

# Proposal from China on discussing k1 and k2 factors of GTR21

2023.7.19

## 2. Issues for Discussion

### Issue: K1,K2 Determination for highly integrated Electric Drive System (EDS)

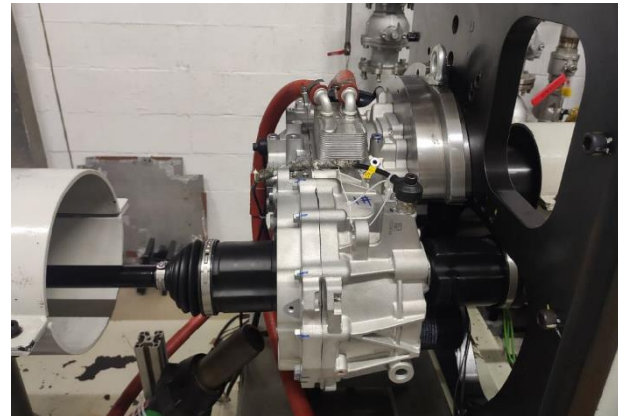
#### 2) Difficulty of directly measuring K1,K2

- Figures below reveal three different types of Electric Driving System (EDS) at different integration level ;
  - ✓ Type 1: It is practically easy to measure K1, some dedicated mounting needed;
  - ✓ Type 2: For water cooled EDS (no fluid flows between motor and reducer/gearbox, the complexity of the dedicated mounting increases, but still OK to conduct experiment;
  - ✓ Type 3: For oil cooled EDS, oil flows between motor and speed reducer/gearbox, **which makes it difficult to measure K1**.
- Similar to K1, the determination of K2 would experience the same difficulty for highly integrated EDS;

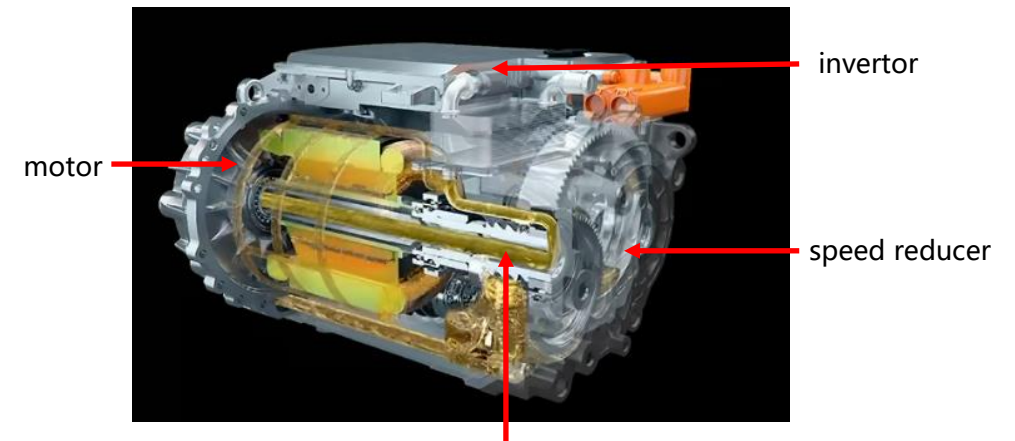
*Type1: 3 in 1*



*Type2: 7 in 1 (water cooled)*



*Type3: 7 in 1 (oil cooled)*



oil flows between motor and speed reducer(cannot separate)

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#### 3) Possible Solution – Adopting CAN data

- A 7 in 1 (water cooled) EDS has been selected to conduct a comparison: 1) tested on testbed with external transducers; 2) CAN data applied;
- As can be seen, a discrepancy in efficiency (K1) is 0.44% occurred;
- Noted: the accuracy of the CAN data to be requested.

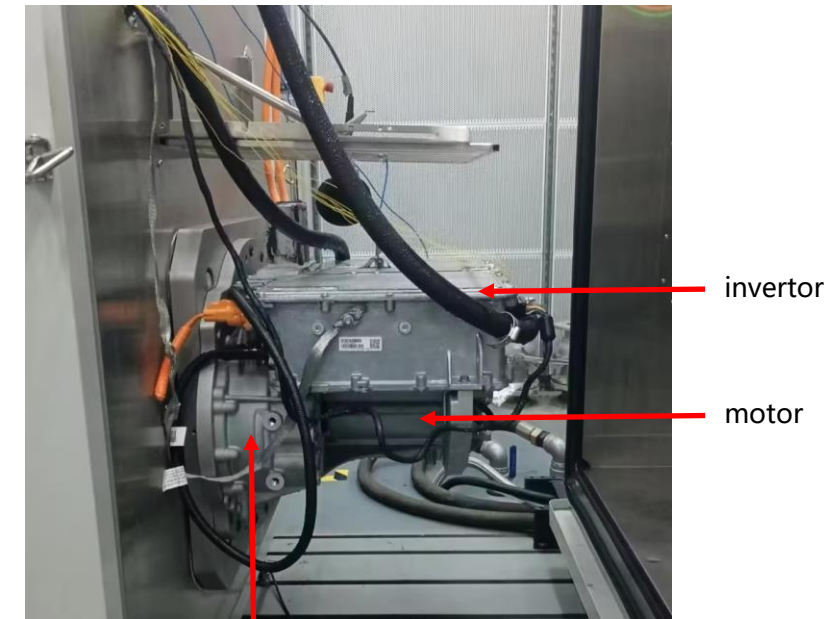
#### Testbed Data

Current	Voltage	Motor speed	Torque	Efficiency (K1)
457.3	296.5	6598	176.6	0.900

#### CAN Data

Current	Voltage	Motor speed	Torque	Efficiency (K1)
458.2	296.4	6598	176.1	0.896

#### Motor System Testbed



excluding speed reducer

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#### 3) Possible Solution – Adopting assembly efficiency instead

- A comparison of indicated power based on K1 from either assembly (motor, inverter and speed reducer) or motor system (motor and inverter):  
1.2% difference;
- Noted: This approach is only valid for TP1 when K1 is needed.

#### *Results from TP1 parallel hybrid vehicle*

7 in 1 (water cooled) EDS	Max Battery Power minus 1kW (kW)	K1	R2 (kW)	R1 (kW)	R1+R2 (kW)
assembly	88	92.2	81.1	118	199.1
motor system	88	95	83.6	118	201.6

#### *Assembly Test*



#### *Motor System*



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#### 4) Suggestion

- If it is not convenient (still possible) to implement external transducers, CAN data can be used to read the actual power; however, the manufacturer needs to supply a validation report showing the comparison of testbed results and CAN data;
- For oil cooled highly integrated EDS where it is impossible to directly acquire data via external transducers, the efficiency of the assembly can be used instead.

- We recommend to add a paragraph following section 2.6.1 in Annex 1 as a supplementary description, shown as below:
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  - 2.6.2. On-board data be used to obtain K1 value for highly integrated electric drive system when it is difficult to applicate external measurements (for example a dedicated fixture needed to separate the motor and transmission in order to implement measurement devices). Verification of on-board data is needed. Alternatively, the reference point can be shifted to the outlet of transmission in order to obtain K1, shown in Figure xxx. In the case of oil cooled highly integrated electric drive system where it is impossible to obtain K1 through external measurements, the reference point needs to move post the transmission.
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  - Figure xxx, Change in reference point location for highly integrated electric drive system

