

The proposal for GTR 21 revision in the next phase

2024.09

Prepared by China

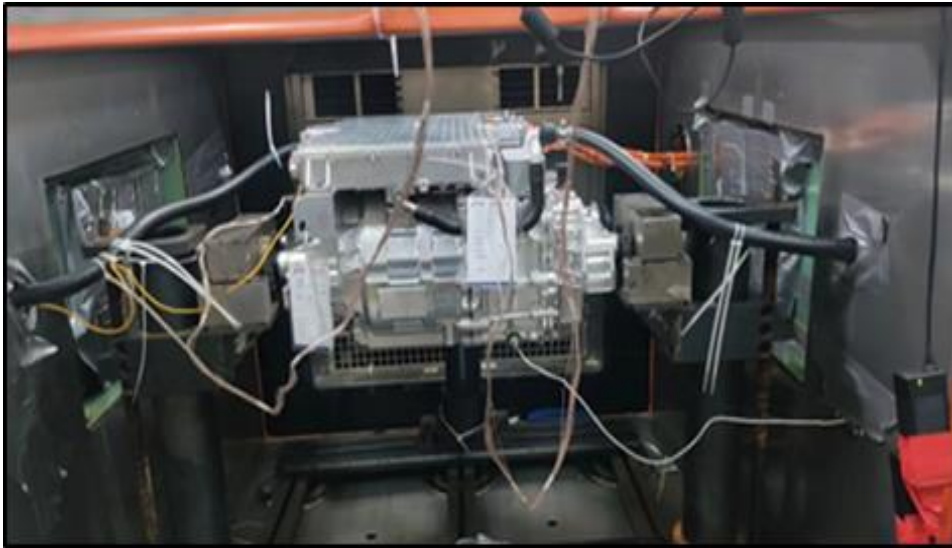
K1 measurement for oil-cooled highly integrated electric drive system

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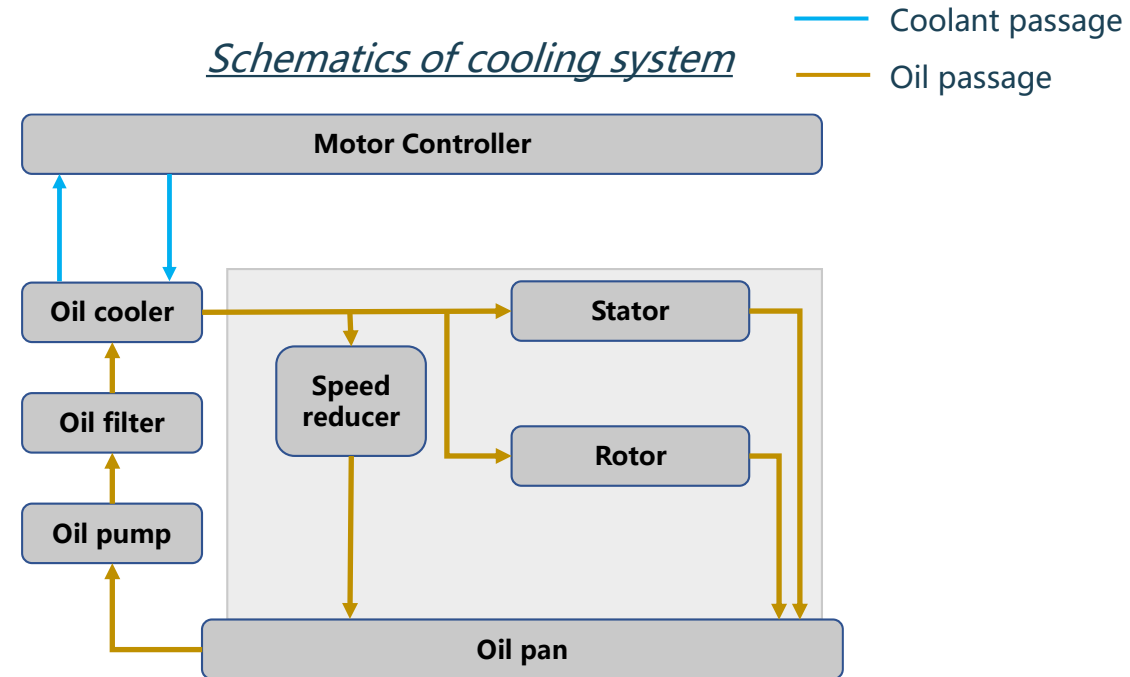
1. Introduction

- One prototype highly-integrated oil-cooled Electric Drive System has been adopted to investigate the validity of direct measurement of K_1 value.
- As can be seen in the schematics of the oil passage, oil flows between the electric motor and the speed reducer, which increases the difficulty of direct measurement.

Test EDS



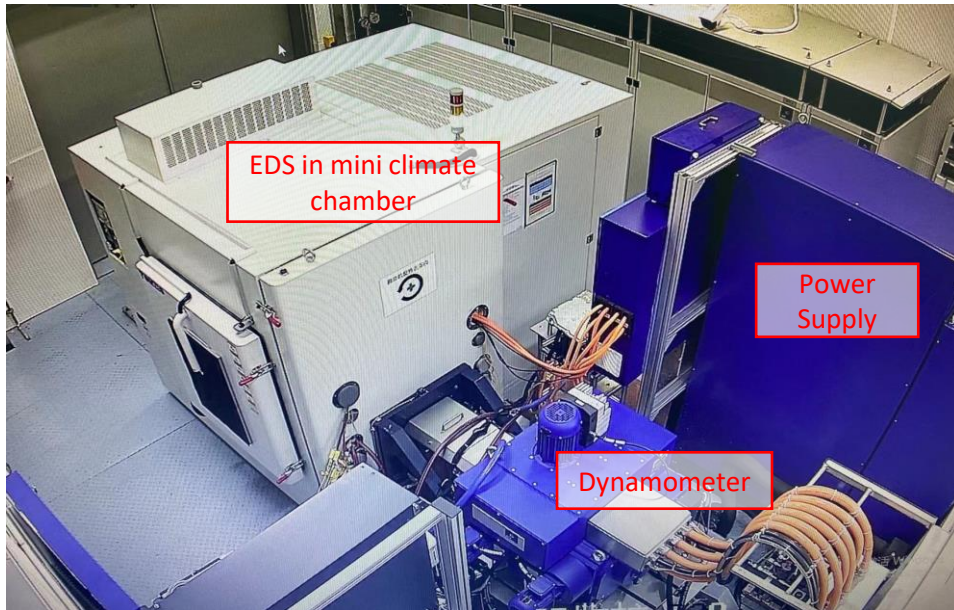
Schematics of cooling system



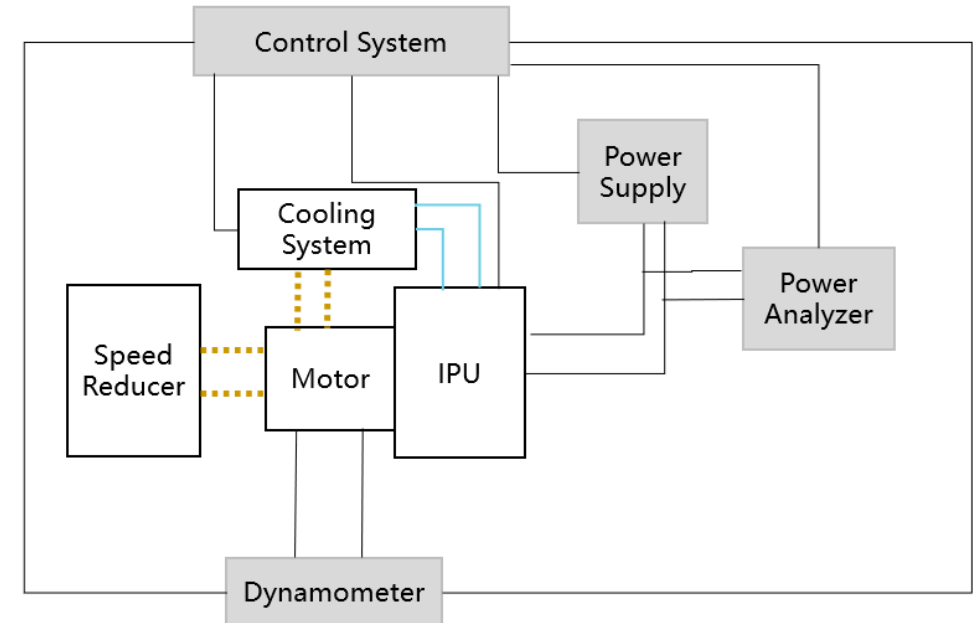
2. Experimental Approach

- The EDS has been placed inside a mini climate chamber and the oil passage between the motor and the speed reducer has been blocked (oil circulated inside the motor to cool the stator and the rotor).

Test System



Schematics of the Test System



— Coolant passage
- - - Oil passage

3. Results Comparison

- Steady state running conditions have been repeated to obtain the K1 value, shown in the table below, which confirms the validity of direct measurement of the K1 value for oil-cooled highly integrated electric drive systems.
- Future work needed: 1) more validation data, 2) comparison with on-board data, 3) possibility of the calculation of K2.

Test No.	Speed (rpm)	Torque (Nm)	Voltage (V)	Current (A)	K1 (Efficiency)
1	3509	36.894	300	0.491	92.03%
2	6514	73.789	300	1.795	93.46%
3	7014	110.684	300	2.884	93.96%
4	6014	147.579	300	3.351	92.45%
5	6514	184.475	300	4.556	92.06%

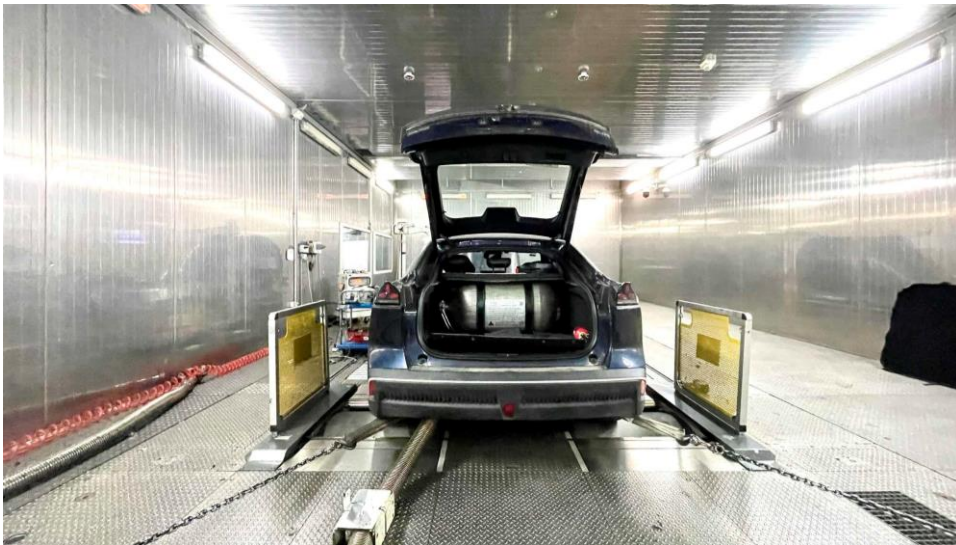
Experimental validation of TP1 test on a fuel cell vehicle

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1. Introduction

- One fuel-cell based sedan has been selected to carry out validation of TP1 test procedure,
- The specification of the FCV is shown in table below.

FCV on chassis dynamometer



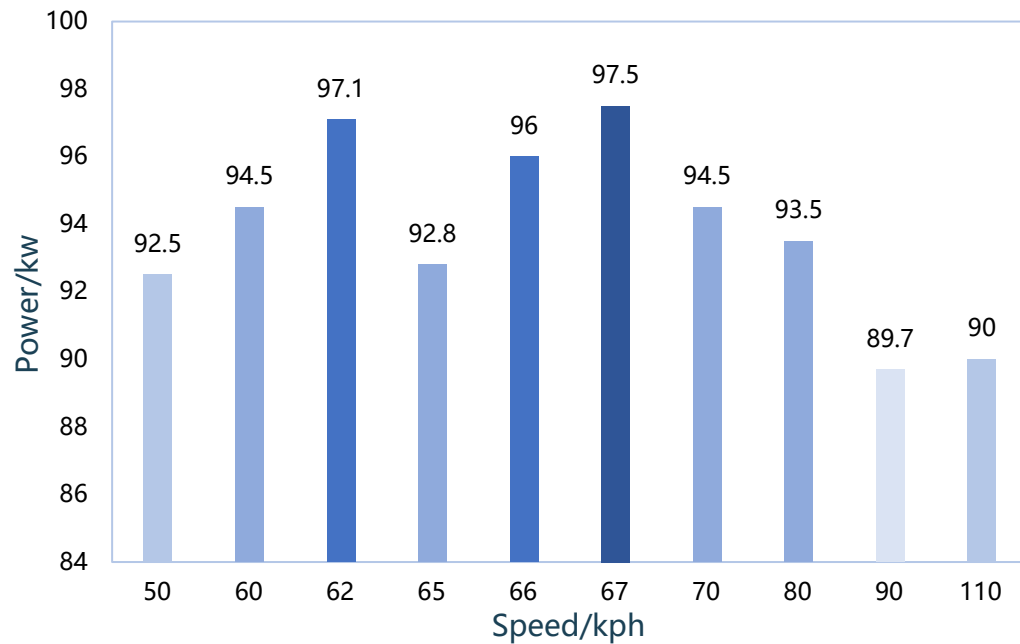
FCV specification

Length (m)	Width (m)	Height (m)	Curb weight (kg)
4.82	1.89	1.48	1900
Fuel cell power rating (kw)		Fuel cell maximum efficiency (%)	
67.5		62	
Fuel cell power density (W/L)		Fuel cell power density (w/kg)	
583.3		625	
Fuel cell durability (h)		Fuel cell Protection degree	
> 10000 (attenuation < 10%)		IP67	
Fuel cell cold-start temperature (°C)			
≤-30			

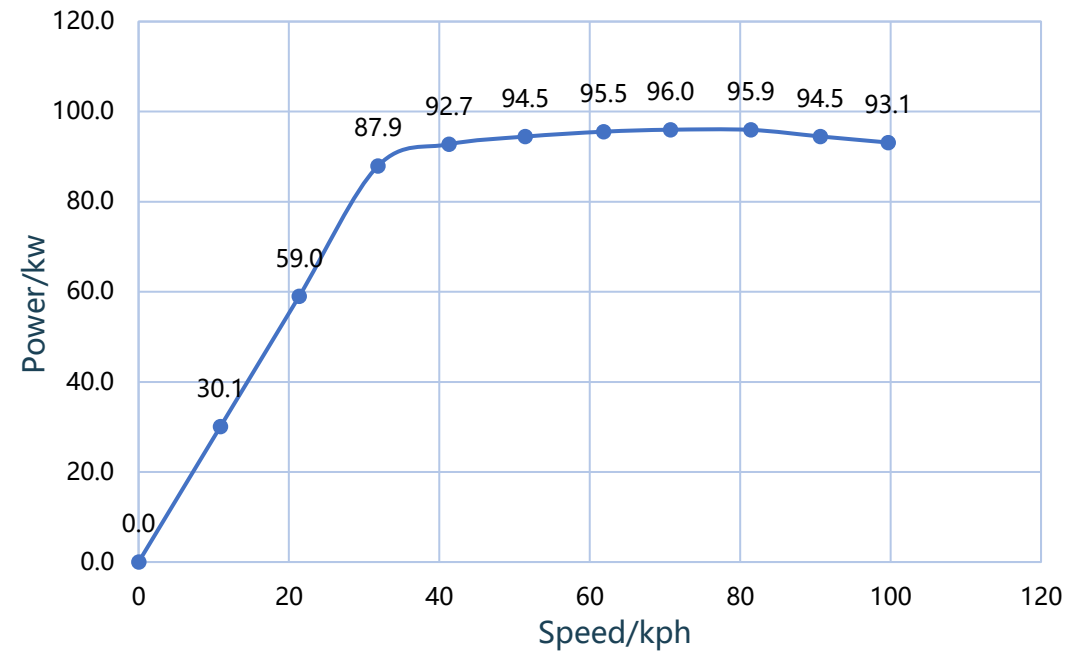
2. Speed of maximum power

- The maximum power 97.5W appears when the speed is 67kph, which shows good agreement with vehicle acceleration results.

Speed –Power Map



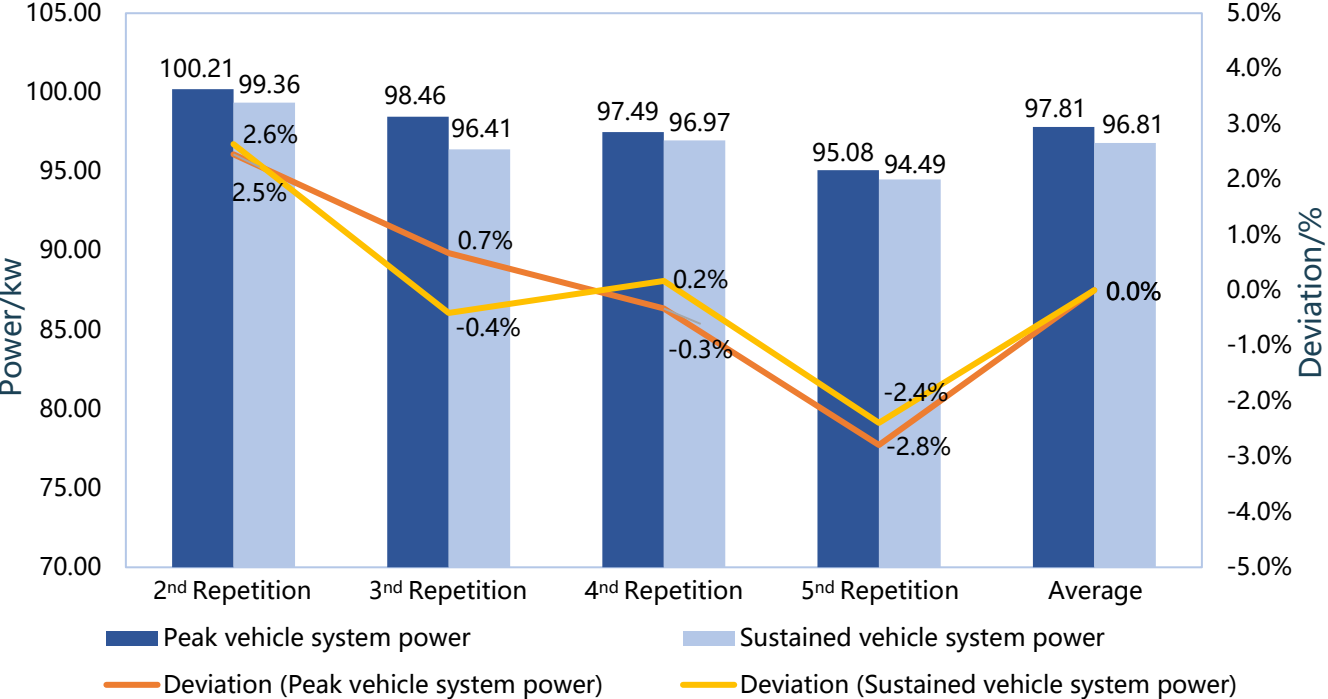
0-100kph Acceleration power profile



3. Results

- The inferred maximum power is 97.81kW while the sustained power is 96.81kW.
- The deviations of four repeats are below 5%.

Vehicle system power



Experimental data

	2nd Repetition	3rd Repetition	4th Repetition	5th Repetition
U _{REESS} (V)	312.35	313.78	312.47	313.0
I _{REESS} (A)	264.99	257.47	255.52	250.03
U _{FCCU} (V)	312.35	313.78	312.47	313.0
I _{FCCU} (A)	85.66	84.42	85.99	82.96
P _{DCDC} (kw)	0.66	0.82	0.81	0.81
P _{aux} (kw)	0.51	0.56	0.65	0.65
K1 (Efficiency)	0.9217	0.9228	0.9226	0.9218
Speed (kph)	67	67	67	67

Note: the electric drive system is water cooled and K1 directly measured