intertek ev GLOBAL CENTRE OF EXCELLENCE

intertek
Total Quality. Assured.

INTERTEK'S

ELECTRIC VEHICLE TOTAL SOLUTIONS

End-to-end testing and consultancy services for electric vehicle manufacturers and suppliers

CONTENTS

Our electric vehicle solutions for a changing world.

Across the world, from consumers to manufacturers and governments, the adoption of green technologies is changing the way we live our lives and operate our businesses. For automotive manufacturers, this brings seismic shifts in electrification technologies to not only meet government legislation but also appeal to ever-changing consumer demands at the rapid speeds at which the market is transitioning.

Intertek, a leading global Total Quality Assurance provider to industries worldwide, is dedicated to partnering with automotive manufacturers to drive innovation and champion the cutting edge green technologies.

Our UK capabilities

With an existing powertrain testing laboratory in Milton Keynes, which has achieved a number of industry firsts, Intertek has developed a new Global EV Testing Centre of Excellence at a nearby secondary location. This new facility provides additional capacity and capabilities, significantly enhancing our offering for customers in the automotive sector, placing us at the forefront of the industry for electric vehicle (EV) powertrain testing capabilities.

Our Milton Keynes testing facilities encompass services for: motors, inverters, axle modules, all on-board vehicle electrical systems and complete electric vehicle testing. Our state-of-the-art UK testing facilities allow us to support the diverse range of customers we are currently partnered with, providing testing and consultation services through our world-class facilities and extensive in-house EV testing expertise.

Our Milton Keynes facilities provide automotive manufacturers a one-stop-shop to test their automotive products to the pinnacle of EV testing capabilities.

Electrification driveline technology solutions

One of the challenges with the development of any new technology is the range of expertise required to make it ready for volume production. In a relatively new field such as EV powertrain, some of these requirements may be unscheduled, required to answer questions revealed by testing but without time in an already hard-pressed programme.

The ability to deliver high-quality insights that accurately reflect real world usage is partnered with a focus on accelerating the development process. The new facility is structured for remote set-up so test cells can achieve very fast turnaround, and a high level of automation is specified to allow safe 24/7 operation. Because electrification technology is evolving so quickly, with many questions as yet undefined, we offer consultation from the design stage, combined with substantial in-house design and build capability so that rigs can be quickly modified, or all new rigs designed and built, to allow new areas of investigation.

Formula E solutions

Intertek's new Global EV Testing Centre of Excellence provides precision testing of next-generation electric powertrains. The new centre is designed from the ground-up to answer the most challenging questions faced by engineers working at the highest levels of electric motorsport. Experience in Formula E already ranges from delivering component-level insights through to e-Motor and eAxle development testing, providing the high resolution analysis of end-to-end efficiency that allows important but subtle optimisation of hardware, software and race strategy. With the introduction of front axle regeneration, even higher speed MGUs and pitstop recharging, Formula E clients are planning to take full advantage of the next-generation facilities currently being installed.

Our dedication to you

At Intertek, we understand the demand and fast-paced nature of automotive industry. Our dedication to our customers goes beyond our state-of-the-art testing technologies or expert engineers. We provide our customers with 24/7, year-round solutions to ensure you not only meet your project deadlines but we're on-hand to adjust test set-up to meet your exact needs and requirements.

Our facilities are also built with our customers in mind. We provide your engineers a dedicated workspace at both our Davy Avenue and Tanners Drive facility to ensure you're able to be on-site throughout the duration of the project and have a private area dedicated to your company.

European EV market report

Over the last few years, the manufacturing and consumer uptake of electric vehicles has risen rapidly. Although the COVID-19 pandemic has caused widespread delays across the automotive industry, EV is still poised to be the largest growth area.

In our market insight report, we explore the following topics relating to the development of electric vehicles across the European market:

- Overview of the EV market 2020 road map
- Policy and regulation
- Consumer sentiment
- OEM strategy
- Corporate company roles
- Economic recovery plans
- And more.

For your complimentary copy of our market report, click here to download it or contact our team at TT-UKinfo@intertek.com.

ELECTRIC VEHICLE TOTAL SOLUTIONS

e-Machine dyno test cells

Our UK facilities are the largest independent test centres in the UK, offering in-depth expertise supported by state-of-the-art test equipment. Combined with our 24/7 year-round operation, our teams of in-house engineers deliver flexible testing solutions for our customers. These unique testing facilities provide manufacturers with the latest industry-leading testing technologies for electric vehicles, featuring:

- High speed capabilities (up to 27,000 rpm direct drive)
- High power dynos (up to 500 kW)
- In-house rig design capabilities
- High data-quality and minimal downtime
- Rapid set-up and device under test (DUT)/ unit under test (UUT) swap-over capabilities

Direct drive, low inertia dynos permit high transient drive-cycle testing of simulated real world driving.

27,000 RPM E-MACHINE
Fastest e-Machine dyno in Europe

For this reason, direct drive e-machine dynamometers are preferred; a technology that Intertek has been driving forward with its test system suppliers.

Test cases

- e-Motor performance & EU Reg.85 power certification – up to 27,000 rpm / 500 kW
- e-Motor thermal surveys and de-rating software development
- e-Motor efficiency mapping
- Inverter software development
- Inverter calibration optimisation
- Thermal performance (climatic hood with -40°C to 85°C capability)

As with all automotive test operations, these must be explored across all likely operating conditions, from extreme heat to extreme cold, dust, salt, vibration and driver abuse.

A further complication is the range of vibrations to which e-machines are subjected when implemented within a hybrid powertrain. Even within an EV, the location of each system will substantially change the input profiles.

Our environmental testing capability includes:

- Dust tests (up to 3.5 m³)
  - EN 60529 – Talcum dust
  - ISO20653 or ISO 16750-4:2010 – Arizona A2 dust
- High pressure steam
  - ISO 20653:2013
  - IPx9K
- Mechanical shock (climatic option)
  - Wide selection of shakers available
  - Up to 180g shock
  - Sine; Random also available
- Salt spray (950 L or 6 m³)
  - ISO 6270-2, ISO 9227, EN 60068-2-11, ISO 6988
  - SO_2 testing, Condensation water testing

27,000 rpm 290 kW e-Machine dyno cell

Cell specification

Cell size specification (W x D x H):

- Cell: 3.17 x 7.65 x 2.67 m
- Control Room: Remote control room
- Cell Loading Door (W x H): 2.42 x 2.67 m

Dyno specification

Low inertia PM motor – direct drive dynamometer

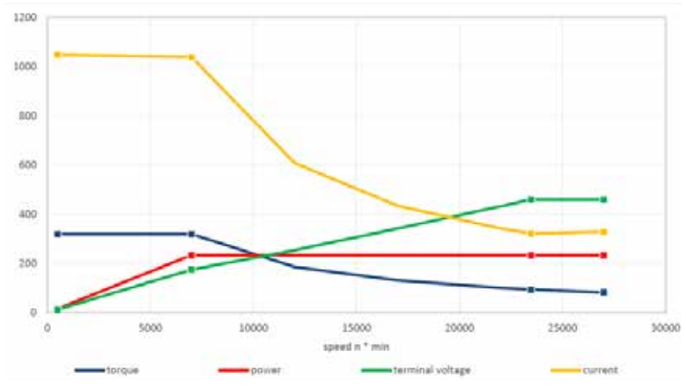
- Nominal Power: 234 kW @ 7,000 rpm
- Peak Power: 293 kW @ 7,000 rpm
- Nominal Torque: 320 Nm @ 7,000 rpm
- Peak Torque: 400 Nm @ 7,000 rpm
- Nominal Speed: 7,000 rpm
- Max. Continuous Speed: 27,000 rpm
- Overload Capability: 125% for 10 seconds every 10 minutes

Torque meter specification

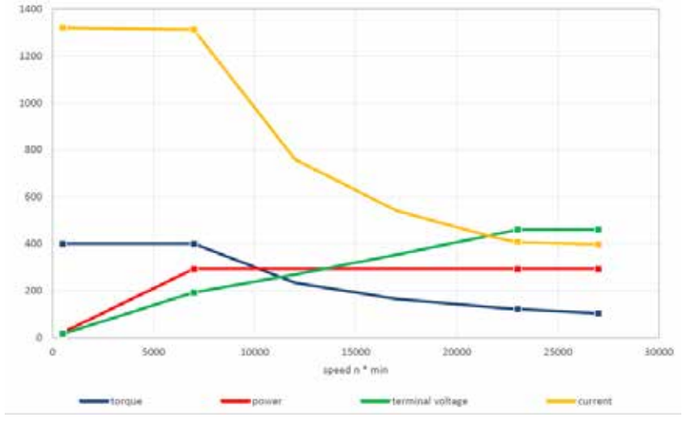
- Range: 0 – 1,000 Nm
- Accuracy: < ±0.05%

Cell 103
e-Machine dyno

Nominal power curve



Overload power curve



Battery emulator

- Nominal Power: 400 kW
- Peak Power: 480 kW
- Voltage: 0 – 1,100 Vdc
- Nominal Current: 1,000 A
- Peak Current: 1,200 A
- Current T90 slew rate: > 300 kA/s
- Overload Capability: 120% for 60 seconds every 5 minutes
- Measurement Accuracy: ±0.05% of full scale
- Resolution: 16 Bit

Power analyser

- Max Voltage - 1,100V RMS
- Max Current - 1,200A RMS
- Up to 6 Phases + DC available
- Fundamental Frequency: 0.1 Hz to 300 kHz
- Max Harmonic Order: Up to 500th Order
- Sample rate = 2 M samples/s

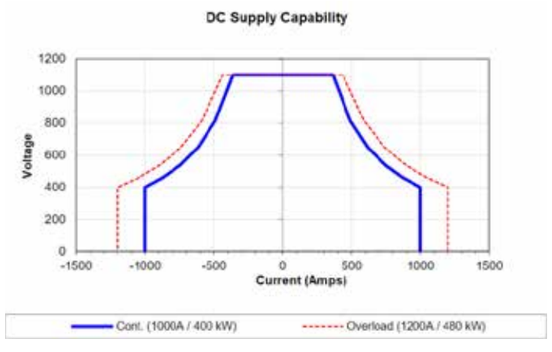
VOLTAGE (V)	CURRENT (A)	POWER (kW)
50	1,000	50
400	1,000	400
1,000	400	400

Fluid conditioning

Three fluid conditioning circuits are provided in each test cell,

- Temperature Range: -30 to +150°C
- Flow Rate: up to 60L/minute
- Cooling Medium: Water/Glycol or. Oil
- Control: Automation System

Battery emulator power curve



IO specification

IO Requirements are as follows:

IO SPECIFICATION	LOGGING RATE
Shaft Speed 0 - 30,000 rpm	200 Hz
Torque ±500 Nm 0.05% accuracy	2 kHz
8x K-type thermocouple's	2 Hz
8x PT100's	2 Hz
8x +-10 V differential inputs	200 Hz
8x Digital inputs	10 Hz
8x Digital outputs	10 Hz
8x +-10V Analogue outputs	10 Hz
2x Flow meter 0-20 lpm	2 Hz
2x CAN busses	1 kHz
1x Flexray Bus	1 kHz
ELECTRICAL POWER MEASUREMENT	
3x Phase voltage 1,000 V	500 kHz
3x Phase current 1,000 A	500 kHz
1x DC voltage 1,000 V	50 kHz
1x DC current 1,000 A	50 kHz

20,000 rpm 500 kW e-Machine dyno cell

Cell specification

Cell size specification (W x D x H):

- Cell: 7.65 x 3.17 x 2.67 m
- Control Room: Remote control room
- Cell Loading Door (W x H): 2.42 x 2.67 m

Dyno specification

Low inertia PM motor – direct drive dynamometer

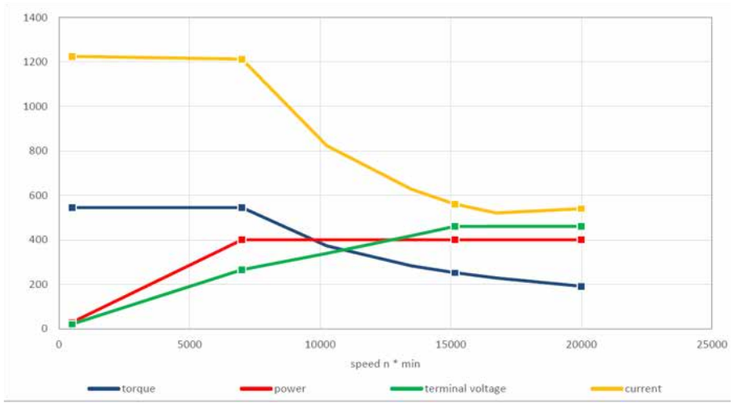
- Nominal Power: 400 kW @ 7,000 rpm
- Peak Power: 500 kW @ 7,000 rpm
- Nominal Torque: 545 Nm @ 7,000 rpm
- Peak Torque: 681 Nm @ 7,000 rpm
- Nominal Speed: 7,000 rpm
- Max. Continuous Speed: 20,000 rpm
- Overload Capability: 125% for 10 seconds every 10 minutes

VOLTAGE (V)	CURRENT (A)	POWER (kW)
50	1,000	50
400	1,000	400
1,000	400	400

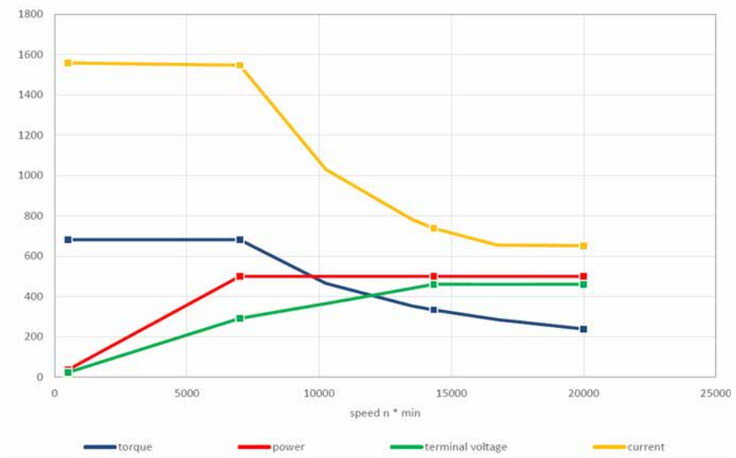
Torque meter specification

- Range: 0 – 1,000 Nm
- Accuracy: < ±0.5%

Nominal power curve



Overload power curve



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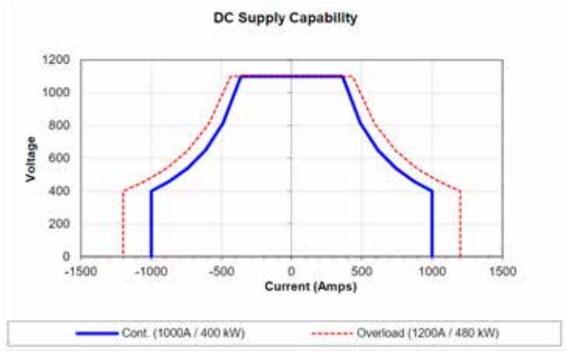
- Overload Capability: 120% for 60 seconds every 5 minutes
- Measurement Accuracy: ±0.05% of full scale
- Resolution: 16 Bit

Fluid conditioning

Three fluid conditioning circuits are provided in each test cell,

- Temperature Range: -30 to +150°C
- Flow Rate: up to 60 L/minute
- Cooling Medium: Water/Glycol or. Oil
- Control: Automation System

Battery emulator power curve



Power analyser

- Max Voltage - 1,100 V RMS
- Max Current - 1,200 A RMS
- Up to 6 Phases + DC available
- Fundamental Frequency: 0.1 Hz to 300 kHz
- Max Harmonic Order: Up to 500th Order
- Sample rate = 2 M samples/s

IO specification

IO Requirements are as follows:

IO SPECIFICATION	LOGGING RATE
Shaft Speed 0 - 30,000 rpm	200 Hz
Torque ±500 Nm 0.05% accuracy	2 kHz
8x K-type thermocouple's	2 Hz
8x PT100's	2 Hz
8x +-10V differential inputs	200 Hz
8x Digital inputs	10 Hz
8x Digital outputs	10 Hz
8x +-10 V Analogue outputs	10 Hz
2x Flow meter 0-20 lpm	2 Hz
2x CAN busses	1 kHz
1x Flexray Bus	1 kHz
ELECTRICAL POWER MEASUREMENT	
3x Phase voltage 1,000 V	500 kHz
3x Phase current 1,000 A	500 kHz
1x DC voltage 1,000 V	50 kHz
1x DC current 1,000 A	50 kHz

20,000 rpm 500 kW e-Machine dyno cell

We have developed specialised e-Machine test rigs capable of testing the latest high-speed machines, supported by high power, high voltage DC supplies. Multiple acquisition channels of high-speed data acquisition can be specified at sample frequencies of up to 2.0 MHz.

Our on-site fabrication and rig build capabilities allow rapid configuration and testing specification changes and updates, as well as bespoke rig or test customisation options. Additionally, our sites can accommodate clients in either communal or private customer offices, allowing them to witness tests and liaise with the project team efficiently.

Cell specification

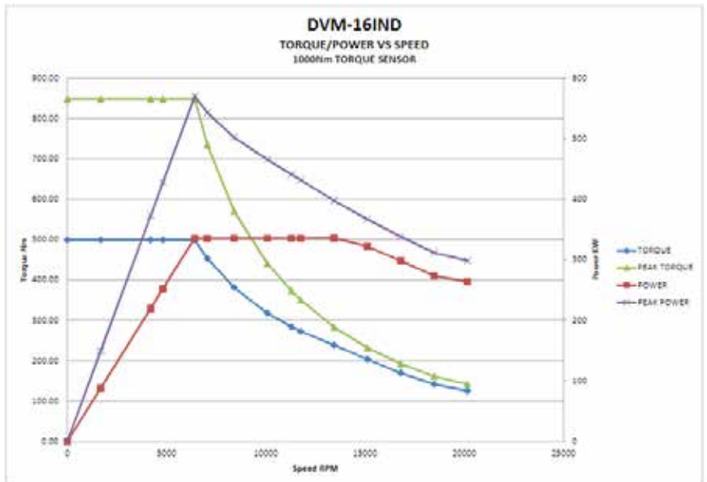
- Cell size specification (W x D x H)
- Cell: 6.0 x 7.0 x 2.0 m
- Cell loading door (W x H): 1.6 x 2 m

Dyno specification

- Nominal Power: 300 kW
- Nominal Torque: 500 Nm
- Peak Power: 500 kW for > 60 sec. @ 6000 rpm
- Peak Torque: 800 Nm for > 60 sec. up to 6000 rpm
- Max. Continuous Speed: 20,000 rpm
- Torque sensor: 1000 Nm range, +/- 1.0 Nm accuracy

DESCRIPTION	SPECIFICATION
Battery emulator limits	400 kW
	Voltage = 1000 Vdc
	Current = 1000 Adc (peak)
Oil rig flow rate limits:	Min = 0.05 lpm
	Max = 10 lpm
Oil rig max temperature	85°C
Coolants temperature limits	Min = -15°C
	Max = 90°C
Coolants max flow rate	20 lpm
Power analyser	6ph + DC Max Voltage - 1,000 V Max Current - 1,000 A Sample rate = 2.2 M samples/s
Data acquisition system	Max sampling frequency: 2 Ms/sec
	Comms: RS485, Ethercat
CAN comm data log	Vector box VN7640 flex ray/CAN

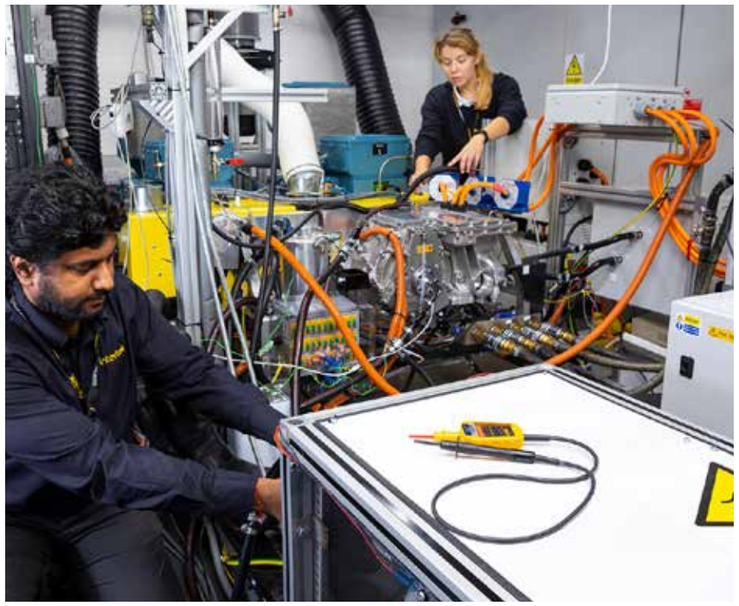
Dyno power curve



18,000 rpm 300 kW e-Machine dyno cell

All of Intertek's eMobility testing engineers and technicians have been trained to the latest health and safety legislative requirements, allowing them to operate the high voltage test equipment and components. Additionally, all of our test facilities are fully accredited to ISO 9001 and can operate 24/7.

ECE Regulation 85 (electric drive trains) certification for e-motors can be conducted in our test cells. Intertek is the first UK test facility to be accredited by the VCA to conduct this testing.



Cell specification

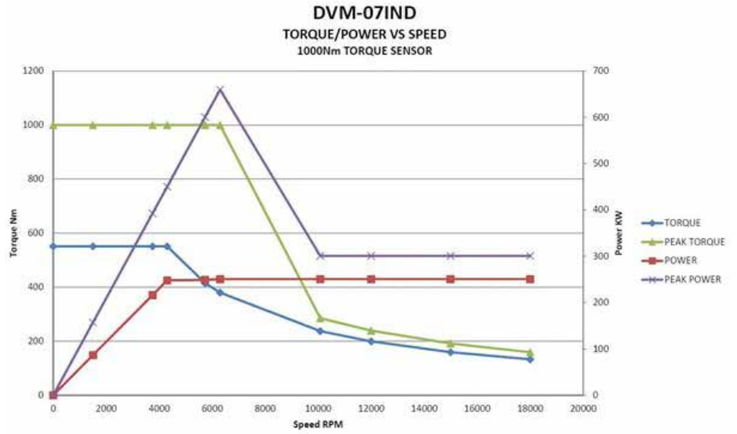
- Cell size specification (W x D x H)
- Cell: 6.0 x 7.0 x 2.0 m
- Cell loading door (W x H): 1.6 x 2 m

Dyno specification

- Nominal Power: 250 kW 4300 to 18000 rpm
- Nominal Torque: 550 Nm 300 to 4300 rpm
- Peak Power: 300 kW for > 120 sec. 3750 to 18000 rpm
- Peak Torque: 1,000 Nm for > 120 sec. 300 to 3,750 rpm
- Nominal Speed: 7,000 rpm
- Max. Continuous Speed: 18,000 rpm
- Torque sensor: 1000 Nm range, +/- 1.0 Nm accuracy

DESCRIPTION	SPECIFICATION
Battery emulator limits	300 kW
	Voltage = 1000 Vdc
	Current = 1000 Adc (peak)
Oil rig flow rate limits:	Min = 0.05 lpm
	Max = 6.5 lpm
Oil rig max temperature	75°C
Coolants temperature limits	Min = -5°C
	Max = 85°C
Coolants max flow rate	15 lpm
Power analyser	3ph + DC Max Voltage - 1,000 V Max Current - 1,000 A Sample rate = 2.2 M samples/s
Data acquisition system	Max sampling frequency: 2 Ms/sec
	Comms: RS485, Ethercat
CAN comm data log	Vector box VN7640 flex ray/CAN

Dyno power curve



Back-to-back e-Motor durability testing rig

This testing rig is primarily designed for efficient durability type testing, where the testing of two machines at once harvests twice the running hours. Our back-to-back rigs are capable of fully automated operation, allowing our customers to utilise the test rig for a shorter period of time, whilst still running the full course of their testing requirements.

With our wide range of customer requirements, we have designed our back-to-back rig to suit a broad range of product sizes and weights. Our equipment is fitted with customer mounting plates, allowing us to accommodate a large range of customer specific DUT. Our custom mounting plates also include a wide spaced linear rail system, allowing for all types of DUT and driveshaft arrangements. Our DUT carriages allow for pre-rigging and enable rapid deployment of testing.

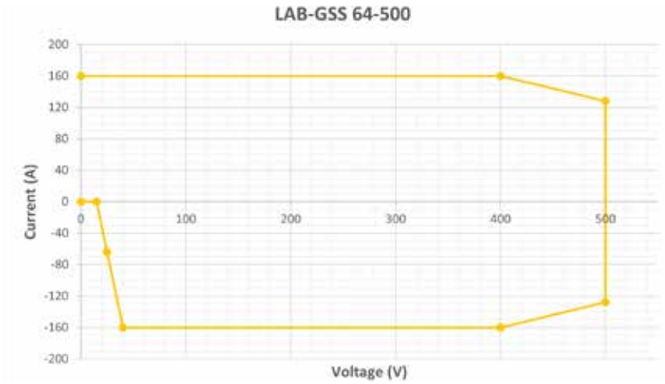
Precision centre bearing furnishes accurate shaft alignment at high speeds and supports high resolution contact-less torque measurement system with custom splined shaft adaptors for DUT coupling including galvanic isolation if required.

Cell specification

- Cell size specification (W x D x H)
- Cell: 4.0 x 6.3 x 4.0 m
- Cell loading door (W x H): 1.59 x 2.0 m

DESCRIPTION	SPECIFICATION
DC source	2x Regatron Lab GSS modules providing up to 64 kW, 500 V or 1000 V
Torque sensor	500 Nm HBM T40b sensor
Max. speed	Up to 20,000 rev/min with existing torque sensor
Control System	National Instruments
Data channels	24 PRT's, 1x vibration monitor, Analog/Digital Channels
Coolant conditioning: twin units	15 to 90°C at 5 to 20 litres/min
Inertia	0.003 kgm 2 plus customer specific shafts and DUT

Nominal power curve



EV motor lubricant test rig

Designed and built in-house, this unique testing solution was created to enhance the performance and cooling of e-Motors specifically designed for electric vehicles. Our EV motor lubricant rig enables development of e-Motors lubrication and/or EV lubricants and can conduct tests at a wide range of temperatures and flow velocities.

Our rig can help you:

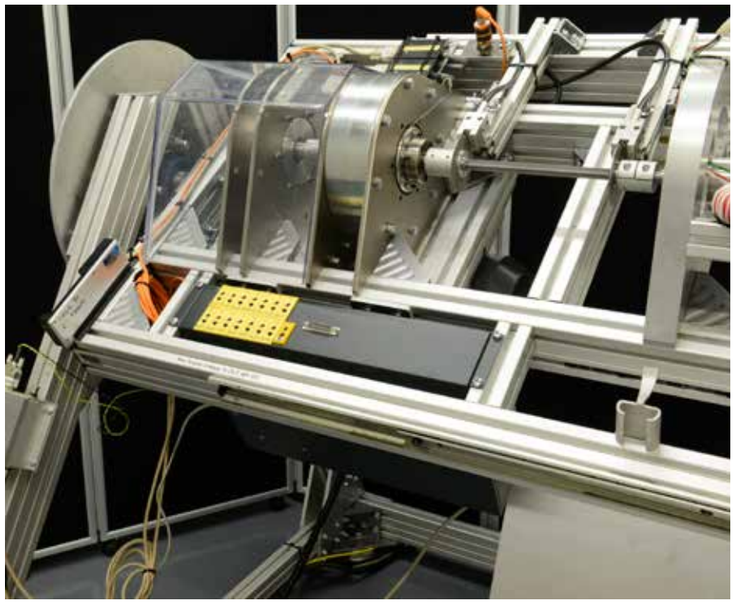
- Reduce e-Motor losses to improve efficiency and vehicle range
- Improve e-Motor cooling to reduce the need for motor de-rating at high load
- Develop improved fluids to better meet the changing needs of the automotive industry

Upon demand, the rig is also ready to provide tilting capabilities and simulate real-world challenges. With the increasing development of electrification technologies in the automotive market, we have designed our EV motor lubricant test rig to suit a broad range of fluid and motor types and designs.

Our equipment can be fitted with customer specific mounting plates, allowing us to accommodate a large range of customer e-Motors. Additionally, all our test facilities are fully accredited to ISO 9001 and can operate 24/7, allowing us to accelerate our customers test programmes.

Development tests that can be conducted

1. Motor rotational loss (no fluid): Evaluation of rotational loss without incurring on windage effect. Possibility to test different bearing types and models.
2. Rotor windage loss (no fluid): Possibility to quantify losses due to windage, through comparison of results between this test and Motor Rotational Loss Measurement.
3. Motor cooling fluid viscous loss: Comparison of drag torques using different fluids, at different temperatures, at different flow rates and at different tilt angles
4. Stator heat transfer to cooling fluid: Fluid cooling capability can be measured at different speeds, temperatures and flow rates, providing the cooling efficiency profile for each test fluid



Our EV motor lubricant rig capabilities

Motor mounting and tilt specifications

- Modular design, flexible mounting options available to suit a wide range of motor units
- Test samples can be tilted in a single axis to ±45°. Multiple axis movement available upon customer demand

Drive system

- Drive is provided by a 7.5 kW (10HP) 2 Pole AC Induction Motor
- Drive is transmitted to the precision balanced flywheel assembly through a one-way clutch drive, preventing any torsional oscillations being transmitted to the 'Phase Shift Torque Meter'
- Maximum continuous speed = 10,000 rpm (max intermittent speed = 12,000 rpm). Variable speed option available upon customer demand

Torque measurement

- Torque is measured by an optical 'Phase Shift Torque Meter'
- Several driven torque limits available to suit all customer` needs. Current beam maximum drive torque of 10 Nm and was designed for an intended operational limit of 0 to 6 Nm.
- Torque measurement accuracy: 0.03 Nm
- High precision speed measurement through a high speed (20 M Hz) thermally stabilized counter, delivering an accuracy of 1 rpm in 15,000 rpm, 6 times per rev (11 ppm)

Temperature and pressure measurement

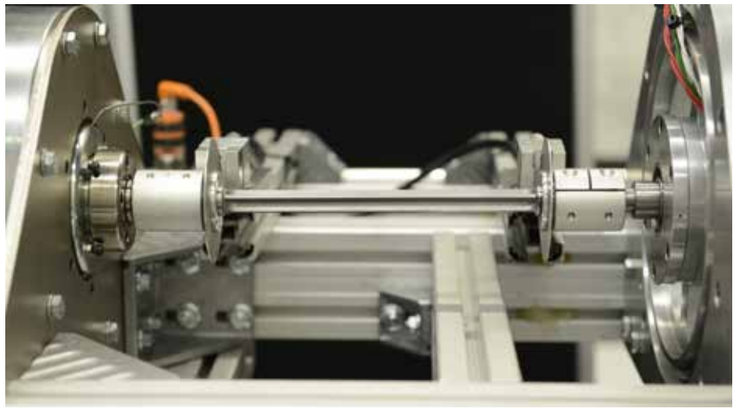
- 14 Off K Type Temperature Channels
- 10 Off high precision pressure measurement channels
- All temperature & pressure channels are synchronously recorded by the logging software at 2 Hz

Fluid conditioning

- Fluid Temperature control
- Oil Flow Rate control
- Scavenge pump to evacuate oil from motor unit under test

Additional specifications:

- Temperature Range = Ambient to 120°C
- Max Flow Rate = 15 l/min. Measurement resolution: 0.05 l/min



ELECTRIC VEHICLE TOTAL SOLUTIONS

e-Axle and EDU testing units

Our analysis of the test requirements for whole vehicles, transmissions and drivelines has identified the following areas in which progress in test techniques will help to facilitate progress in system technology:

- Drivecycle analysis including torque pattern characterisation
- Noise, Vibration and Harshness
- System and Subsystem efficiency
- Lubrication and cooling system losses
- Fast integration of prototype control systems and software
- Very high-speed data collection
- Precise analysis of component performance
- Comprehensive understanding of EMC issues

Test cases

- System integration development
- System level thermal analysis, endurance and durability
- Range and efficiency studies

Early electric vehicles, without regenerative braking, could be tested on a conventional chassis dyno as the energy flow was one way. Since the introduction of regenerative braking, specialist dynamometers are required to provide fast modulation of positive and negative torque. The high current flows in each direction also add the complication of back EMF and other EMI issues.

The next step, already implemented at Intertek, is the introduction of hub dynos. The many advantages of this technique include:

- Increased consistency through direct engagement with the driveline, removing variability from tyres (pressure, temperature, wear, design), tyre slip and strap tensions
- Precise transient responses, e.g. to measure wheel slip and calibrate torque vectoring
- Ability to measure speed differences across each axle
- Low inertia allowing accurate simulation of highly dynamic drive cycles

A well-designed dyno should also offer two or four-wheel drive capability and the ability to operate E-Machines at different voltages on each axle. They must also be far more robust than their ICE counterparts, as very high transient torque loads place tough demands on equipment reliability and must not be allowed to introduce inaccuracy through unwanted movement in the rig or driveline components.

Multi-speed transmissions will require more traditional durability analysis, but even here the conditions are more extreme, with higher torque, potentially from a 'cold' start, very fast shifting and fast control systems. As with E-Machines, lubricants have a significant impact on efficiency so should also be studied as small physical changes can significantly reduce energy losses.

Testing challenges for electrification technologies

As the automotive industry continues to drive innovation and the electrification of transport technologies to meet changing legislative and consumer demands, it is vital the testing industry evolves and meets the challenge.

We explore the various challenges automotive manufacturers and the testing industry are facing and how they can be overcome, such as:

- E-Machines
- Power electronics
- Whole vehicles, transmissions and drivelines
- Batteries

For your free copy of our white paper, click here to download it or contact our team at TT-UKinfo@intertek.com.

Transmission testing

Cell specifications

Intertek offers 3 highly configurable and dedicated transmission test cells, providing our customers with a transient, steady-state, and spin rig cell for calibration and friction loss testing. These cells can be fitted with multiple bespoke simulations to provide testing capabilities for the most complex transmission systems, whether manual, hybrid or full electric.

Transient rig

- 3E Rig
- Input machine matched to engine performance
- Peak figures: 523 kW, 10000 rpm, 1k Nm
- Output machines paired
- Peak figures (each): 552 kW, 3500 rpm, 4.2k Nm
- High precision torque flanges on all machines
- Battery emulator
  - 150 kW continuous capacity
- Fluid handling from -30°C to 130°C , flow rate 15 lpm
- Tri Axis accelerometer capability

Steady-state rig

- 3E Rig
- Input machine matched to engine performance
- Peak figures: 520 kW, 9000 rpm, 1k Nm
- Steady State Absorption output dynamometers
- Peak figures (each): 870 kW, 6500 rpm, 6k Nm
- Battery emulator:
  - 150 kW continuous capacity
- Fluid handling from -30°C to 130°C , flow rate 15 lpm
- Tri Axis accelerometer capability

Spin rig

- Single input (1E) 110 kW spin rig
- High precision torque flange
- Input speed capability up to 8,500 rev/min
- High speed data acquisition up to 25 kHz
- Cold chamber for ambient air to -25°C
- Fluid handling from -30°C to 130°C , flow rate 15 lpm

Cell 22 - transmission cell
2WD with input dyno

4,200 Nm 550 kW 2WD EDU cell

Cell specification

- - Cell size specification (W x D x H)
- - Cell: 4.0 x 6.3 x 4.0 m
- - Cell loading door (W x H): 1.59 x 2 m

Dyno specification

- 2WD EDU - 550 kW per dyno
- 4,200 Nm per dyno
- ±3,500 rpm
- HBM torque flange – T40B (10,000 Nm)

Battery emulator

- 250 kW
- 10- 1000 V
- ± 1000A continuous

Power analysis

- PMM4 (3 phase) or Newtons4th (PPA5510 DC), PPA5530 (3 phase AC)
- Max Voltage - 1,000 V
- Max Current - 1,000 A
- Sample rate = 2.2 M samples/s

Base I/O specification for cell 20

- 60 Thermocouples
- 16 PRTs
- 32 Pressure transducers (including 8 off 0-1 Bar, 1 off Barometric)
- 1 Available CAN Network (extra CAN cards can be provided + ETAS, Vector)

Cell 20
2WD EDU cell

2,750 Nm 434 kW 2WD EDU cell

Cell specification

- Cell size specification (W x D x H)
- Cell: 4 x 7 x 3 m
- Cell loading door (W x H): 1.6 x 2 m

Dyno specification

- 2WD EDU - 434 kW per dyno (640 kW peak)
- 2,750 Nm per dyno (4,000 Nm peak)
- ±3,500 rpm
- HBM torque flange – T40B (10,000 Nm)

Battery emulator

- 500 kW
- 10- 1000 V
- ± 2000 A continuous

Power analysis

- PMM4 (3 phase) or Newtons4th (PPA5510 DC), PPA5530 (3 phase AC)
- Max Voltage - 1,000 V
- Max Current - 1,000 A
- Sample rate = 2.2 M samples/s

Base I/O specification for cell 25

- 60 Thermocouples
- 16 PRTs
- 32 Pressure transducers (including 8 off 0-1 Bar, 1 off Barometric)
- 1 Available CAN Network (extra CAN cards can be provided + ETAS, Vector)

Cell 25
2WD EDU cell

2WD E-Axle test cell

Cell specification

Each 2WD configuration footprint (W x D x H):

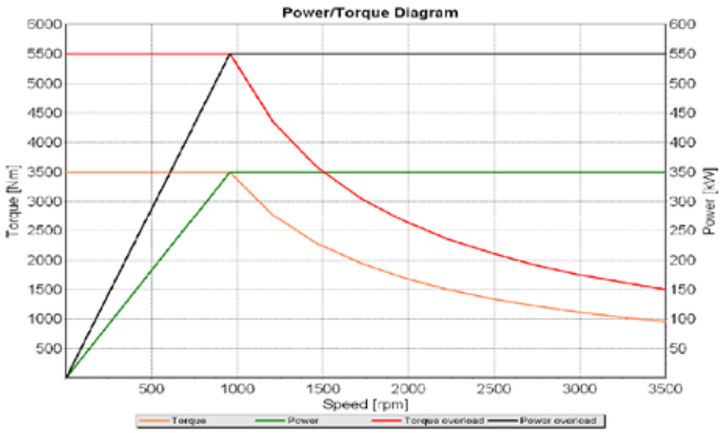
- Cell 1: 8.5 x 4 x 2.6 m
- Cell 1 Control Room: 3.2 x 4.9 x 2.6 m
- Minimum Track Width: 1,450 mm
- Maximum Track Width: 1,750 mm

Dyno specification (each)

Two low inertia transient hub dynos, each with the following specification:

- Nominal Power: 350 kW @ 955 rpm
- Peak Power: 550 kW @ 955 rpm
- Nominal Torque: 3,500 Nm @ 955 rpm
- Peak Torque: 5,500 Nm @ 955 rpm
- Nominal Speed: 955 rpm
- Max. speed: 3,500 rpm
- Dyno rotor moment of inertia: 1.1 kgm2
- Acceleration rate to base speed: 30,380 rpm/sec

Power curve



- Acceleration rate to base speed (with overload): 47,740 rpm/sec
- Acceleration rate between base speed and 2,700 rpm: 10,745 rpm/sec
- Acceleration rate between base speed and 2,700 rpm (with overload): 16,882 rpm/sec
- Overload Capability: 157% for 4 seconds every 3 minutes and 130% for 60 seconds every 10 minutes
- Noise Level (unloaded): 80 dBA

Torque meter specification

- Range: 0 – 1,000 Nm
- Accuracy: <±0.03%

Battery emulation 2WD

Battery emulation is provided to accommodate 316 kW, 1090A, 1100 V for each 2WD test cell, with a third Battery emulator available to be switched to either cell if required.

Single Unit

- Nominal Power: 316 kW
- Peak Power: 410.8 kW
- Voltage: 12 – 1100 Vdc
- Nominal Current: 1090 A
- Peak Current: 1308 A
- Current T90 slew rate: > 300 kA/s
- Overload Capability: 130% for 60 seconds every 5 minutes
- Measurement Accuracy: ±0.05% of full scale
- Resolution: 16 Bit

2 Emulators in Parallel

- Nominal Power: 632 kW
- Peak Power: 821.6 kW
- Voltage: 12 – 1100 Vdc
- Nominal Current: 2180 A
- Peak Current: 2616 A
- Current T90 slew rate: > 300 kA/s
- Overload Capability: 130% for 60 seconds every 5 minutes
- Measurement Accuracy: ±0.05% of full scale
- Resolution: 16 Bit

DUT mounting system

- Dyno centreline heights is 850mm above the bed plate.
- An intermediate drive shaft and bearing system provides the interface between the DUT and dyno torque flange. The intermediate driveshaft and bearing supports the weight of the DUT.

Cell air climatic control

- Cell air inlet temperature control: +10°C and 40°C with a tolerance of +/- 3°C.

IO specification

IO Requirements are as follows:

IO SPECIFICATIONS (PER 2WD CELL)	LOGGING RATE
Shaft Speed 0-3500 rpm	300 Hz
Torque +-5500 Nm 0.05%	2 kHz
8x K-type Thermocouple's	2 Hz
8x PT100's	200 Hz
8x +-10V differential inputs	10 Hz
8x Digital Inputs	10 Hz
8x Digital Outputs	10 Hz
8x +-10V Analogue Outputs	10 Hz
2x Flow Meter 0-20 lpm	2 Hz
2x CAN busses	1,000 Hz
1x Flexray Bus	1,000 Hz

Power analyser

- Max Voltage - 1,100V RMS
- Max Current - 1,200A RMS
- Up to 6 Phases + DC available
- Fundamental Frequency: 0.1 Hz to 300 kHz
- Max Harmonic Order: Up to 500th Order
- Sample rate = 2 M samples/s

4WD vehicle climatic chamber and powertrain test cell

Our vision is to be able to support our customers testing requirements for a full vehicle design verification plan (DVP). This meant it was essential for Intertek to include a full 4WD Vehicle-in-the-Loop test bed. This state-of-the-art test cell is multi-functional to be able to adapt to our customers' requirements.

Set-up options

- 4WD vehicle-in-the-Loop
- 4WD powertrain-in-the-loop
- 2 x 2WD E-Axle

- Option to split the 4WD system in two, with complete separation between the two test cells allowing independent customers to access each cell with complete confidentiality.
- The cell air is also split to each cell to allow each cell to run independent ambient air cycles (10°C to 40°C).
- Enables high transient full 4WD powertrain testing, including torque split and wheel slip simulation for chassis dynamics development

4WD TEST CHAMBER
1.2MW Climatic 4WD EV test chamber

- Future investment will add the capability to allow the real to battery to be used with the addition of a fully climatic environmental chamber (-40°C to +120°C).

ELECTRIC VEHICLE TOTAL SOLUTIONS

- This will allow customers to perform range tests across a wide range of climatic conditions
- It will also give the capability to perform benchmark tests against other models and allow validation of battery models that have been used in the development of the powertrain.

The 4WD cell is dividable in all respects (cell, control room, automation system, data acquisition, battery emulation, etc) to operate as two entirely separate 2WD cells to the specifications given below, whilst maintaining project privacy between the two cells for separate projects and customers but with the flexibility to accommodate a wide range of vehicle platforms including large SUV's. This set-up allows Intertek to meet the fast moving and demanding requirements of electrified powertrains:

Cell specification

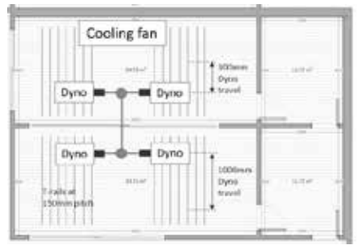
Each 2WD and 4WD configuration footprint (W x D x H):

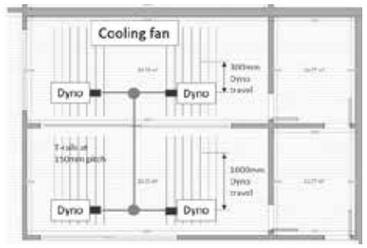
- Cell 1: 8.5 x 4 x 2.6 m
- Cell 1 Control Room: 3.2 x 4.9 x 2.6 m
- Cell 1 Loading Door (W x H): 3 x 2.23 m
- Cell 2: 8.5 x 5.95 x 2.6 m
- Cell 2 Control Room: 3.2 x 4.9 x 2.6 m
- Cell 2 Loading Door (W x H): 2.8 x 2.45 m
- 4WD Configuration: 8.5 x 9.95 x 2.6 m
- Minimum Track Width: 1,450 mm
- Maximum Track Width: 1,750 mm
- Minimum Wheelbase: 2,500 mm
- Maximum Wheelbase: 3,200 mm

Dyno specification (each)

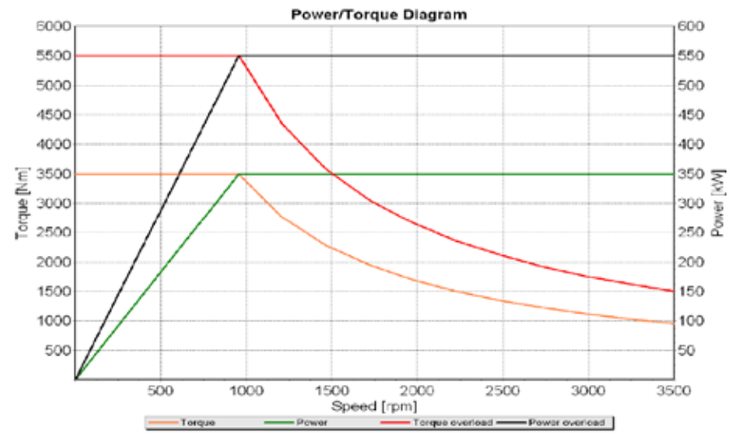
Four low inertia transient hub dynos, each with the following specification:

- Nominal Power: 350 kW @ 955 rpm
- Peak Power: 550 kW @ 955 rpm
- Nominal Torque: 3,500 Nm @ 955 rpm
- Peak Torque: 5,500 Nm @ 955 rpm
- Nominal Speed: 955 rpm
- Max. speed: 3,500 rpm
- Dyno rotor moment of inertia: 1.1 kgm2
- Acceleration rate to base speed: 30,380 rpm/sec
- Acceleration rate to base speed (with





Power curve



Power analyser

- Max Voltage - 1,100V RMS
- Max Current - 1,200A RMS
- Up to 6 Phases + DC available
- Fundamental Frequency: 0.1 Hz to 300 kHz
- Max Harmonic Order: Up to 500th Order
- Sample rate = 2 M samples/s

ELECTRIC VEHICLE TOTAL SOLUTIONS

Torque meter specification

- Range: 0 – 1,000 Nm
- Accuracy: <±0.03%

Battery emulation 4WD

Battery emulation is provided to accommodate 948 kW, 3,270 A, 1,100 V for the 4WD test cell.

- Nominal Power: 948 kW
- Peak Power: 1,232.4 kW
- Voltage: 12 – 1,100 Vdc
- Nominal Current: 3,270 A
- Peak Current: 3,924 A
- Current T90 slew rate: > 300 kA/s
- Overload Capability: 130% for 60 seconds every 5 minutes
- Measurement Accuracy: ±0.05% of full scale
- Resolution: 16 Bit

DUT mounting system

- Dyno centreline heights is 850 mm above the bed plate.
- An intermediate drive shaft and bearing system provides the interface between the DUT and dyno torque flange. The intermediate driveshaft and bearing supports the weight of the DUT.

Cell air climatic control

- Cell air inlet temperature control: +10°C and 40°C with a tolerance of +/- 3°C.
- Cooling capacity: up to 200 kW of heat rejection capacity

Air flow

- 150 km/hr air flow capability to be supplied to a vehicle under test.

IO specification

IO Requirements are as follows:

IO SPECIFICATIONS (PER 2WD CELL)	LOGGING RATE
Shaft Speed 0-3500 rpm	300 Hz
Torque +-5500 Nm 0.05%	2 kHz
8x K-type Thermocouple's	2 Hz
8x PT100's	200 Hz
8x +-10V differential inputs	10 Hz
8x Digital Inputs	10 Hz
8x Digital Outputs	10 Hz
8x +-10V Analogue Outputs	10 Hz
2x Flow Meter 0-20 lpm	2 Hz
2x CAN busses	1,000 Hz
1x Flexray Bus	1,000 Hz

ELECTRIC VEHICLE TOTAL SOLUTIONS

High-voltage functional test bed

Our background

Our Transportation Technologies team at Milton Keynes, UK, has designed and developed a unique High Voltage Functional test bench (HV-FTB) in order to expand its eMobility test and validation capabilities outside of the direct sphere of rotating machinery. This custom test bench enables integrated, automated and transparent development of the necessary High Voltage support systems found in a modern EV or Hybrid vehicle, including HV junction boxes, battery management systems, DC:DC converters, AC and DC charging interfaces and other HV systems that are now routinely powered from a traction battery.

The modular, expandable HV-FTB

The HV-FTB is modular, expandable and evolves a single point testing architecture into an arena, that previously has required many, individual support systems each with their own test agenda. To streamline the optimisation or validation of functional hardware, simultaneous near real time generation of all primary Vehicle and EVSE Power-buses is supported.

In conjunction, the HV-FTB allows the validation of control code, which is often new, unproven and unique to the DUT and can be multi-dimensional in scope, especially where networked communication buses such as Flexray or Green-PHY are involved.

Key features

- High Voltage DC generation – 0 to 1000 Vdc in two 32 kW bi-directional (sink-source) units. Units can be connected in series or parallel, and can operate, and transition, seamlessly between either load quadrant. This functionality is to simulate the vehicle's main traction battery and also EVSE DC charging, and can run in various modes (CV,CC, Batsim etc)
- High Voltage AC Generation – 0 to 680 Vac, 12 kW, 1 or 3 ph variable VF supply. Providing power to support the test and integration of EVSE AC charging systems, and able to simulate grid disturbances (fundamental frequency shift, harmonic content, voltage glitches etc)
- High Voltage AC/DC Passive Configurable Load Bank – A water cooled 5 kW resistive load bank arranged in a ladder type arrangement gives the ability to simulate AC or DC systems with variable loading. It also enables rapid (<1 mS) step-wise load changes, designed to test the output stability and damping of DC:DC converters.
- High Voltage DC Linear Load Bank – 5 kW 600 V highly dynamic DC load. Providing a high fidelity, low noise sink for DC:DC converter testing or other DC loading tests
- EVSE DC Fast Charger – 50 kW - Supporting industry standard DC fast chargers, and enabling validation of High Voltage Junction Box type devices, as well as functional test on charging system interface controllers
- All units are housed in standard sized, custom racking that enables the FTB to be easily shrunk or expanded. This brings simple hardware integration for additional future capability.

All units within the HV-FTB are networked, allowing a single, central test automation system to manage both the DUT and the HV-FTB resources themselves. Further integration of networked data acquisition and analysis devices (oscilloscopes, power analysers, temperature sensing etc) is also both possible and expected to leverage the highest level of single point, integrated testing.

Facility extras and additional services

With the speed at which electrification technologies are developing, our state-of-the-art Global EV Testing Centre of Excellence was designed and built with efficiency in mind.

We provide our customers with 24/7, year-round support to ensure you not only meet your project deadlines but we're available to adjust test set-up to meet your exact needs and requirements. Enabled by our unique, rapid quick-change pallet set up system and the cutting-edge technologies powering our facility, we're able to drastically reduce test configuration and set up times, delivering automotive products to market faster.

Additionally, we can utilise the extensive expertise from our highly skilled EV Engineering team, to provide consultancy around design, performance analysis, global regulatory requirements, certification, homologation and benchmarking exercises.

24/7 OPERATION

24/7 facility operation for maximum test productivity

With our world-class technical capabilities combined with our teams extensive industry expertise, Intertek aims to be the partner of choice to our customers.

- Bespoke test methodologies and custom rig design
- Consultancy from design to finished product
- Reduced test set up by 70% to speed up time to market
- Over 100 years' combined expertise in EV propulsion testing services
- 24/7 facility operation for maximum test productivity

Development testing of Formula E powertrain technologies

Over the years, electric vehicle technologies and components have seen drastic enhancements and radical leaps in technology design and capability. Many of these innovative steps are realised in the electrification of racing. As Formula E and other electric motorsports have continued to rise in popularity, so has the capabilities of the cars manufactured.

In our white paper, we delve into the generational progression of Formula E, and how new and enhanced powertrain testing capabilities can allow engineers to develop and fine-tune their powertrains that can define a generation of racing.

For your free copy of our white paper, click here to download it or contact our team at TT-UKinfo@intertek.com.

Climatic hoods

The three e-Motor test cells share a single common climatic hood which can be quickly mounted in any of the three test cells. Thanks to a common interface design each of the three test cells has a permanently installed climatic wall which the e-Motor interfaces through. If climatic testing is required the hood is simply then wheeled into the test cell and positioned up to the fixed climatic wall and fastened together:

- Temperature control down to -40°C to +85°C
- Is mobile to be used between the three different dyno cells as required by customer projects
- Provides DAQ/control capability via the test cell automation system
- Accommodates a DUT up to approx. 650 mm diameter and 800 mm length including 400 mm allowance for mounting hardware

Quick-change loading pallet

Quick change loading pallet
Across our new facility, our three e-Machine test cells are equipped with our quick change loading pallet system. This innovative and unique capability allows our engineers to rapidly reduce the time required to set up customers motors in the test cells. Our quick change loading pallet reduces the set up time from one week to approximately one hour. This equipment not only increases test efficiency across our facility but also allows the customer to make amends to the test set up and change the motor without increasing test costs and impacting project deadlines.

QUICK CHANGE LOADING PALLET
Reduces the set up time from one week to approximately one hour

Lessons learned testing electric vehicles webinar

Automotive electrification technologies are becoming increasingly advanced, requiring independent testing facilities to keep up to speed with the latest in testing technologies and skills.

By undergoing the hours of testing customer products and developing internal equipment and skills to enhance the results, many lessons can be learned to improve future technologies and enhance testing performance.

The topics covered will include:

- Test Set-Up and Automation – Benefits of Scripted Tests
- Reliable and Accurate Data Acquisition in Electrically Noisy Test Environments
- Development of Improved and Automotive Friendly Electrical Power Analysis Systems
- Development of a Quick-Change Test Motor Pallet System

For on-demand access to our webinar, click here to watch it or contact our team at TT-UKinfo@intertek.com.

Consultancy services

Product Design
Intertek consulting services support your product design, R&D, and innovation teams in developing competitive products and bringing them to rapidly changing markets. We help at every stage, from identifying compliance, certification, and testing challenges to providing clear, actionable performance and safety assessments, and assistance with documentation. With our "design it right the first time" expertise, you'll reduce rework and product failures, and get your products to market faster.

Business & Process Advisory
Get the expert guidance you need to manage complex global supply chains, reduce costs, and mitigate risks. Intertek consultants have the breadth of expertise to build strategies around component selection, chemical and environmental compliance, and product management to meet changing technical and regulatory requirements in more than 100 countries. We can optimise existing infrastructure to streamline your testing process, or design and construct a turnkey laboratory to meet your needs. From concept to commercialisation, Intertek insight gives your business a competitive advantage.

Training
Let our experts train yours. We help you understand new technologies, enter new markets, simplify complex requirements, comply with upcoming or current regulations, and avoid common product failure pitfalls. Our consultants will tailor a program to sharpen your teams' skills and arm them with the knowledge to resolve existing issues and anticipate future challenges.

BESPOKE SOLUTIONS

Bespoke testing methodologies and custom rig design

Our Consultancy Services

- Creation and operation of entire test programmes from DVP to Certification
- Individual work packages to support design, test and verification of sub-systems
- Specialist knowledge in design, test and analysis of:
  - Battery systems
  - Electric motors
  - Inverters
  - Power electronics
  - HVAC
- Recommendations for DUT performance or efficiency improvements
- Guidance through global homologation processes to achieve certification in minimum timeframe for lowest cost
- System teardown
- Benchmarking
- Specialist and bespoke training courses

It's your business. Intertek consultancy services help you simplify it.

Your business. Simplified.

- ✓ Get to market faster
- ✓ Access on-demand expertise
- ✓ Reduce costs
- ✓ Mitigate risk
- ✓ Establish global reach

Resources, skills and operating model

Guided by our Chief Engineer, and managed by our EV Test Manager, our EV Services team bring a wealth of complementary skills to your projects. We have in-depth expertise in electric motor design, battery design, mechanical design, vehicle integration and homologation; and of course testing.
Our best-in-class technologies combined with our highly skilled team means we can deliver you the testing you need, when you need it; with pace, precision and passion. Our diverse teams come from backgrounds including vehicle OEMs, tier 1 OEMs, motorsport, industrial and consultancy.

100 YEARS' EXPERTISE

Over 100 years' combined expertise in EV testing

Additionally, Intertek's expert team can work with you to develop bespoke test configurations for the most demanding requirements.

All of Intertek's e-Mobility testing engineers and technicians have been trained to the latest health and safety legislative requirements, allowing them to operate the high voltage test equipment and components. Additionally, all of our test facilities are fully accredited to ISO 9001 and can operate 24/7.

Intertek's facilities are supported by comprehensive in-house instrumentation and facilities maintenance, ensuring minimum down-time with maximum data quality.

Intertek advantage

Intertek partners with customers at the forefront of the next generation of automotive development, supporting them to develop the best electric vehicles for the future.

As the largest independent automotive EV powertrain testing facility in the UK and with over 30 years' industry experience, we have been testing high voltage EV and HEV systems since 2011. Our powertrain testing expertise includes the testing and optimisation of eMobility driveline systems, including full electric and hybrid-electric powertrains.

We understand the requirements for EV testing to deliver high-quality insights that accurately reflect real world usage, partnered with a focus on accelerating the development process. Our facilities are built to achieve accurate test results with a very fast turnaround, and a high level of automation allows safe 24/7 operation. Our engineers provide specialist in-house design and build capabilities, meaning rigs can be modified for specific requirements, or all new rigs designed and built for a completely bespoke testing programme.

Our state-of-the-art Global EV Testing Centre of Excellence, designed from the ground-up to offer manufacturers world-class testing and consultation solutions for all electric vehicles and components, combined with our teams of specialists with over 100 years' of EV propulsion testing expertise, Intertek is the partner of choice for both commercial and electric motorsport test programmes.

About Intertek

Intertek is a leading Total Quality Assurance provider to industries worldwide. Our network of more than 1,000 laboratories and offices in more than 100 countries, delivers innovative and bespoke Assurance, Testing, Inspection and Certification solutions for our customers' operations and supply chains. Intertek Total Quality Assurance expertise, delivered consistently with precision, pace and passion, enabling our customers to power ahead safely.

OUR UK SERVICES

- EV propulsion services
- Consultancy services
- Engine R&D testing
- EMS mapping
- Engine durability testing
- Transmission testing
- Exhaust catalyst ageing
- Fuel additive testing
- Prototype manufacturing
- On-road vehicle testing

Davy Avenue
Intertek Transportation Technologies
Davy Ave, Knowlhill
Milton Keynes
MK5 8NL
UK

Tanners Drive
Intertek Transportation Technologies
8 Tanners Drive
Blakelands
Milton Keynes
MK14 5BN
UK

+44 1908 513018

TT-UKinfo@intertek.com

intertek.com/automotive/electric-vehicle-testing

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