

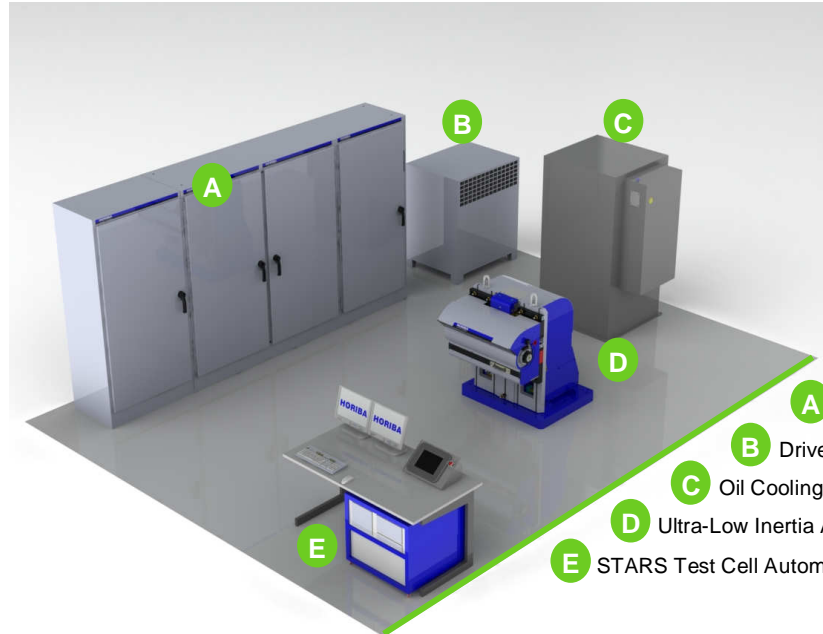
A Complete Hardware-in-the-Loop (HIL) Driveline Test System Featuring Advanced Engine Simulation

Shorten the Product Launch Cycle

- Use production-intent engine performance characteristics early in the development cycle.
- Eliminate invalid tests due to incorrect engine calibration.
- Easily connect and test any type of transmission as if it were installed in a real vehicle.
 - FWD and RWD
 - Right-hand and left-hand output shafts
 - HEV, DCT, CVT, manual, and automatic
- Improve test repeatability with predictable, controlled "engine" performance.

Increase Test Cell Efficiency

- Quickly set up single cylinder to V16 "engines" of different fuel types and displacements to get different torque signatures.
- Test transmissions of varying sizes (with inertia values up to 0.5 kgm²).
- Eliminate frustration and costs associated with fueled engines:
 - No fuel handling
 - No exhaust extraction
 - No engine calibration
 - No bolt-up headaches



Virtual Engine uses advanced software control and a specialized AC dynamometer to accurately simulate IC engine performance.

- A** SPARC Controller and Drive Cabinets
- B** Drive Transformer
- C** Oil Cooling/Conditioning Unit
- D** Ultra-Low Inertia AC Dynamometer
- E** STARS Test Cell Automation System

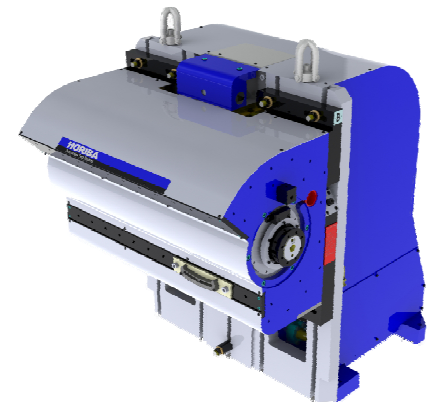
Expect Excellent Correlation to ICEs

Virtual Engine accurately replicates the torque signature of an internal combustion engine (ICE) using real-time closed loop feedback with adaptive control algorithms. The closed-loop adaptive controls compensate for:

- Mismatch between real engine inertia and input dynamometer inertia
- Mechanical dynamics due to specimen and attachment properties
- Electro-mechanical conversion of energy at different torque levels and speed

Reduce Capital and Operational Costs

- Eliminate costly and labor-intensive prototype engines prior to test start up
- No engine cooling requirement
- No fuel, oil, filters or labor for engine maintenance





Virtual Engine

Three-Part Solution for Driveline Development and Validation *without* a Fueled Engine

1 Advanced Simulation Software

Advanced, torque-control based, real time model of ICE. Provides 48 engine orders, closed loop torque correction in amplitude and frequency, and correction for friction loss. Includes simulation of engine torque management schemes for driving and operating events. Generates CAN bus messages and/or special pulse train signals to satisfy any power train control unit.



Engine Controls Simulation (ECS)

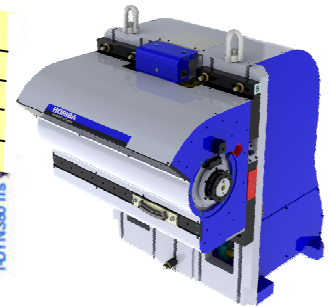
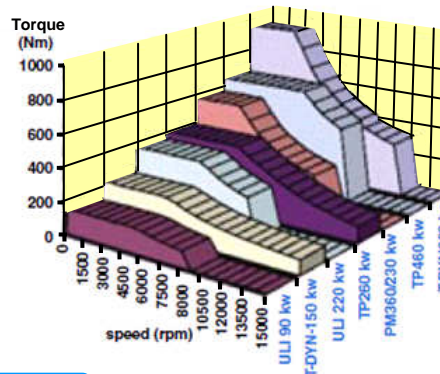
- Altitude affects, Fuel cutoff
- Variable displacement
- Accessory load variations
- Electronic throttle
- Torque intervention schemes
- Engine start / stop strategy
- Timing & Position Pulse Train

Torque Pulsation Simulation

- Torque from combustion pressure
- Piston bore, inertia, # of cylinders, stroke
- Mean torque by special "rotating" filter
- Angular Acceleration on FEAD
- Engine friction
- Engine flywheel inertia

2 Ultra-Low Inertia AC Dynamometer

HORIBA's TP-series high performance AC dynamometers produce high torque and acceleration rates of 50k rpm/sec for gasoline and 20k rpm/sec for diesel. It also features extremely small motor diameters, allowing a production half shaft connection for FWD transmissions.



3 Mechanical Support

HORIBA's Virtual Engine System offers superior mechanical support components engineered to withstand the rigorous requirements of transmission development and durability testing. The dynamometer headstand offers superb flexibility, quickly accommodating different transmissions at mounting angles that match in-vehicle installations.

Transmission Fixture Interface



Intermediate Bearing Support



± 90° Rotation, ± 7° Tilting