Powertrain Inertia
Measuring on Complete Vehicles

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Test modes

Steady State

- Cooling capacity
- Engine knocking problems
- General overheating problems (exhaust system, etc)

Acceleration (steady rate)

- Drive-train inertia (engine flywheel etc)
- Dynamic engine ECU control
- Turbo response
- Dynamic cam phasing & induction system

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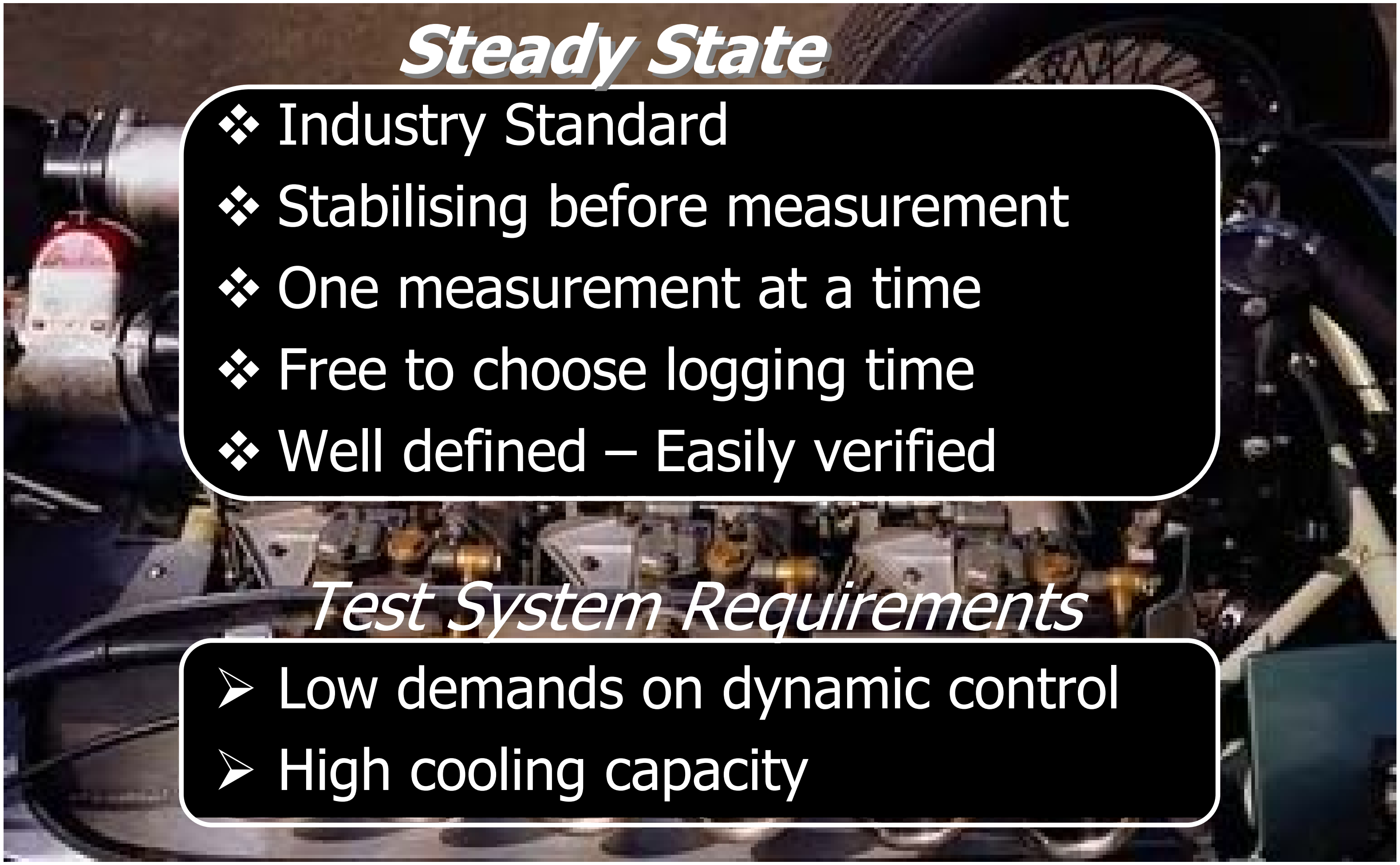
Test Modes



Steady State

- ❖ Industry Standard
- ❖ Stabilising before measurement
- ❖ One measurement at a time
- ❖ Free to choose logging time
- ❖ Well defined – Easily verified

Test System Requirements

- ➢ Low demands on dynamic control
- ➢ High cooling capacity

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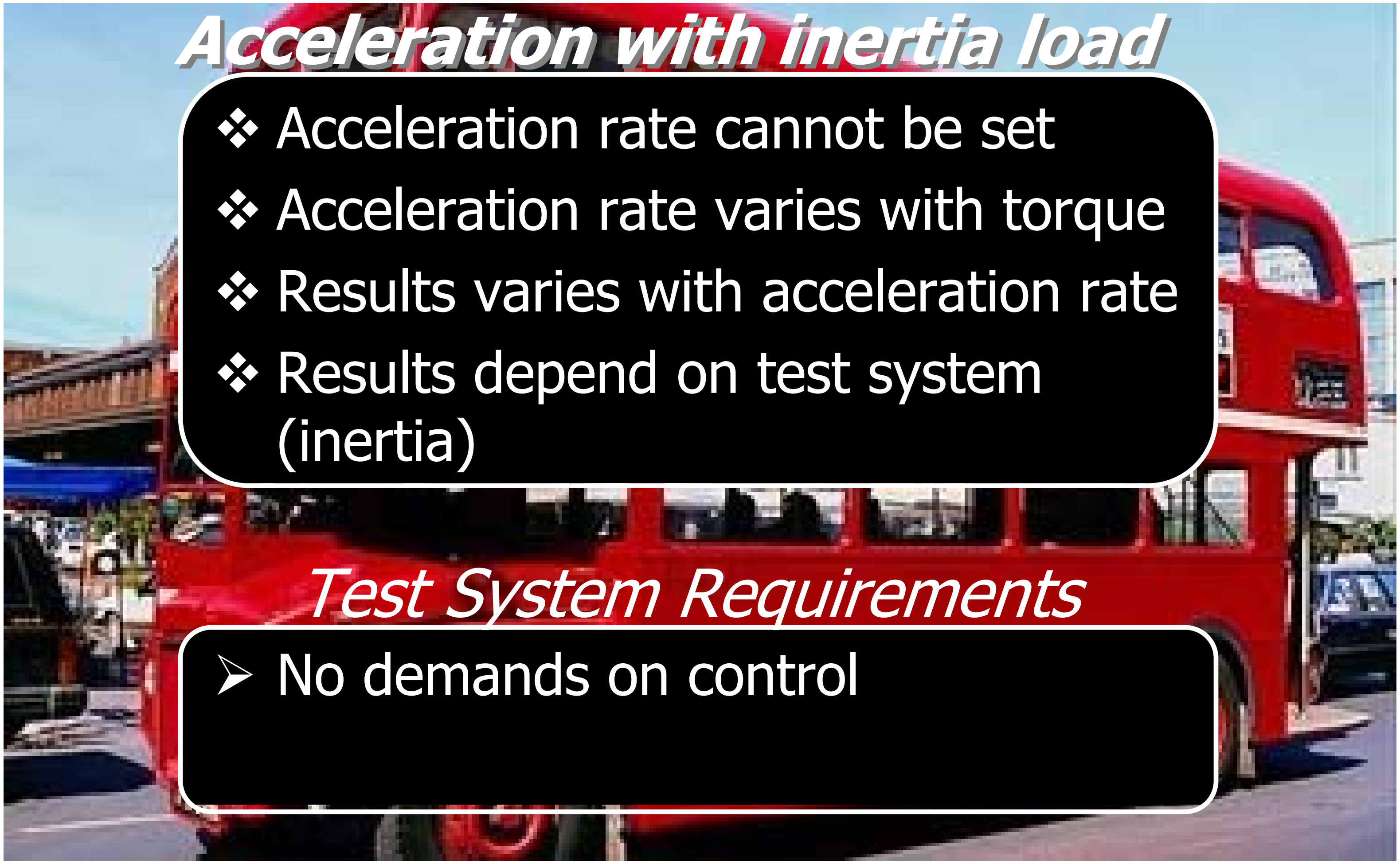
Test Modes



Acceleration with inertia load

- ❖ Acceleration rate cannot be set
- ❖ Acceleration rate varies with torque
- ❖ Results varies with acceleration rate
- ❖ Results depend on test system (inertia)

Test System Requirements

- ➢ No demands on control

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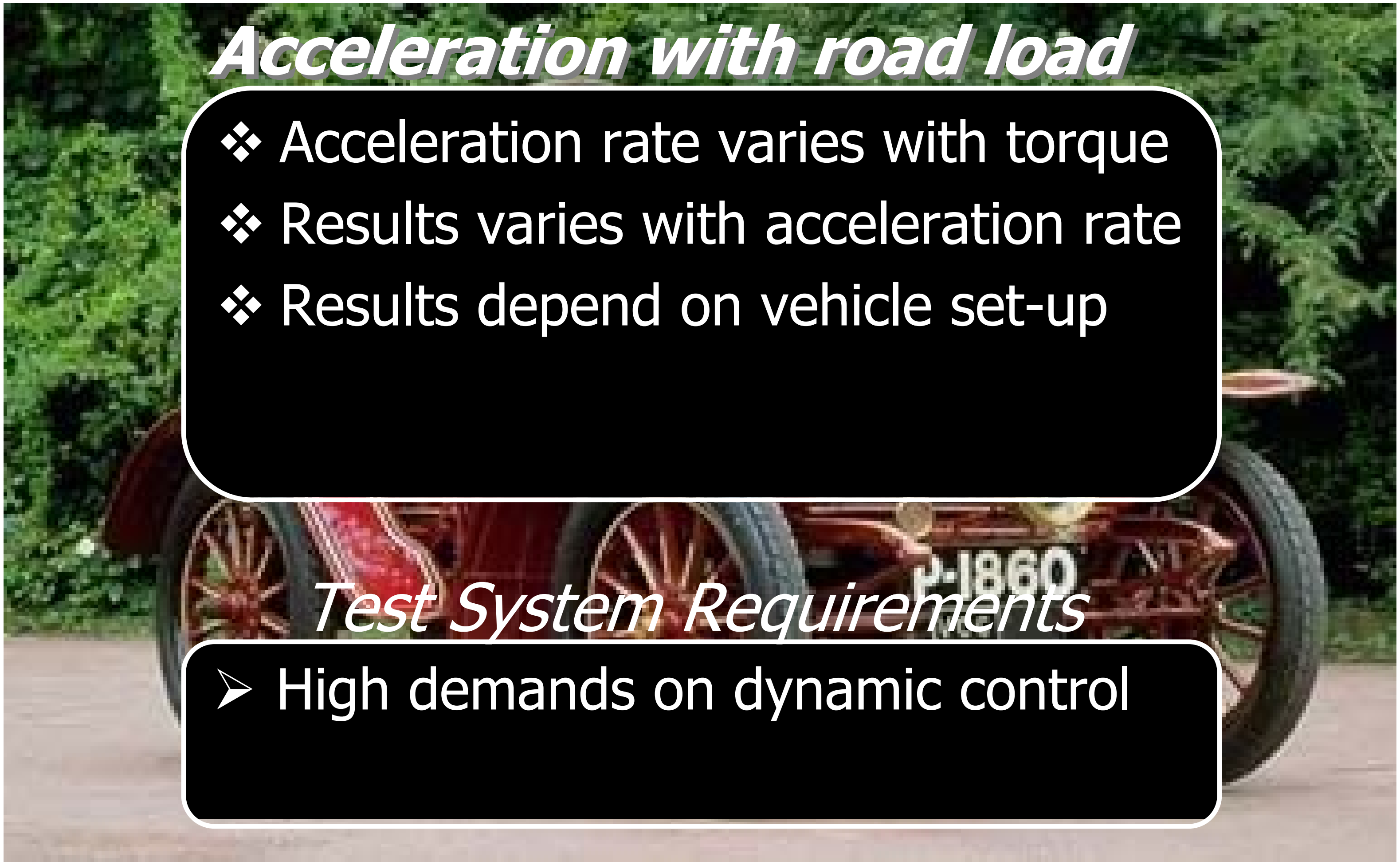
Test Modes



Acceleration with road load

- ❖ Acceleration rate varies with torque
- ❖ Results varies with acceleration rate
- ❖ Results depend on vehicle set-up

Test System Requirements

- ➢ High demands on dynamic control

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Test Modes

Acceleration at steady rate

- ❖ Free to choose acceleration rate
- ❖ Well defined – Easily verified

Test System Requirements

- ➢ High demands on dynamic control

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Test Vehicle

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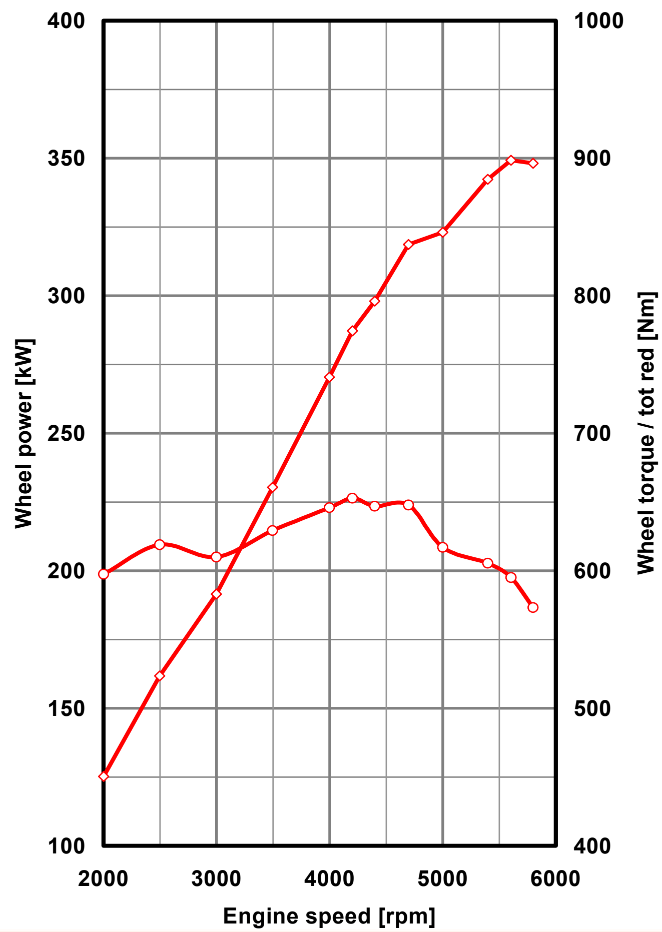
Test Results Steady State

<u>Comments</u>

Small dips at 4400 and 5000 rpm indicate areas where improvements can be made.



5 sec @ Gear 4

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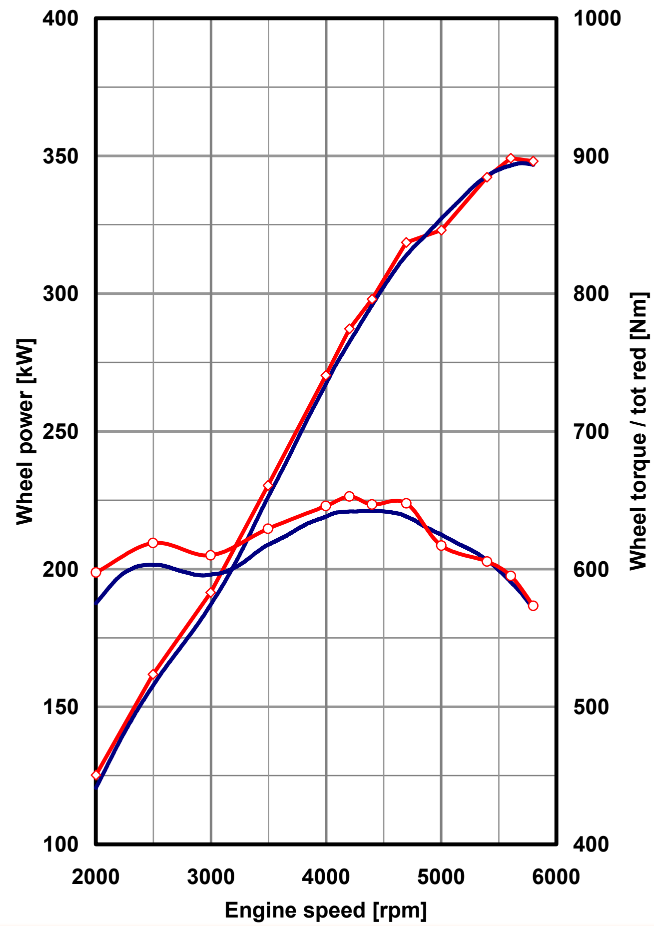
Steady State vs Steady Rate

<u>Comments</u>

The difference between steady state and steady rate decreases with speed. Steady state map can not be optimized for performance at higher engine speed.



5 sec @ Gear 4

300 rpm/s @ Gear 4

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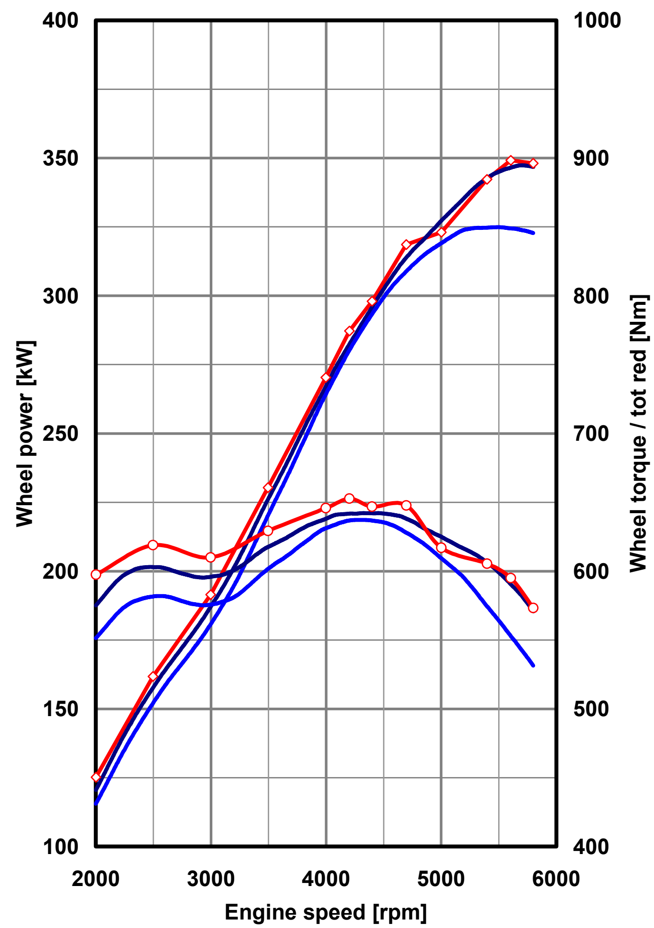
Steady rate tests at different gears

<u>Comments</u>

The difference between 4^{th} and 5^{th} gear is ~3.5% at low speed.

4^{th} gear is straight through the gearbox whereas 5^{th} gear is 0.74:1 (overdrive).



5 sec @ Gear 4

300 rpm/s @ Gear 4

300 rpm/s @ Gear 5

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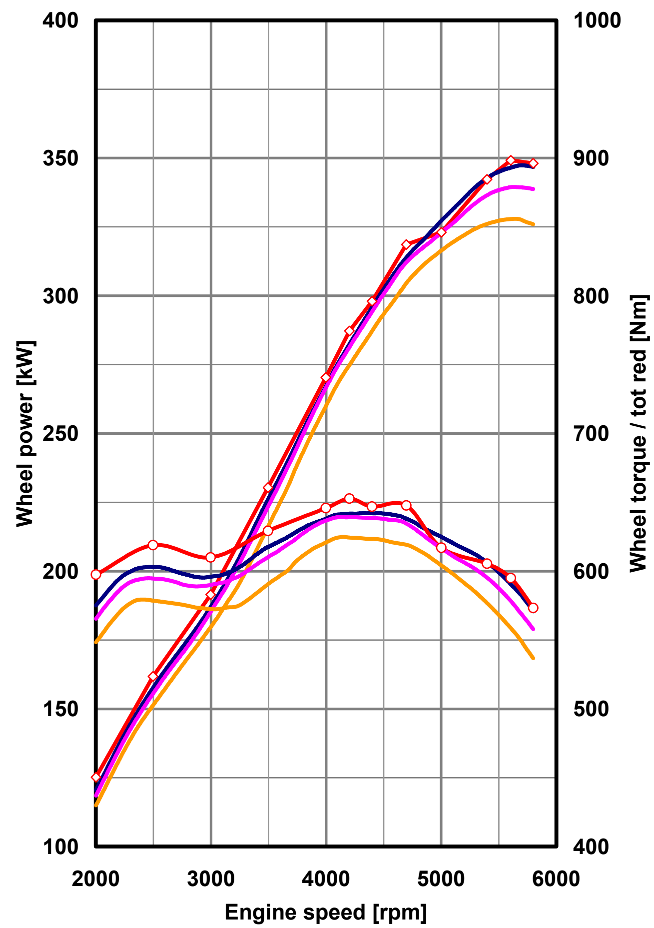
Steady Rate tests at different rates

Comments

Higher steady rates will result in less power available to the wheels.

The difference between 300 and 500 rpm/s indicates that there is a potential to improve the result at 300 rpm/s rate.



5 sec @ Gear 4

300 rpm/s @ Gear 4

500 rpm/s @ Gear 4

700 rpm/s @ Gear 4

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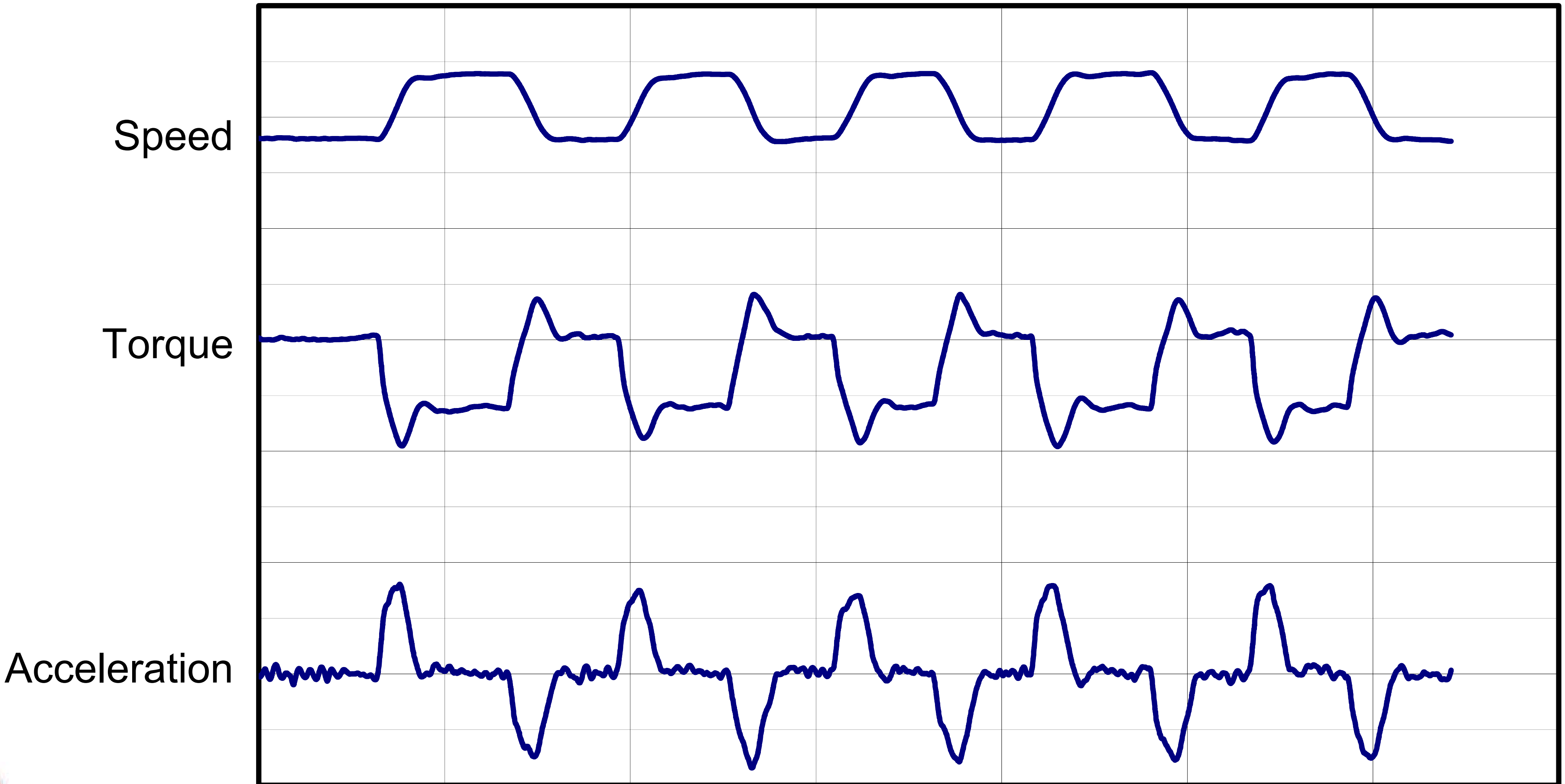
How to measure Powertrain Inertia



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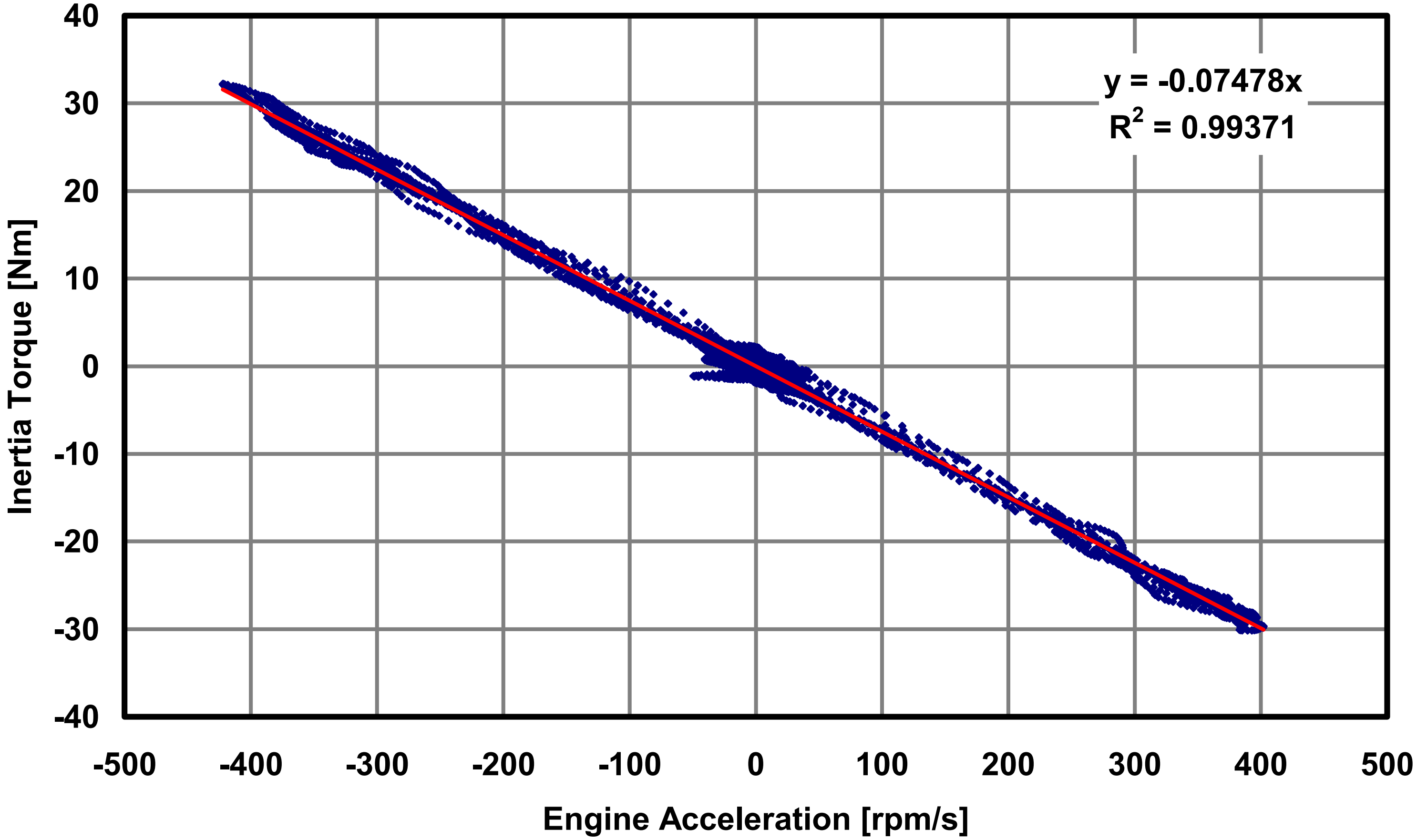
Variation of Torque due to Inertia



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Measured Powertrain Inertia

Gear	Inertia [kgm^2]
4	0.71
5	0.76

(Measured inertia is related to engine)

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Evaluating Steady Rate Results

- Normal transmission losses are presumably not dependant of the sweep rate.
- Results from different sweep rates should only be effected by inertia and engine performance.
- If the inertia is known the results of different steady rates can be compensated and compared to eachother.

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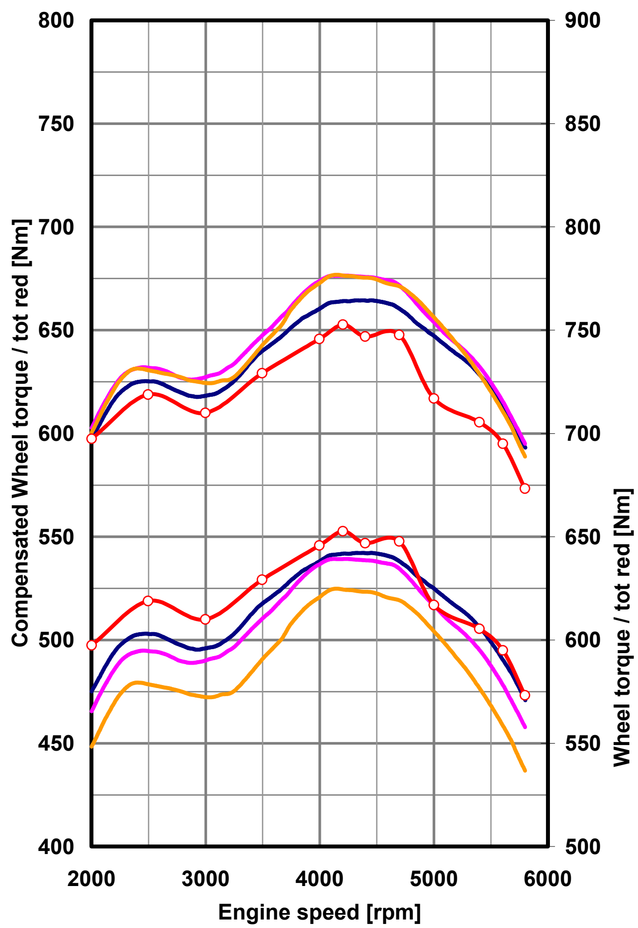
Evaluating Steady Rate Results

Comments

Compensation of inertia shows that the engine is producing about the same on the two faster rates but lower on the slower rate.

The steady state test is producing the least.

This is of course only valid for this specific vehicle!



5 sec @ Gear 4

300 rpm/s @ Gear 4

500 rpm/s @ Gear 4

700 rpm/s @ Gear 4

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Summary

- Normal steady state tests shows basic information
- Tests at different rates of acceleration will show more relevant information about the performance in real situations
- Test results from different rates of acceleration can be compared when the inertia is known

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