU) vehicle speed was selected.

Additional input data is listed in paragraphs 2.1 and 2.2.

2.1. Diesel car

CO ₂ Reference mass:	2,1	kg
CO ₂ WLTP Phase 1:	260	g/km
CO ₂ WLTP Phase 3:	185	g/km
CO ₂ WLTP Phase 4:	170	g/km

Rated Power: 81 kW

Road Load parameters:	f ₀ :	89,6	N
	f ₁ :	0	N/(km/h)
	f ₂ :	0,0391	N/(km/h) ²
	inertia:	1360	kg

Willians Coefficients:	D:	1673,5	g/h
	K:	664,02	g/kWh

2.2. Gasoline car

CO ₂ Reference mass:	2,0	kg
CO ₂ WLTP Phase 1:	163	g/km
CO ₂ WLTP Phase 3:	113	g/km
CO ₂ WLTP Phase 4:	138	g/km

Rated Power: 81 kW

Road Load parameters:	f ₀ :	89,6	N
	f ₁ :	0	N/(km/h)
	f ₂ :	0,0391	N/(km/h) ²
	inertia:	1360	kg

Willians Coefficients:	D:	1673,5	g/h
	K:	664,02	g/kWh

3. Results

3.1. Trip Requirements and Dynamic

3.1.1. Trip Requirements and Dynamic Diesel

		Emroad	Sensors	TÜV Nord	Clear 2.0
Trip distance	in km	87,91	87,87	87,92	87,86
Trip duration	in min.	103	103	103	103
Urban distance	in km	32,05	32,37	32,06	32,37
Rural distance	in km	22,12	21,84	22,12	21,84
Motorway distance	in km	33,74	33,66	33,74	33,66
Urban distance share	in %	36,46	36,84	36,46	36,83
Rural distance share	in %	25,16	24,86	25,16	24,85
Motorway distance share	in %	38,38	38,30	38,38	38,30
Urban average speed	in km/h	28,19	28,27	28,17	28,25
Rural average speed	in km/h	74,07	74,17	74,07	74,39
Motorway average speed	in km/h	119,56	119,54	119,56	119,6
Motorway speed above 145 km/h	in %	0	0	0	0
Motorway speed above 100 km/h	in min.	14,73	14,68	14,73	14,68
Urban stop time	in %	18,93	19,22	18,60	19,95
Start and end points elevation absolute difference	in m	22,70	21,7	21,7	--
Cumulative positive elevation gain	in m/100km	304,71	307,30	307,34	307,28
Urban RPA	m/s ²	0,163	0,163	0,159	0,161
Rural RPA	m/s ²	0,111	0,112	0,111	0,113
Motorway RPA	m/s ²	0,097	0,097	0,097	0,097
Urban 95th percentile Speed*Acc	m ² /s ³	10,79	10,76	10,78	10,78
Rural 95th percentile Speed*Acc	m ² /s ³	33,72	33,68	33,72	33,48
Motorway 95th percentile Speed*Acc	m ² /s ³	38,56	38,49	38,56	38,64

Table 1: Trip Requirements and Dynamic Diesel

3.1.2. Trip Requirements and Dynamic Gasoline

		Emroad	Sensors	TÜV Nord	Clear 2.0
Trip distance	in km	82,69	82,9	82,9	82,9
Trip duration	in min.	96	96	96	96
Urban distance	in km	30,36	30,63	30,36	30,63
Rural distance	in km	33,03	32,81	33,03	32,81
Motorway distance	in km	19,30	19,46	19,54	19,46
Urban distance share	in %	36,72	36,95	36,61	36,95
Rural distance share	in %	39,94	39,57	39,83	39,57
Motorway distance share	in %	23,34	23,48	23,57	23,47
Urban average speed	in km/h	32,46	32,59	32,46	32,58
Rural average speed	in km/h	70,32	70,43	70,32	70,42
Motorway average speed	in km/h	101,00	100,95	100,94	100,95
Motorway speed above 145 km/h	in %	0	0	0	0
Motorway speed above 100 km/h	in min.	8,88	8,33	8,88	8,33
Urban stop time	in %	7,63	7,12	7,46	7,59
Start and end points elevation absolute difference	in m	23,7	18,6	18,6	--
Cumulative positive elevation gain	in m/100km	350,60	350,66	350,60	350,68
Urban RPA	m/s ²	0,167	0,168	0,167	0,168
Rural RPA	m/s ²	0,070	0,068	0,070	0,068
Motorway RPA	m/s ²	0,036	0,036	0,037	0,036
Urban 95th percentile Speed*Acc	m ² /s ³	11,35	11,42	11,35	11,46
Rural 95th percentile Speed*Acc	m ² /s ³	11,39	10,34	11,39	10,49
Motorway 95th percentile Speed*Acc	m ² /s ³	10,92	10,82	10,75	10,53

Table 2: Trip Requirements and Dynamic Gasoline

3.2. MAW results

3.2.1. MAW results Diesel

		Emroad	Sensors	TÜV Nord
CO total emissions	in mg/km	110,68	110,64	110,57
NO _x total emissions	in mg/km	158,66	158,84	158,41
CO urban emissions	in mg/km	147,22	147,19	147,19
CO rural emissions	in mg/km	106,50	106,43	106,31
CO motorway emissions	in mg/km	77,21	77,21	77,10
NO _x urban emissions	in mg/km	112,75	112,79	112,70
NO _x rural emissions	in mg/km	145,65	146,06	145,70
NO _x motorway emissions	in mg/km	218,95	219,05	218,23
Total number of windows	#	4159	4162	4160
Number of urban windows	#	1410	1410	1406
Number of rural windows	#	1356	1360	1362
Number of motorway windows	#	1393	1392	1392
Share of urban windows	in %	33,90	33,88	33,80
Number of rural windows	in %	32,60	32,68	32,74
Number of motorway windows	in %	33,49	33,45	33,46
Share of normal urban windows	in %	41,56	41,56	41,18
Number of normal rural windows	in %	98,16	98,16	97,14
Number of normal motorway windows	in %	100	100	100
Urban severity index	in %	-25,63	-25,62	-25,68
Rural severity index	in %	-17,68	-17,63	-17,73
Motorway severity index	in %	0,63	0,66	0,43

Table 3: MAW results Diesel

3.2.2. MAW results Gasoline

		Emroad	Sensors	TÜV Nord
CO total emissions	in mg/km	361,56	362,66	361,79
NO _x total emissions	in mg/km	11,49	11,52	11,50
CO urban emissions	in mg/km	519,82	523,41	519,67
CO rural emissions	in mg/km	330,51	330,10	331,68
CO motorway emissions	in mg/km	229,56	229,59	229,23
NO _x urban emissions	in mg/km	14,17	14,28	14,15
NO _x rural emissions	in mg/km	11,00	11,01	11,05
NO _x motorway emissions	in mg/km	9,22	9,20	9,21
Total number of windows	#	4338	4369	4347
Number of urban windows	#	2040	2075	2041
Number of rural windows	#	1720	1717	1729
Number of motorway windows	#	578	577	577
Share of urban windows	in %	47,03	47,49	46,95
Number of rural windows	in %	39,65	39,30	39,77
Number of motorway windows	in %	13,32	13,21	13,27
Share of normal urban windows	in %	100	100	100
Number of normal rural windows	in %	100	100	100
Number of normal motorway windows	in %	100	100	100
Urban severity index	in %	7,48	7,75	7,43
Rural severity index	in %	5,11	5,04	5,14
Motorway severity index	in %	-12,96	-12,90	-13,01

Table 4: MAW results Gasoline

3.3. Power Binning Results

3.3.1. Power Binning results Diesel

		Clear 2.0	Sensors	TÜV Nord
CO total emissions	in mg/km	89,9	90,0	90,0
NO _x total emissions	in mg/km	98,7	99,1	99,1
CO urban emissions	in mg/km	125,4	126,5	126,6
NO _x urban emissions	in mg/km	107,4	107,7	107,7

Table 5: Power Binning emission results Diesel

Power class	Actual Frequency. in %			counts		
	Clear 2.0	Sensors	TÜV Nord	Clear 2.0	Sensors	TÜV Nord
1+2	32,29	32,31	32,30	1235	1235	1234
3	59,69	59,65	59,67	2283	2280	2280
4	6,93	6,93	6,94	265	265	265
5	0,63	0,63	0,63	24	24	24
6	0,31	0,31	0,31	12	12	12
7	0,08	0,16	0,16	3	6	6
8	0,05	--	--	2	--	--
9	0	--	--	0	--	--
10	0,03	--	--	1	--	--
11	0	--	--	0	--	--

Table 6: Power Binning results urban part Diesel

Power class	Actual Frequency in %			counts		
	Clear 2.0	Sensors	TÜV Nord	Clear 2.0	Sensors	TÜV Nord
1+2	24,82	24,81	24,81	1465	1465	1465
3	51,94	51,95	51,96	3066	3067	3068
4	14,91	14,91	14,89	880	880	879
5	5,61	5,61	5,61	331	331	331
6	1,30	1,30	1,30	77	77	77
7	0,59	1,42	1,42	35	84	84
8	0,39	--	--	23	--	--
9	0,15	--	--	9	--	--
10	0,14	--	--	8	--	--
11	0,08	--	--	5	--	--

Table 7: Power Binning results total trip Diesel

3.3.2. Power Binning results Gasoline

		Clear 2.0	Sensors	TÜV Nord
CO total emissions	in mg/km	358,5	363,9	362,6
NO _x total emissions	in mg/km	14,5	14,9	14,9
CO urban emissions	in mg/km	329,6	332,4	330,18
NO _x urban emissions	in mg/km	10,5	10,6	10,55

Table 8: Power Binning emission results Gasoline

Power class	Actual Frequency in %			counts		
	Clear 2.0	Sensors	TÜV Nord	Clear 2.0	Sensors	TÜV Nord
1+2	20,11	20,10	20,10	673	672	673
3	70,81	70,84	70,85	2370	2369	2372
4	7,29	7,33	7,26	244	245	243
5	1,40	1,38	1,40	47	46	47
6	0,39	0,359	0,39	13	12	13
7	0	0	0	0	0	0
8	0	--	--	0	--	--
9	0	--	--	0	--	--
10	0	--	--	0	--	--
11	0	--	--	0	--	--

Table 9: Power Binning results urban part Gasoline

Power class	Actual Frequency in %			counts		
	Clear 2.0	Sensors	TÜV Nord	Clear 2.0	Sensors	TÜV Nord
1+2	13,97	13,96	13,96	799	799	799
3	73,12	73,10	73,16	4183	4183	4186
4	11,22	11,24	11,18	642	643	640
5	1,26	1,26	1,26	72	72	72
6	0,33	0,33	0,33	19	19	19
7	0,07	0,11	0,10	4	6	6
8	0	--	--	0	--	--
9	0,03	--	--	2	--	--
10	0	--	--	0	--	--
11	0	--	--	0	--	--

Table 10: Power Binning results total trip Gasoline

4. Conclusion

The examination shows that all evaluation software have similar results regarding Trip Requirements and Dynamic, MAW and Power Binning results.

Test laboratory accredited by DAkkS Deutsche Akkreditierungsstelle GmbH:

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This report contains pages 1 to 11.

TÜV NORD Mobilität GmbH & Co. KG
IFM - Institut für Fahrzeugtechnik und Mobilität
Adlerstr. 7, 45307 Essen

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B.Eng. Jens Badur

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