

# HORIBA

**RDE** 

**SMART SOLUTIONS  
FOR CLEANER AIR**



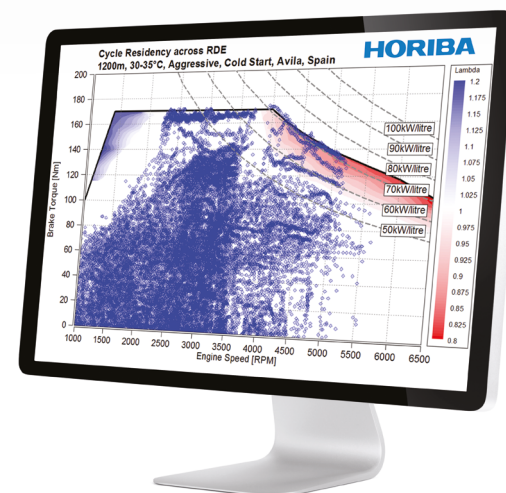
## THE CHALLENGE

The introduction and anticipation of stringent new real driving emissions (RDE) regulations, coupled with the proliferation of increasingly complex electrified propulsion solutions, has led to a situation that is severely disrupting new product introduction processes.

Developing vehicles that meet emissions and efficiency targets for real-world conditions adds development time, cost and complexity with increasing numbers of prototypes and real-world based validation.

As the number of powertrain variants increases rapidly due to demand for new hybrid systems, the level of investment available is reducing due to the demands of electrification and connected-autonomous systems.

How can manufacturers be certain that their products will comply for a lifetime? How can these products be brought to market more quickly, with higher confidence and lower development cost? How can OEMs and Tier 1s do more for less? **This is The Challenge.**



## WHAT IS RDE+?

To meet the challenge, HORIBA offers you RDE+. A rapid, robust, integrated process and toolchain to deliver design, development, validation and verification with optimum efficiency.

Connecting new virtual tools that model the environment and vehicle systems to HORIBA lab equipment, real-world test conditions are replicated, emulated and brought into the lab.

Delivering faster and more efficient development and validation of powertrains for RDE compliance, RDE+ reduces the need for prototype hardware and testing in the real-world.

RDE+ will reduce development and validation time and cost by using:

- » Rapid accurate and efficient lab testing
- » Hardware-in-the-loop with simulation
- » Scenario-based development

RDE+ can save up to \$17M USD on a vehicle programme by reducing the number of vehicle prototypes required for testing\*.

\*Report by Frost & Sullivan: Real-World Driving Emissions  
– The Future of Powertrain Engineering and Development, 2020

## RDE+ VIRTUAL

## RDE+ POWER

## RDE+ CHASSIS

## RDE+ ROAD



### RDE+ VIRTUAL

This application links a plethora of virtual tools to HORIBA's portfolio of hardware and test automation software.

This model-based approach allows 'front-loading' and more accurate and robust target setting within the early phases of a product development programme. Virtual environments and vehicles can be used to follow a scenario-based development methodology that develops and validates system hardware-in-the-loop (HiL) with virtual-based vehicle systems, environments and RDE scenarios.

Use of virtual vehicles and environments for validation eliminates the need for hardware and expensive environmental road testing, leading to increased confidence in the design. This allows safer and earlier decisions to be made in the vehicle development programme, resulting in huge time and cost savings.



### RDE+ POWER

This application links road-based RDE tests to the propulsion lab.

Using HORIBA STARS automation software and DYNAS powertrain dynos, vehicle tests can be replicated accurately. RDE environment emulation is achieved by a HORIBA MEDAS system which delivers a faithful reproduction of an entire RDE test or partial RDE scenario.

The RDE+ propulsion lab can run RDE tests an order of magnitude faster than on-road testing. Superior accuracy, repeatability and reliability allow RDE development to progress with increased efficiency.

HiL approaches allow virtually generated vehicles and RDE scenarios to be played out on the powertrain hardware. This delivers further time and cost savings to the vehicle programme and allows for earlier validation of powertrain systems.



### RDE+ CHASSIS

This application links road-based RDE tests to the chassis lab.

RDE+ CHASSIS delivers time and cost savings by reducing vehicle prototypes, road testing and seasonal delays.

Using HORIBA STARS automation software and VULCAN chassis-dyno hardware, whole-vehicle RDE tests can be replicated accurately with superior repeatability.

RDE tests can be faithfully emulated, enabling rapid development and validation of whole-vehicle systems and calibrations. This approach eliminates the need for seasonally dependent environmental testing.

HiL approaches allow virtually generated RDE scenarios to be driven by whole vehicles.



### RDE+ ROAD

This application uplifts the process of delivering RDE tests for validation, verification and certification.

The application generates RDE data from real-world testing that can be used throughout the development cycle from concept through to certification.

Test success rates and efficiency are pushed to over 90% by RDE CoDriver, the app-based driver's aid that gives the tester access to real-time feedback.

Information is post-processed and transferred from the road test to the lab automation systems, ready for accurate RDE test replication.

Getting RDE testing right first time reduces programme time and cost and reduces the number of vehicle prototypes.

This application links a plethora of virtual tools to HORIBA's portfolio of hardware and test automation software.

## BENEFITS

### Time and Cost Savings from Programme Front-Loading

- » Early development and optimisation of prototype propulsion and vehicles
- » Early data to support advanced design freeze
- » Reduction in prototype hardware required

### Advantages of Scenario-Based Development

- » Early programme running of scenarios for future legislation
- » Identification of worst-case RDE scenarios for robust validation

### Model-Based Development – Virtual Calibration

- » Explore more of the design space, more effectively
- » Rapid optimisation based on accurate response measurements
- » Rapid optimisation of control systems

## DEVELOPMENT IN THE VIRTUAL WORLD

### Creation of the Virtual World

Real or virtually generated RDE tests and scenarios can be modelled, including environment, traffic and driver behaviour.

### Digital Twin Vehicle

Ego vehicle model can be driven in the Virtual World to rapidly determine worse-case RDE scenarios and the impact of system optimisation of RDE attributes.



## CONNECTING REAL AND VIRTUAL WORLDS

### Hardware-in-the-Loop (HiL)

Connecting hardware (engines, powertrain, e-machines) to the virtual domain delivers tangible measurements from simulated scenarios.

### Model-in-the-Loop (MiL)

Incorporating accurate attribute response models within the virtual domain enables office-based optimisation of power system attributes and calibrations.





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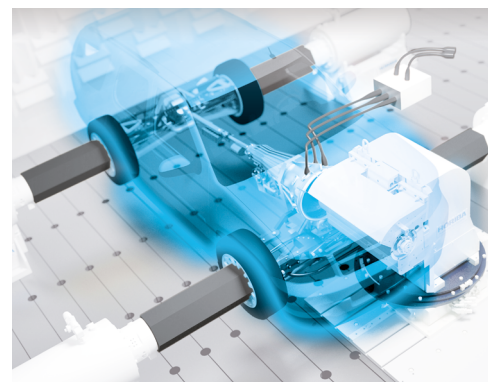
## BENEFITS

### Time and Cost Savings

- » More accurate and reliable data promotes earlier and safer decision-making
- » Higher productivity – propulsion testing is faster, more productive and lower cost than chassis testing
- » Test can be run more quickly, back to back, and automated
- » Eliminate delays – environmental testing is decoupled from natural seasons
- » Fewer vehicle prototypes required

### Confidence and Accuracy Improvements

- » Precision lab testing to evaluate and develop components, systems, calibrations and fuels and lubes on the powertrain early in the programme
- » Evaluate changes over real measured RDE test cycles
- » Higher repeatability – run sections of tests over and over
- » Higher accuracy and repeatability reduces error margins in attribute targets



## RELIABILITY OF THE AUTOMATED LABORATORY

### Accuracy and Repeatability

Accurate and repeatable measurement of the effects of RDE scenarios enables rapid and robust power system development and calibration optimisation with very low margins of error.

### Acceleration of Development and Validation

Automated and remote-operating systems deliver faster and more productive testing with higher efficiency and lower operational costs and resources.

## EMULATION OF THE REAL WORLD

### Delivering the Right Atmosphere

The HORIBA Multi-Functional Dynamic Altitude Simulator (MEDAS) system instantaneously supplies the correct atmospheric conditions to the power system.

### Complete RDE Emulation

Combining MEDAS with HORIBA DYNAS power system dynamometers and STARS controllers, complete RDE road tests from the real or virtual worlds can be accurately emulated.







This application links road-based RDE tests to the chassis lab.

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## BENEFITS

### Cost and Operational Benefits of Torque-Matching Method

- » No need to take complex vehicle measurements over RDE test
- » Lower cost, efficient replication of RDE tests
- » Easy RDE emulation for vehicle development and validation

### Advantages for Vehicle Emissions Development

- » Rapid generation of rig-based RDE tests for prototype vehicles
- » Shortened development and validation timescales
- » Accelerated durability/degradation test deterioration factors from real-world driving
- » Highly repeatable real-world testing with altitude and environment in the lab

### Reduced Requirement for In-field Environmental Testing

- » Reduced cost of road trips, travel and transportation
- » Reduced number of prototype vehicles required
- » De-coupling of the development testing programme from seasonal timing
- » Repeatable environmental testing in the lab

## EASY ROAD-TO-RIG

### HORIBA's "Torque Matching" App (Patent Pending)

Simple and easy RDE route capture with novel chassis-dyno control, delivers high fidelity replication of the RDE test.

### Seamless Data Capture and Transfer

STARS Enterprise cloud-based applications enable automated data capture from the HORIBA OBS-ONE PEMS, post-processing and transmission to STARS VETS for immediate RDE replication on the VULCAN chassis-dyno.



## ACCURATE REPEATABLE RDE REPLICATION

### HORIBA's ADS EVO Automatic Driving System

To reliably develop and validate vehicle systems and calibrations, the matching of pedal positions and vehicle speed over the full RDE test is achieved by the ADS EVO time after time.

### Complete RDE Environment Replication

The HORIBA Multi-Functional Dynamic Altitude Simulator (MEDAS) system instantaneously supplies the correct atmospheric conditions to the vehicle under the control of STARS VETS.



This application links road-based RDE tests to the chassis lab.

## BENEFITS

### Time and Cost Savings from Improved Productivity

- » More efficient programme planning
- » Increased resource utilisation
- » CoDriver driver's aid gives real-time feedback on RDE metrics to ensure that test criteria are met on the road
- » Increased RDE road test success rate to over 90%
- » Higher facility throughput and PEMS utilisation

### Confidence, Robustness and Accuracy Improvements

- » Automated data capture and seamless transfer to HORIBA VETS for Road-to-Rig RDE replication in the lab
- » Improved governance, traceability and data recall
- » Better accuracy with new exhaust flow measurement systems
- » Better correlation with the lab



## SUCCESSFUL RDE ROAD TESTS

### HORIBA's RDE CoDriver™ Application

The easy-to-use CoDriver app reports RDE test metrics to the driver in real-time allowing in-test adjustments to route and driving style to ensure a valid test every time.

### Increased Productivity

High rates of success can double productivity and PEMS utilisation, minimising wasted time and costs.

## DATA RESILIENCE AND SECURITY

### STARS Enterprise RDE Application

Data captured by HORIBA OBS-ONE PEMS Weather Station and vehicle CAN interfaces can be uploaded onto cloud-based Enterprise servers where it is stored securely, post-processed automatically and transmitted onwards to other RDE+applications for RDE replication.







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