Automatic Driving Robot for Improving the Efficiency of RDE Testing

Contents

EXECUTIVE SUMMARY

Increasing vehicle product development effectiveness is imperative for the automotive industry. Environmental regulations are becoming stricter, new technologies such as electrification, autonomy and connectivity require new skills, and traditional vehicle systems need more efficient development approaches.

To address some of these challenges posed by ever increasing amounts of work it is necessary to standardize and automate processes to achieve product validation and verification with the same or fewer resources.

The ADS EVO driving robot helps address some of these challenges by substantially reducing the driver input variability - enabling vehicle development teams to focus on the job at hand.

INTRODUCTION

The automotive industry is undergoing a major transformation with new technological trends referred to as Connected, Autonomous, Shared & Services, Electric (CASE). These trends require new development approaches and the optimization of complex systems in the same or shorter timeframes. It is also necessary to balance this against the need to comply with stricter environmental regulations and take into consideration the Real Driving Emissions (RDE) test requirements. In addition, the investment decisions made today must also factor in future regulatory developments and be future proofed to ensure high utilization.

ISSUES IN RDE REGULATIONS

Meeting RDE Regulatory Requirements are Onerous and Require Coordination

Environmental regulations for vehicles have been enforced for various purposes, including improving air pollution and combating global warming since their introduction around 1970. Traditionally, emissions were measured by driving a vehicle on a chassis dyno in a test cell over a specific sequence. This method is characterized by testing conditions which are uniform and therefore consistent. In Europe before 2017 this test protocol was the New European Driving Cycle (NEDC).

In 2011, it was discovered that there was a discrepancy in the measurement of NOx emissions between the chassis dyno testing and on-road driving testing of diesel vehicles. This raised concerns about the extent to which on-road tests were able to reflect the emissions of this driving. It led to the consideration of new regulations that were strongly aligned toward actual driving. The United Nations Economic Commission for Europe (UNECE) introduced a new chassis-based test protocol called the Worldwide Harmonized Light Vehicle Testing Procedure (WLTP) as well as a test for on-road real driving conditions called RDE.

The intention for both of these protocols is to verify that legislative caps for pollutants are not exceeded under use in the real world by making the test criteria more representative of the real modern driving conditions. In 2017, WLTP and RDE regulations began in Europe. Other countries, for example, Japan, China, India, South Korea and Brazil, are planning their introductions either in full, in part or modified.

RDE testing has a similar set of testing requirements to WLTP to ensure that it is a viable certification test (Fig.1). However, the operating range of RDE testing is much wider than the WLTP laboratory test.

RDE Requirements

Urban	Rural	Motorway
Minimum Distance 16 km	Minimum Distance 16 km	Minimum Distance 16 km
Composition 29 to 44%	Composition 23 to 43%	Composition 23 to 43%
Speed ≥ 60 km/h	Speed 60 to 90 km/h	Speed 90 to 145 km/h

The Trip Duration 90 to 120 minutes
Various other requirements such as altitude and temperature

Pollutants : NOx, PN (, CO*) *CO emissions shall be measured and recorded at RDE tests.

Figure 1 – Overview of RDE test (EU)

Both protocols use the same emissions limits, but the difference is that RDE uses conformity factors (CF) to take into account certain measurement inaccuracies due to the nature of measuring on the road with the Portable Emissions Measurement System (PEMS) equipment as well as the influence of the PEMS equipment itself on the vehicle being tested. From 2017 (Phase 1 of RDE), the CF was set at 2.1 - this meant that a vehicle may initially emit 2.1 times as much as it does when tested under laboratory conditions. In future, it is expected that this margin, together with the emissions development targets themselves, will be decreased. This will add pressure to reduce the tolerances in the development (Fig.2).

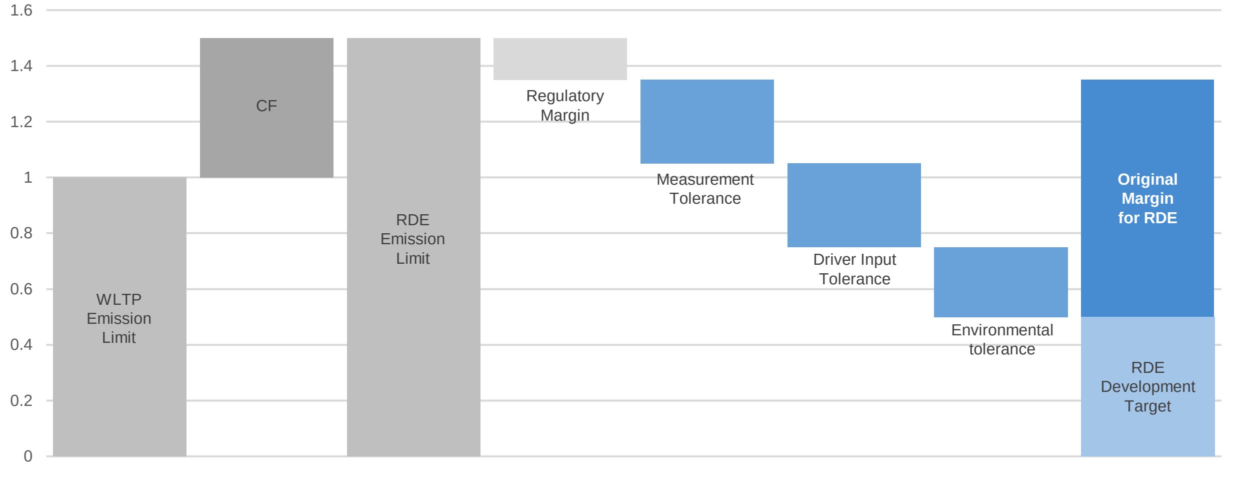

Figure 2 – Illustration of how the conformity factors and development tolerances relate to one another

Issues with Using a Chassis Dyno for Reproducing RDE Tests

Compliance with both WLTP and RDE regulations requires the development of vehicle systems and emissions strategies which are much more comprehensive and robust than in the past. In order to achieve this, it's critical that development work is done in the most representative way possible whilst keeping costs under control.

One way of doing this is to replicate on-road testing on a chassis dyno. Testing can be done quickly, repeatedly and without the impact of external environmental factors such as traffic and weather conditions. This in theory allows for a reduction in variables so engineers can focus on development work and resolving issues quickly.

However, there are several issues to overcome in order to make chassis dynos a viable option for emissions development. Focusing on RDE, since this has a wider testing scope, it's important to consider all of the factors which create variability. An RDE test takes between 90 and 120 minutes and requires many conditions to be met in order to achieve a successful test. In addition to this, there are effects of the driver input which, during a chassis test, needs to follow a predetermined profile. This is harder to do than achieving acceleration and speed targets as required on an real world RDE test. Finally, the environmental factors need to be replicated. HORIBA has the MEDAS system to address this. (Learn more about MEDAS).

Calibration workflows typically require multiple long runs as well as shorter runs in order to investigate specific issues. Repeatability and achieving successful test completions are critical to understanding the impact that system improvements and calibration changes have on a vehicle's emissions and fuel economy. This ability to reduce some variables leads to more confidence in assessing the gap from where the design currently is to successfully comply with the regulations.

With regards to the act of driving a vehicle on a dyno, there is a requirement to adhere to the speed profile measured on the road. This requires complicated accelerator control compared with conventional chassis testing and gives rise to the driver input tolerance. Additionally, although accelerator control is necessary for gradient mode, it is very difficult to achieve the correct gradient in practice and therefore it is a major challenge to reproduce it. "HORIBA Torque Matching Road-to-Rig" addresses this issue by using a patented torque matching technique for load reproduction. (Learn more about Torque Matching Road-to-Rig)

IMPROVING THE EFFECTIVENESS OF VEHICLE DEVELOPMENT WITH THE ADS EVO

Achieving the required emissions reduction system performance and engine calibration to meet RDE regulations can be achieved on a chassis dyno but requires long and highly complex real world driving scenarios to be reproduced many times with high accuracy.

The ADS EVO automates the act of driving on a chassis dynamometer accurately. It reduces the number of tests needed due to its high traceability and repeatability. In addition, combining the ADS EVO with HORIBA's Road to Rig solution Torque Matching enables an even more efficient and accurate reproduction of RDE test scenarios on the chassis dyno. Torque Matching and the ADS EVO together help improve the emissions development workflow by using a patented torque matching technique for load reproduction (Fig.3). This approach removes the need for several assumptions and is a simple and intuitive approach to replication.

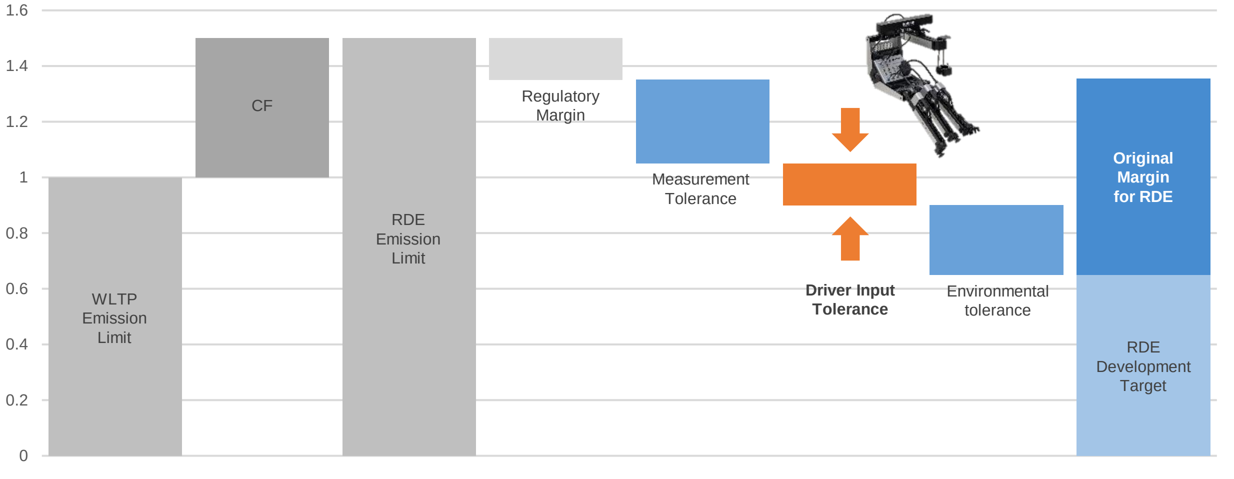

Figure 3 – Illustration of how the ADS EVO contributes reducing the driver input tolerance

In addition, HORIBA has significantly improved the installation and setup of the ADS EVO over the previous generation by reducing the weight of each unit to less than 8 kg, making the assembly quicker and enhancing the self-learning feature. This improves test laboratory efficiency by allowing quicker vehicle changes and test preparation. It's high repeatability and the fact that setup settings can be saved, means that test variability due to differences in test laboratories around the world can be minimized. It also has a flexible system architecture that allows for future expansion, allowing for flexible vehicle and test configurations.

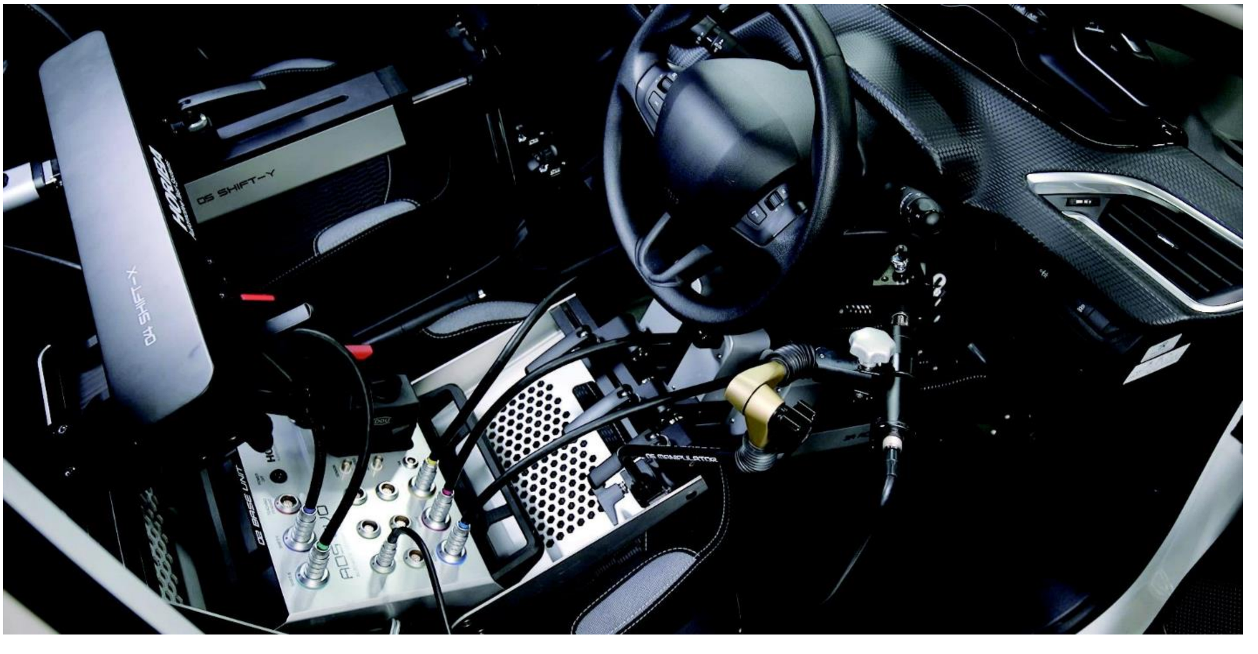

Figure 4 – ADS EVO mounted on driver seat

SUMMARY

Vehicle development requirements are increasing due to the diversification of power sources, stricter environmental regulations, and the increasing complexity of systems. It is imperative for manufacturers of complete vehicles and related industries to develop vehicles efficiently. As mentioned above, conventional vehicle testing methods are facing various challenges to improve efficiency, such as the increase in development effort due to the lengthening of duration time and the increase in the number of tests to compare and average results. HORIBA's robot driver, the ADS EVO is a driving robot with excellent accuracy, repeatability, and easy installation. It contributes to the effectiveness of customers' vehicle development.

Learn more about the ADS EVO
https://www.horiba.com/en_en/products/detail/action/show/Product/ads-evo-1994/

HORIBA

Headquartered in Kyoto, Japan, the HORIBA Group is a global leading supplier of measurement technology and systems for various fields from automotive testing, process and environmental monitoring, in-vitro medical diagnostics, semiconductor manufacturing and metrology to scientific R&D and QC measurements.

ASIA

HORIBA Ltd.
2 Miyanohigashi
Kisshoin Minami-ku
Kyoto, Japan

EUROPE

HORIBA Europe GmbH
Hans-Mess-Straβe 6
61440 Oberursel
Germany

THE AMERICAS

HORIBA Instruments Inc.
5900 Hines Drive
Ann Arbor, MI 48108
USA