

Report No. LM2107030-01_V2
Project No. LM2107030

FUEL CONSUMPTION TESTS ACCORDING TO THE SORT 2014 PROCEDURE

Client's reference:

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1. OBJECTIVE

The purpose of this project was to realise SORT fuel consumption tests carried out by IDIADA in cooperation with SOLARIS at Pila (Poland), following UITP-2014 SORT procedure. SOLARIS was in charge of the test equipment (belonging to SOLARIS) correctly functioning and correctly measuring and for driving the tested bus under supervision of an IDIADA's engineer. The IDIADA's engineer was responsible for realization of the whole test according to the UITP-2014 SORT standard.

2. VEHICLE INFORMATION

2.1. Basic vehicle information

The table below shows the vehicle characteristics:



Test applicant	Solaris Bus & Coach Sp. z o.o.	
Manufacturer	Solaris Bus & Coach Sp. z o.o.	
Type	Urbino 12 Hybrid	
Reception date	01/07/2021	
Chassis n°	SUU241161GB016124	
Engine	DAF/Paccar MX-11 250 H4	
Gearbox	Voith Diwa NXT D855.8H	
Tyres	Bridgestone UAP 001 M+S	
Mileage Initial / final (km)	22.787	22.836

The results refer exclusively to the sample tested.

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3. TEST RESULTS

3.1. SORT fuel consumption results

The table below shows the SORT vehicle fuel consumption results:

		Fuel consumption
SORT 1	l/100km	40,1
SORT 2	l/100km	33,9
SORT 3	l/100km	30,9

3.2. Vehicle test weight

The table below shows the vehicle weights for the SORT tests:

		SORT
Front axle	(kg)	4.860
Rear axle	(kg)	9.500
Total weight	(kg)	14.560

3.3.Final SORT1 fuel consumption result

3.3.1. Direction 1 SORT1

The table below shows the results of fuel consumption. The SOC variation and the energy values obtained during the SORT 1 direction 1:

Test N°	Fuel consumption		SOC	NEC	Fuel Energy	NEC variation	Total energy
	(l)	(l/100km)	(Δ Ah)	(kJ)	(MJ)	(%)	(MJ)
1	0,656	40,3	-1,30	-224,64	22,96	-0,98	22,74
2	0,650	39,9	-1,10	-190,08	22,75	-0,84	22,56
3	0,652	40,0	-1,10	-190,08	22,82	-0,83	22,63

SORT 1 Direction 1 fuel consumption result	(l/100km)	40,1
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3.3.2. Direction 2 SORT1

The table below shows the results of fuel consumption. The SOC variation and the energy values obtained during the SORT 1 direction 2:

Test N°	Fuel consumption		SOC	NEC	Fuel Energy	NEC variation	Total energy
	(l)	(l/100km)	(Δ Ah)	(kJ)	(MJ)	(%)	(MJ)
1	0,656	40,3	-1,00	-172,80	22,96	-0,75	22,79
2	0,654	40,2	-1,20	-207,36	22,89	-0,91	22,68
3	0,649	39,9	-1,30	-224,64	22,72	-0,99	22,49

SORT 1 Direction 2 fuel consumption result	(l/100km)	40,1
---	------------------	-------------

Fuel Consumption Average SORT 1	(l/100km)	40,1
--	------------------	-------------

Due to the NEC variance of the tests is lower than 1%. It is not necessary to do a linear interpolation to obtain a fuel consumption value.

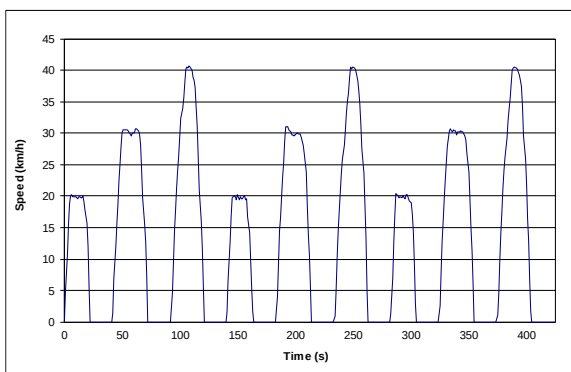
3.4. SORT 1 test cycle

The tables below show test characteristics in both directions of SORT1 cycles:

SORT 1 - Test 1

DIRECTION 1

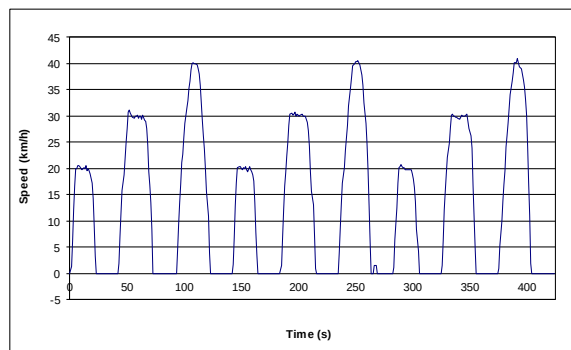
Date
06/07/2021 11:12



Total test distance	(m)	1.559,3
Total test time	(s)	424,0
Fuel consumption	(l/100km)	40,3
Cycle speed	(km/h)	13,2

DIRECTION 2

Date
06/07/2021 11:41



Total test distance	(m)	1.561,1
Total test time	(s)	424,0
Fuel consumption	(l/100km)	40,3
Cycle speed	(km/h)	13,3

Speed average	(km/h)	13,2
Fuel consumption average	(l/100km)	40,3

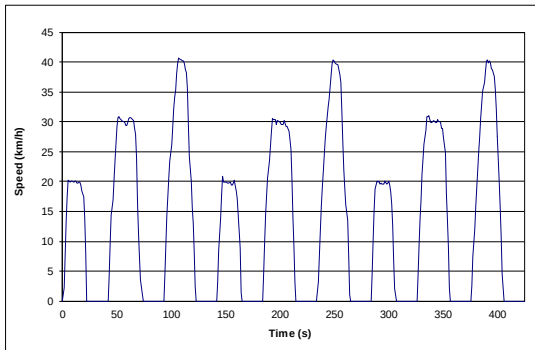
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SORT 1 - Test 2

DIRECTION 1

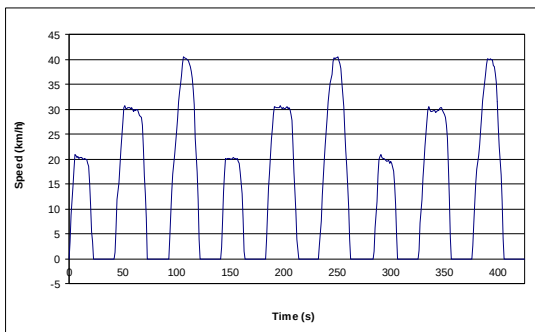
Date
06/07/2021 12:11



Total test distance	(m)	1.558,6
Total test time	(s)	425,0
Fuel consumption	(l/100km)	39,9
Cycle speed	(km/h)	13,2

DIRECTION 2

Date
06/07/2021 12:01



Total test distance	(m)	1.563,5
Total test time	(s)	425,0
Fuel consumption	(l/100km)	40,2
Cycle speed	(km/h)	13,2

Speed average	(km/h)	13,2
Fuel consumption average	(l/100km)	40,0

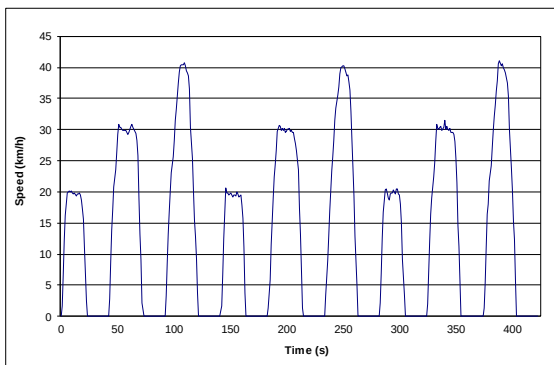
The results refer exclusively to the sample tested.

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SORT 1 – Test 3

DIRECTION 1

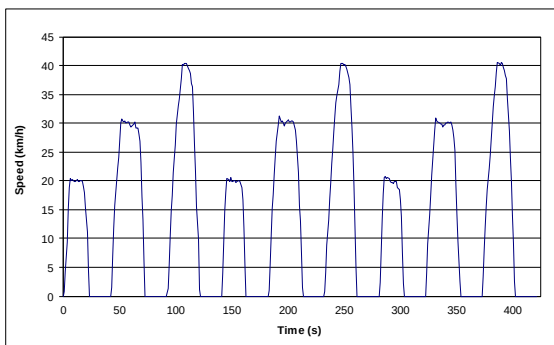
Date
06/07/2021 12:31



Total test distance	(m)	1.561,0
Total test time	(s)	423,0
Fuel consumption	(l/100km)	40,0
Cycle speed	(km/h)	13,3

DIRECTION 2

Date
06/07/2021 12:21



Total test distance	(m)	1.560,8
Total test time	(s)	422,0
Fuel consumption	(l/100km)	39,9
Cycle speed	(km/h)	13,3

Speed average	(km/h)	13,3
Fuel consumption average	(l/100km)	39,9

The results refer exclusively to the sample tested.

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3.5. Final SORT2 fuel consumption result

3.5.1. Direction 1 SORT2

The table below shows the results of fuel consumption. The SOC variation and the energy values obtained during the SORT 2 direction 1:

Test Nº	Fuel consumption		SOC	NEC	Fuel Energy	NEC variation	Total energy
	(l)	(l/100km)	(Δ Ah)	(kJ)	(MJ)	(%)	(MJ)
1	0,664	34,6	-0,40	-69,12	23,24	-0,30	23,17
2	0,655	34,1	-0,60	-103,68	22,93	-0,45	22,82
3	0,663	34,5	-0,70	-120,96	23,21	-0,52	23,08

SORT 2 Direction 1 fuel consumption result	(l/100km)	34,4
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3.5.2. Direction 2 SORT2

The table below shows the results of fuel consumption. The SOC variation and the energy values obtained during the SORT 2 direction 2:

Test Nº	Fuel consumption		SOC	NEC	Fuel Energy	NEC variation	Total energy
	(l)	(l/100km)	(Δ Ah)	(kJ)	(MJ)	(%)	(MJ)
1	0,641	33,4	-1,20	-207,36	22,44	-0,92	22,23
2	0,644	33,5	-0,70	-120,96	22,54	-0,54	22,42
3	0,640	33,3	-0,60	-103,68	22,40	-0,46	22,30

SORT 2 Direction 2 fuel consumption result	(l/100km)	33,4
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Fuel Consumption Average SORT 2	(l/100km)	33,9
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Due to the NEC variance of the tests is lower than 1%. It is not necessary to do a linear interpolation to obtain a fuel consumption value.

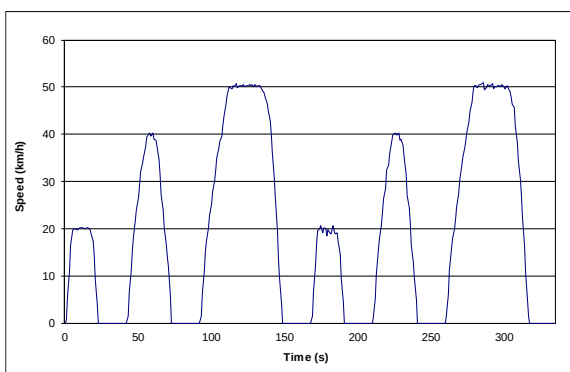
3.6. SORT 2 test cycle

The tables below show test characteristics in both directions of SORT2 cycles:

SORT 2 - Test 1

DIRECTION 1

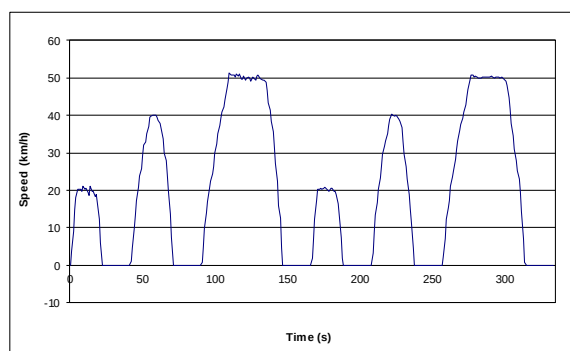
Date
06/07/2021 9:35



Total test distance	(m)	1.839,0
Total test time	(s)	337,0
Fuel consumption	(l/100km)	34,6
Cycle speed	(km/h)	19,6

DIRECTION 2

Date
06/07/2021 9:42



Total test distance	(m)	1.840,4
Total test time	(s)	334,0
Fuel consumption	(l/100km)	33,4
Cycle speed	(km/h)	19,8

Speed average	(km/h)	19,7
Fuel consumption average	(l/100km)	34,0

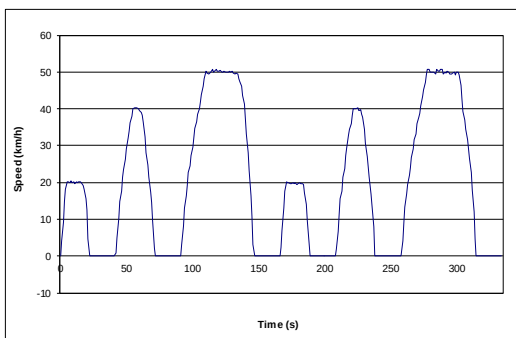
The results refer exclusively to the sample tested.

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SORT 2 - Test 2

DIRECTION 1

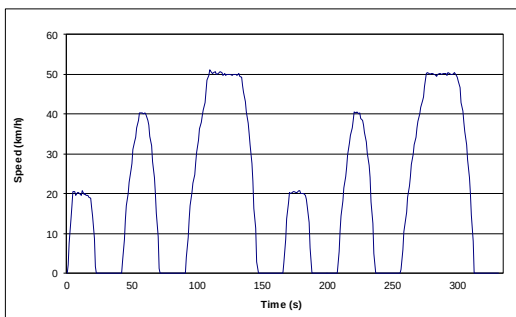
Date
06/07/2021 9:49



Total test distance	(m)	1.839,6
Total test time	(s)	334,0
Fuel consumption	(l/100km)	34,1
Cycle speed	(km/h)	19,8

DIRECTION 2

Date
06/07/2021 9:58



Total test distance	(m)	1.840,0
Total test time	(s)	332,0
Fuel consumption	(l/100km)	33,5
Cycle speed	(km/h)	20,0

Speed average	(km/h)	19,9
Fuel consumption average	(l/100km)	33,8

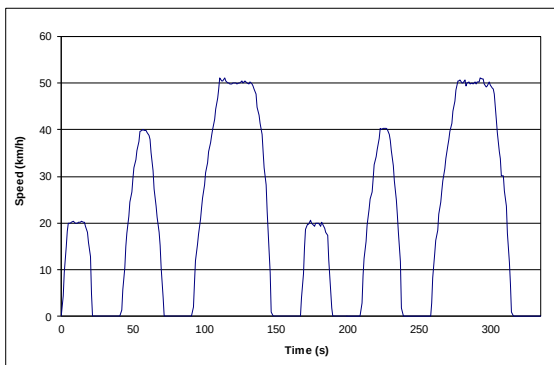
The results refer exclusively to the sample tested.

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SORT 2 – Test 3

DIRECTION 1

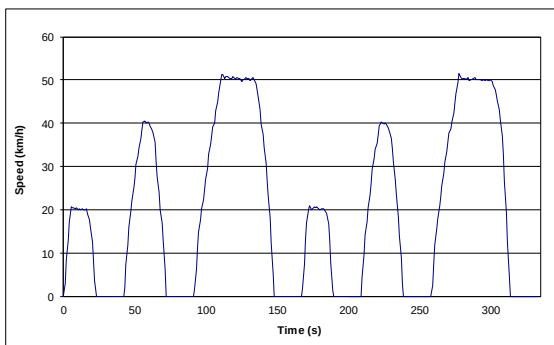
Date
06/07/2021 10:06



Total test distance	(m)	1.843,4
Total test time	(s)	335,0
Fuel consumption	(l/100km)	34,5
Cycle speed	(km/h)	19,8

DIRECTION 2

Date
06/07/2021 10:15



Total test distance	(m)	1.845,4
Total test time	(s)	333,0
Fuel consumption	(l/100km)	33,3
Cycle speed	(km/h)	20,0

Speed average	(km/h)	19,9
Fuel consumption average	(l/100km)	33,9

The results refer exclusively to the sample tested.

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3.7.Final SORT3 fuel consumption result

3.7.1. Direction 1 SORT3

The table below shows the results of fuel consumption. The SOC variation and the energy values obtained during the SORT 3 direction 1:

Test Nº	Fuel consumption		SOC	NEC	Fuel Energy	NEC variation	Total energy
	(l)	(l/100km)	(Δ Ah)	(kJ)	(MJ)	(%)	(MJ)
1	0,463	30,6	-0,90	-155,52	16,21	-0,96	16,05
2	0,469	31,0	-0,90	-155,52	16,42	-0,95	16,26
3	0,472	31,2	-0,80	-138,24	16,52	-0,84	16,38

SORT 3 Direction 1 fuel consumption result	(l/100km)	30,9
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3.7.2. Direction 2 SORT3

The table below shows the results of fuel consumption. The SOC variation and the energy values obtained during the SORT 3 direction 2:

Test Nº	Fuel consumption		SOC	NEC	Fuel Energy	NEC variation	Total energy
	(l)	(l/100km)	(Δ Ah)	(kJ)	(MJ)	(%)	(MJ)
1	0,474	31,3	-0,80	-138,24	16,59	-0,83	16,45
2	0,468	30,9	-0,90	-155,52	16,38	-0,95	16,22
3	0,466	30,8	-0,80	-138,24	16,31	-0,85	16,17

SORT 3 Direction 2 fuel consumption result	(l/100km)	31,0
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Fuel Consumption Average SORT 3	(l/100km)	30,9
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Due to the NEC variance of the tests is lower than 1%. It is not necessary to do a linear interpolation to obtain a fuel consumption value.

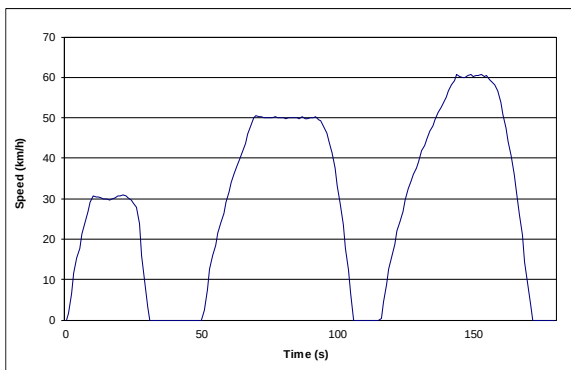
3.8. SORT 3 test cycle

The tables below show test characteristics in both directions of SORT3 cycles:

SORT 3 - Test 1

DIRECTION 1

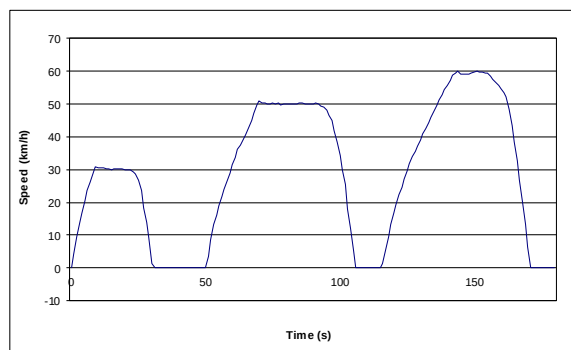
Date
06/07/2021 13:43



Total test distance	(m)	1.449,6
Total test time	(s)	182,0
Fuel consumption	(l/100km)	30,6
Cycle speed	(km/h)	28,7

DIRECTION 2

Date
06/07/2021 13:49



Total test distance	(m)	1.449,5
Total test time	(s)	180,0
Fuel consumption	(l/100km)	31,3
Cycle speed	(km/h)	29,0

Speed average	(km/h)	28,8
Fuel consumption average	(l/100km)	30,9

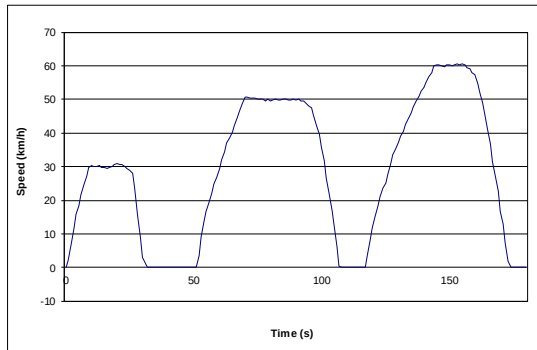
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SORT 3 - Test 2

DIRECTION 1

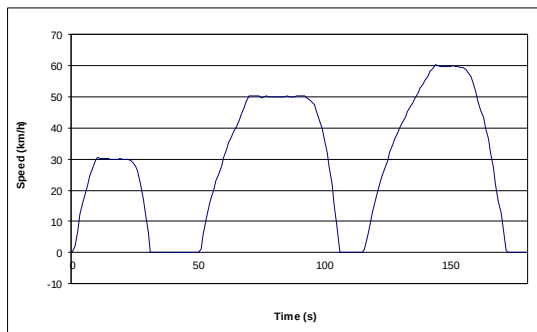
Date
06/07/2021 13:54



Total test distance	(m)	1.449,0
Total test time	(s)	183,0
Fuel consumption	(l/100km)	31,0
Cycle speed	(km/h)	28,5

DIRECTION 2

Date
06/07/2021 14:00



Total test distance	(m)	1.450,6
Total test time	(s)	181,0
Fuel consumption	(l/100km)	30,9
Cycle speed	(km/h)	28,9

Speed average	(km/h)	28,7
Fuel consumption average	(l/100km)	30,9

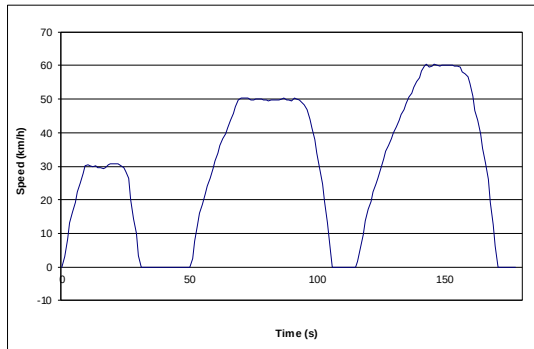
The results refer exclusively to the sample tested.

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SORT 3 – Test 3

DIRECTION 1

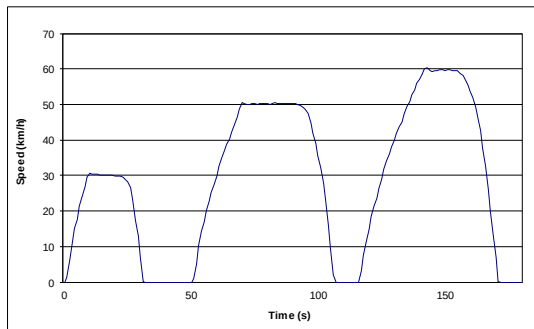
Date
06/07/2021 14:15



Total test distance	(m)	1.450,0
Total test time	(s)	178,0
Fuel consumption	(l/100km)	31,2
Cycle speed	(km/h)	29,3

DIRECTION 2

Date
06/07/2021 14:10



Total test distance	(m)	1.450,0
Total test time	(s)	180,0
Fuel consumption	(l/100km)	30,8
Cycle speed	(km/h)	29,0

Speed average	(km/h)	29,2
Fuel consumption average	(l/100km)	31,0

The results refer exclusively to the sample tested.

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4. VEHICLE INSTRUMENTATION

The vehicle instrumentation used during the test was as follows:

Equipment	Brand	Model	Serial number
GPS speed	Racelogic	VB2SX	054217
Fuel flow meter	AIC	4008	047177
Weather Station	Kestrel	3500	2502596

Annex I: Sheet 3 Test protocol

Test protocol

For tests to be repeatable, it is necessary to definition with accuracy the vehicle actually tested, especially because a certain level of margin is left to manufacturers.

The test must consequently be documented with accuracy in a test protocol describing the most relevant elements, so that in case of later confirmation tests, the tested bus is clearly defined and cannot give rise to dispute or misinterpretation.

Date of test	06/07/2021
Time of test begin	10:50 (GMT+1)
Time of test end	16:30 (GMT+1)
Place of test	Pila – Airport (Poland)

A. Test external conditions (for information)

1. Street conditions

N°	Item	Value	Unit
1.1	State of track surface	Dry	
1.2	Min / Max longitudinal gradient	-0,2 / +0,3	%
1.3	Track altitude	100	m
1.4	Min. radius	--	m
1.5	Track length	2.000	m

2. Weather conditions

N°	Item	Value		Value		Value		Unit
		SORT 1		SORT 2		SORT 3		
		06/07/2021		06/07/2021		06/07/2021		
		Initial	Final	Initial	Final	Initial	Final	
2.1	Wind speed	2,2	2,0	1,1	2,0	1,8	2,0	m/s
2.2	Temperature	27,4	28,9	24,7	27,1	29,1	29,8	°C
2.3	Humidity	44,0	43,0	45,0	44,0	42,0	39,0	%
2.4	Atmospheric pressure	100,3	100,1	100,3	100,3	100,1	100,1	kPa

B. Vehicle set-up

1.1. Type and dimension:

N°	Item	Value	Unit
1.1.1	Vehicle type	Urbino 12 Hybrid	
1.1.2	Length	12	m
1.1.3	Width	2,55	m
1.1.4	Height	3,04	m
1.1.5	Empty weight	11.400	kg
1.1.6	Mileage	22.787	km

1.2. Engine

N°	Item	Value	Unit	At (rpm)
1.2.1	Manufacturer and type	DAF / Paccar MX-11 250 H4		
1.2.2	Engine capacity	10.837	cc	
1.2.3	Maximum power	251	kW	1.675
1.2.4	Maximum torque	1.500	Nm	900-1400
1.2.5	Driving mode of engine ventilator	Standard		

The results refer exclusively to the sample tested.

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1.3. Gearbox

N°	Item	Value
1.3.1	Manufacturer and type	Voith, Diwa NXT D855.8H
1.3.2	Programme used	--

1.4. Tyres

N°	Item	Value	Unit
1.4.1	Manufacturer and type*	Bridgestone UAP 001 M+S	
1.4.2	Dimensions*	275/70 R22,5	
1.4.3	Front axle nominal pressure	8,5	bar
1.4.4	Rear axle nominal pressure	8,5	bar
1.4.5	Pattern depth of new tyres	20,0	mm
1.4.6	Actual pattern depth measured	18,0 – 19,0	mm

1.5. Rear Axle

N°	Item	Value
1.5.1	Manufacturer and type*	ZF AV133
1.5.2	Reduction ratio	5,3

1.6. Engine lubricant

N°	Item	Value
1.6.1	Type	ACEA E6
1.6.2	SAE Grade	10W-40
1.6.3	Other features	--

1.7. Gearbox lubricant

N°	Item	Value
1.7.1	Type	Shell Spirax S6 ATF VM Plus
1.7.2	SAE Grade	--
1.7.3	Other features	--

1.8. Batteries

N°	Item	Value	Unit
1.8.1	Type	Varta Silver ProMotive 225 Ah	
1.8.2	Number	2	
1.8.3	Nominal unit voltage	12	V
1.8.4	Unit weight	55	Kg

1.9. Miscellaneous equipment

N°	Item	Value
1.9.1	Number of doors	3
1.9.2	ABS/ASR	--
1.9.3	Retarder	Yes
1.9.4	Air conditioning	Yes
1.9.5	Other	--

1.10. Calculation of the load characteristics CL of the tested vehicle.

N°	Item	Value
1.10.1	Load factor CL (load)	$CL = 116.19 \times (L - 1.20) \times W$ 3.200 kg
CL	Lump load	

The results refer exclusively to the sample tested.

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1.11. Optional equipment

N°	Item	Weight to deduct from lump load	Unit
1.11.1	Air-conditioning	50	kg
1.11.2	Ticketing equipment	--	kg
1.11.3	Automatic vehicle monitoring system (AVM)	20	kg
1.11.4	Information equipment	--	kg
1.11.5	Security driver cabin	--	kg
1.11.6	Double glazing	--	kg
1.11.7	Lubrimatic equipment	--	kg
(1)	Total weight to be deducted from lump load	70	kg

1.12. Other factors to take into account

N°	Item	Actual weight (A)	Reference weight (B)	Difference (A-B)	Unit
1.12.1	External destination displays	--	--	--	kg
1.12.2	Seats (number:28)	280	300	-20	kg
1.12.3	Fuel tank capacity (350)	294	168	126	kg
1.12.4	On board persons	250	--	250	kg
1.12.5	Fuel measuring equipment	20	--	20	kg
(2)	Total weight to be deducted from lump load			376	kg

1.13. Final value of lump load to apply

N°	Item	Value		
1.13.1	Empty weight	11.400		kg
1.13.2	Lump load	3.200		kg
1.13.3	Optional equipment (1)	70		kg
1.13.4	Other factors (2)	376		kg
1.13.5	= 3.200 - (1) - (2)	2.754		kg
1.13.6	Empty weight + load	Calculated	14.154	kg
		Measured	14.360	kg

1.14. Energy storage devices

N°	Item	Value	Unit
1.14.1	Type	Impact, Battery Pack LTO HP	
1.14.2	Nominal operating value	48	Vdc
1.14.3	Power	25 kW - 40 kW	kW
1.14.4	Weight	45	kg
1.14.5	Capacity C3	20	Ah
1.14.6	Minimum SOC level	-	
1.14.7	Maximum SOC level	-	
1.14.8	Battery case: Exterior temperature		
	Before test	-	
	After test		

The results refer exclusively to the sample tested.

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1.15. Electric motor

N°	Item	Value	Unit
1.15.1	Type	MI10-V1-48	
1.15.2	Number	1	
1.15.3	Power	--	kW
1.15.4	Weight	n/a (built-in into the gearbox)	kg

1.16. Hybrid drive chain

N°	Item	
1.16.1	Configuration (series/parallel)	Serie

1.17. Variation of State of Charge (NEC _{Variance})

N°	Item	
1.17.1	NEC _{Variance} between start and end of the test	Refer to SAE J2711
1.17.2	Device used to measure the current: Specify or document	CAN bus

** Vehicle information provided by the customer and verified by IDIADA. All other technical specifications shown in this report have been informed by the customer but could not be verified by IDIADA.*

2. Fuel

N°	Item		
2.1	EC standard	--	
2.2	Sulphur rate	--	ppm
2.3	Fuel temperature at test start	58,0	°C
2.4	Fuel temperature at test end	63,1	°C
2.5	Adblue®	-	L
	Quantity at the beginning of the test	-	L
	Quantity at the end of the test	-	L

The results refer exclusively to the sample tested.

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