2023

Company services
Testing Facilities

POWERLABS

Engineering services for e-Mobility solutions

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About EPowerlabs | Our company

We are a power electronics & controls Company creating market ready products for Electric Mobility

Where we come from…

Our team has background from leading industry players

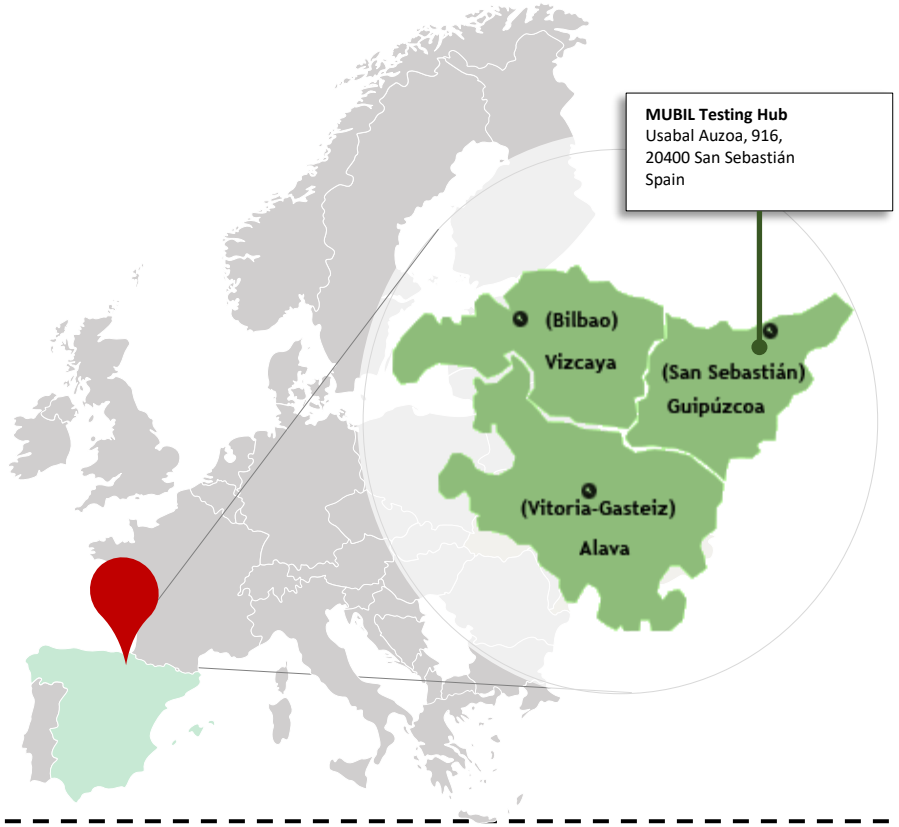
AVL · Applus IDIADA · pwc · BENTLEY · Ferrari · PORSCHE · punch powertrain (Gear up for the future) · Faiveley Transport (A Wabtec Company) · LiTHIUM BALANCE (BATTERY MANAGEMENT SYSTEMS)

Generated experience

14	Powertrain developments	+10k	Testing hours	17	People	20	Executed & Ongoing projects

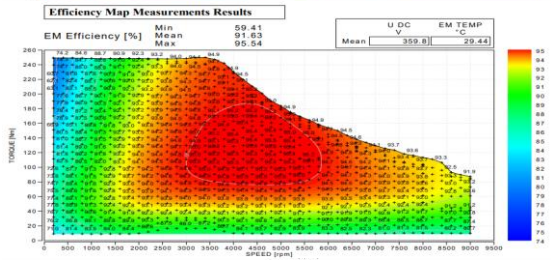
Testing Centre - Overview

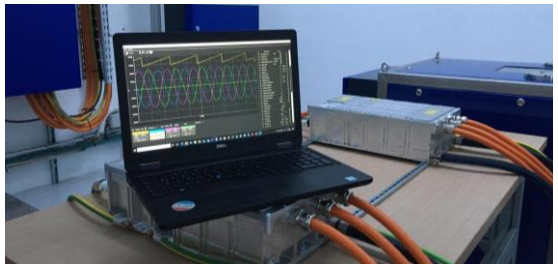
Location



Test centre for electromobility inaugured by March 2021 and comprises best-in-class equipment in the market including E-Motor, Power Electronics and Battery testing equipment

Powertrain testing Cell





Powertrain

Testing Capabilities

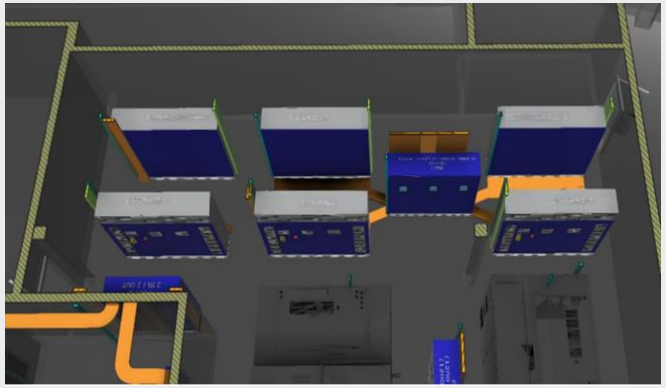
Epowerlabs operates state of the art test benches for electromobility at MUBIL Technology Center, providing our long-term expertise and innovative strength of the automotive branch.

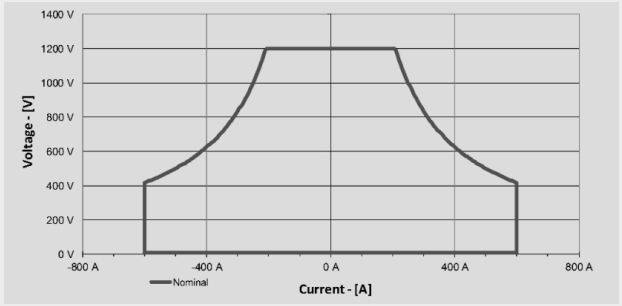
Wide range of testing capabilities e.g.:

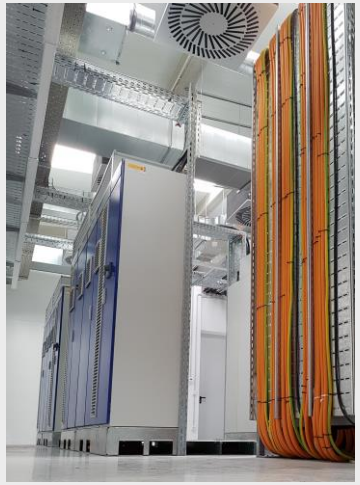
- Performance testing
  - Power curves (4)
  - Efficiency Mapping (5)
  - Flux Mapping
  - MTPA (3)
  - BEMF (2)
  - Drag losses (1)
  - No Load & Locked rotor
- Endurance testing
  - Heat Cycle
  - High Temperature Cycle
  - Humidity Cycle
- HiL testing

Full automated Powertrain testbed with AVL PUMA2 automation and measurement system

Powertrain testing Cell – Battery Simulator







Technical specifications

Battery Simulator

- Max. Output Power: 250kW
- Max. Output Voltage: 1200V
- Max. Current: ±600A
- Max. Current gradient: 1000A/ms
- Control modes:
  - Voltage regulation
  - Current control
  - Power control
- Virtual internal resistance setting (-2Ω to +2Ω)
- Power Distribution Unit (PDU) is capable to allocate two different voltage sources, e.g., a customers battery pack for being tested.
- 5 Battery Simulators available, each of them of 250kW.
- Up to 4 Battery Simulators can be used in parallel mode → 1MW
- 6th Battery Simulator planned for Q4 2021

Full automated Powertrain testbed with AVL PUMA2 automation and measurement system

Powertrain testing Cell – Dyno EM & Inverter

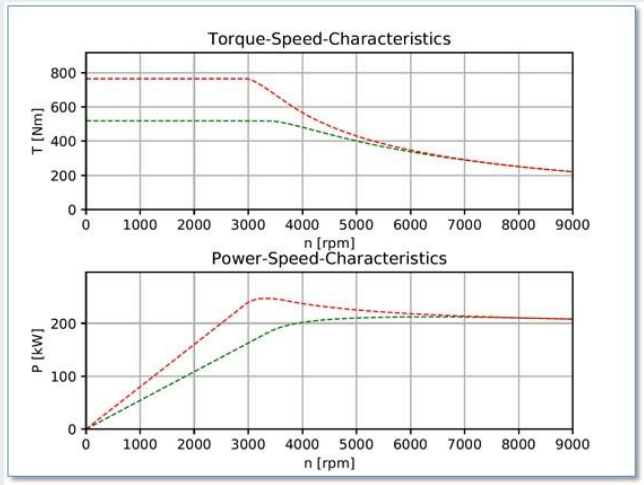
Technical specifications

Power Traction Inverters

- Nominal Power: 190kW
- Peak Power: 260kW
- Vdc supply range: 200V → 800V
- Nominal current: 300Arms
- Peak current; 490Arms → 6s
- Switching Frequency range: 2kHz → 10kHz
- LV Supply range: 9,9V → 16V

Capabilities

- Inverter **totally parametrizable** via INCA
- Max. electric rotation frequency, e.g., ground wave, is 1kHz.
- Active Short Circuit can be activated by software on demand.
- SinCos RLS can be read.
- Excitation signal for RLS, Vout: 3,2V → 4V
- Two inverters are available for customers, highly valued and cost effective for EM developers.



Technical specifications

Dyno Motor – RAMME HO245

- Continuous Power: 190kW
- Continuous Torque: 520Nm
- Speed range: 0rpm → 9000rpm
- Nominal Phase current: 300Arms

- Peak Power: 241kW
- Peak Torque: 762Nm
- Peak Phase current: 470Arms

- Increases flexibility for testing only an inverter if the customer has no EM.
- 2 units are available

Full automated Powertrain testbed with AVL PUMA2 automation and measurement system

Powertrain testing Cell – High-Speed High-Torque Gearbox

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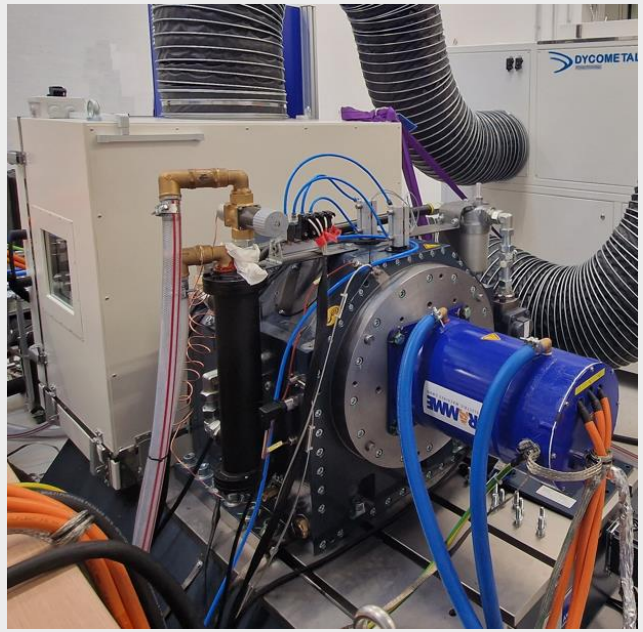
State-of-the-Art High Speed – High Torque Gearbox with two ratios 4Q working principle – i1:1 or i1:2,6 – the shifting mechanism can be activated on demand

Technical specifications Low Speed Input – High Speed Output

Low Speed Input *Performance Data*		High Speed Output *Performance Data*	
Rotation Speed Nom.	3.750 min^{-1}	Rotation Speed Nom.	9.896 min^{-1}
Rotation Speed Max.	9.000 min^{-1}	Rotation Speed Max.	23.751 min^{-1}
Torque Nom.	520 Nm	Torque Nom.	197 Nm
Torque Max.	762Nm	Torque Max.	289 Nm
Gear ratio	2.639 ±3%	Gear ratio	2.639 ±3%
Power	250kW	Power	250kW
Direction of rotation	4 quadrant operation	Direction of rotation	4 quadrant operation

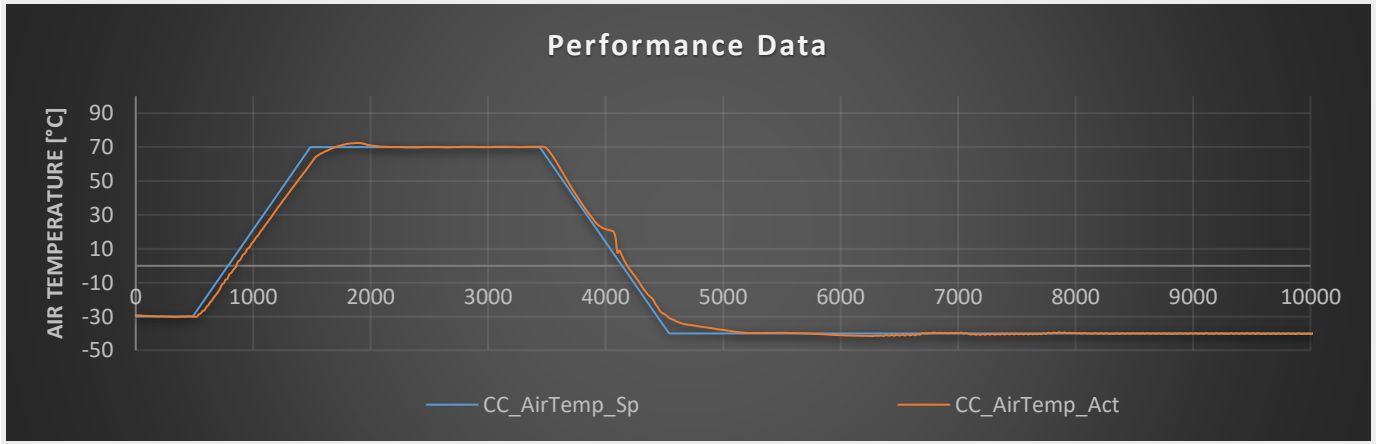


Technical specifications High Speed Input – Low Speed Output

High Speed Input *Performance Data*		Low Speed Output *Performance Data*	
Rotation Speed Nom.	3.750 min^{-1}	Rotation Speed Nom.	1.420 min^{-1}
Rotation Speed Max.	9.000 min^{-1}	Rotation Speed Max.	3.410 min^{-1}
Torque Nom.	520 Nm	Torque Nom.	1.372 Nm
Torque Max.	762Nm	Torque Max.	2011Nm
Gear ratio	2.639 ±3%	Gear ratio	2.639 ±3%
Power	250kW	Power	250kW
Direction of rotation	4 quadrant operation	Direction of rotation	4 quadrant operation

Full automated Powertrain testbed with AVL PUMA2 automation and measurement system

Powertrain testing Cell – Climatic Chamber for Single EM or B2B



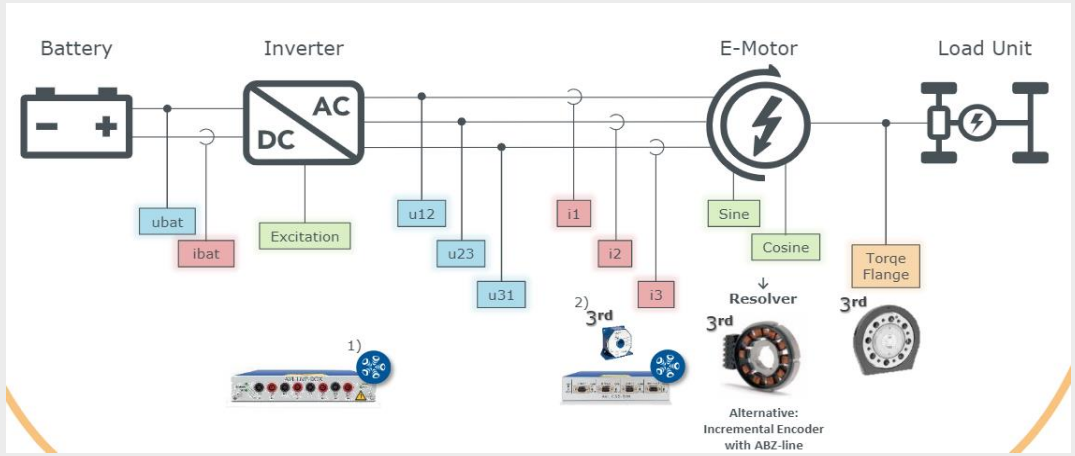
Technical specifications

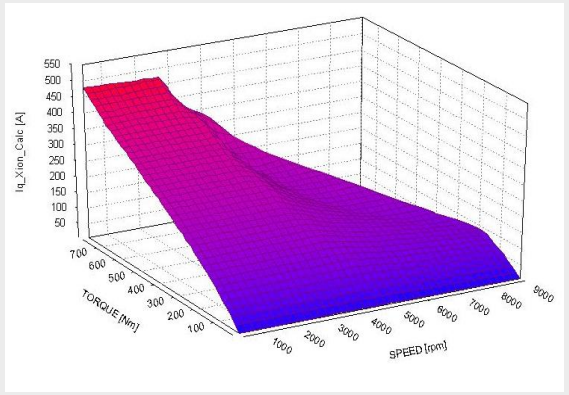
Climatic Chamber – CETM-40/1320g

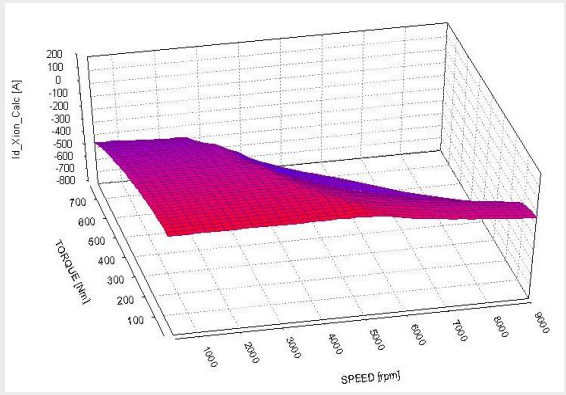
- Temperature range: -40ºC → +120ºC
- Temperature Cooling/Heating gradients:
  - 4K/min under load
  - 10K/min no load
- Anti Ice and Condensation protection on negative temperature ranges – transitions
- Two thermal boxes available:
  - 300L Box for one EM against Dyno testing
  - 1500L Box for B2B testing
  - Thermal boxes are specifically design for the baseplate guaranteeing perfect isolation
- The Climatic Chamber can be used in standalone for EV component testing

Full automated Powertrain testbed with AVL PUMA2 automation and measurement system

Powertrain testing Cell – Power Measurement System X-Ion







Technical specifications

Input Range
- 4 Channels Differential Input: ±1500V
- 4 Channels ±1000A
- 1 Channel Torque Measurement: Up to 2kN
- 3 Channels RLS position – Exc, Sin, Cos

Torque Transducer
- HBM T40B: 2kN & 15krpm
- HBM T40B: 1kN & 23krpm
- Other torque ranges available under request

Accuracy
- Voltage: 0.015% Reading + 0.02% Range
- Current: 0.005% Reading + 0.03% Range
- Torque: Accuracy class 0.05%

Capabilities of X-Ion & Indicom
- Real Time Calculations of Power & Efficiency
- Possibility of Adding Custom Calculations
- Up to 2MHz of Sampling Rate per Channel

Full automated Powertrain testbed with AVL PUMA2 automation and measurement system

Powertrain testing Cell – Coolant & Oil Conditioners

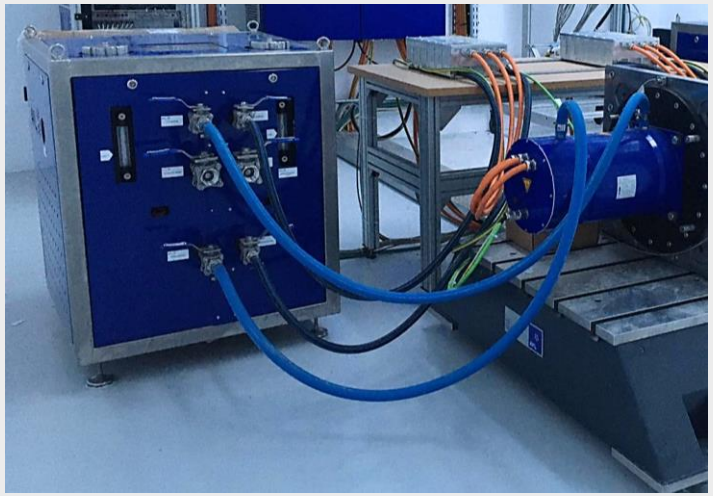
Technical specifications

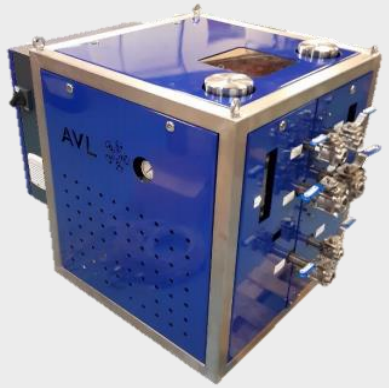
Water-Glycol Conditioner Huber Unistat 530w

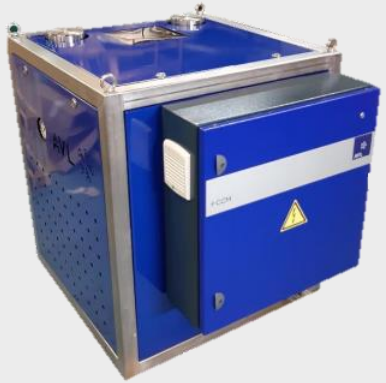
- Flow rate: up to 60 l/min
- Cooling Capacity:
  - -40ºC → 3kW
  - -20ºC → 9kW
  - 0ºC → 16kW
  - 20ºC → 21kW
- Heating Capacity: 12kW
- Water – Glycol mixture up to 50%-50%
- Temperature range: -40ºC → 85ºC

Full automated Powertrain testbed with AVL PUMA2 automation and measurement system

Powertrain testing Cell – Coolant & Oil Conditioners







Technical specifications

Water-Glycol Conditioner

- Flow rate: up to 28l/min
- Max. Heat dissipation: 14kW
- Water – Glycol mixture up to 50%-50%
- Temperature range: 10ºC → 65ºC

Oil Conditioner

- Flow rate: up to 26l/min
- Max. Heat dissipation: 14kW
- Wide range of admissible oil types
- Temperature range: 10ºC → 100ºC

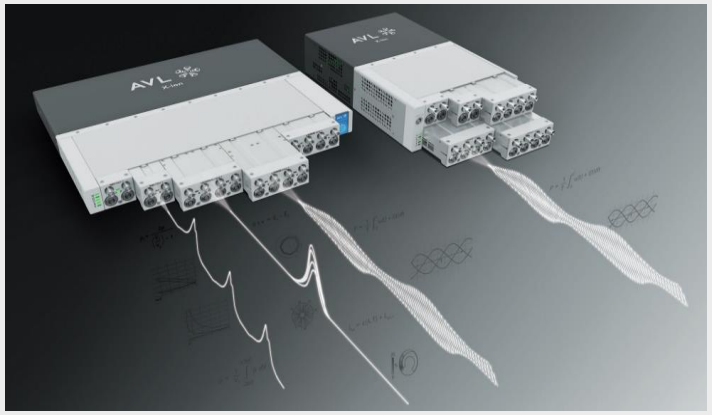
Availability

- 2 units for glycol fluid conditioner
- 2 units for oil liquid conditioner

Ad-hoc cooling circuits can be prepared fulfilling customer needs

Full automated Powertrain testbed with AVL PUMA2 automation and measurement system

Powertrain testing Cell – DAQ’s



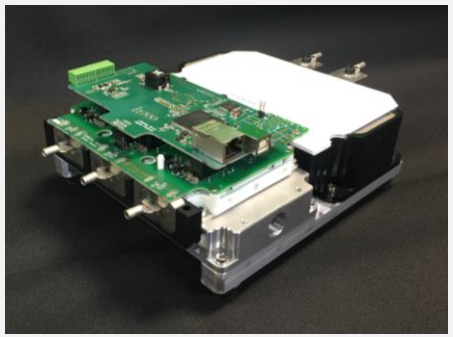
Technical specifications

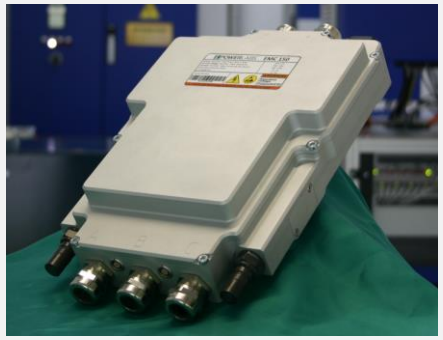
Data Acquisition System

- x4 CAN/CAN-FD Channels
- x1 FEM-DCC Module:
  - 8 Analog Outputs 16-bit
  - 16 Digital Outputs
  - 16 Digital Inputs
  - 8 Incremental counter up to 500kHz
- x2 FEM-AIS Module (Analog Inputs):
  - 16 Universal input channels per Module → 32 Channels in total
  - Each channel can be used, configured and calibrated for:
    - Voltage source → ±75mV, ± 2.4V, ±13.5V
    - Current source → ±25mA
    - Thermocouples with wide range of types
    - PT100 or PT1000
    - Strain Gage
- x2 FEM-DIO (Digital Inputs & Outputs):
  - 16 Digital Inputs → 32 in total
  - 16 Digital Outputs → 32 in total

Full automated Powertrain testbed with AVL PUMA2 automation and measurement system

Power electronics testing Cell





Power Electronics

Testing Capabilities

Epowerlabs offers end to end engineering services independently, or supported by technological partners, offering complete DVP&R and RCA for the overall e-mobility components such as Inverters, DC/DC, BMS, eDrives, xCU's and others.

In the Power Electronics field to help the upcoming challenges of WBG semiconductors converters in their development and test, a full measurement equipment with high precision voltage and current probes and posterior signal conditioning are among EPowerlabs testing capabilities.

Full automated Power Electronics testbed with AVL PUMA2 automation and measurement system

Power electronics testing Cell – Grid emulator & Electronic Loads

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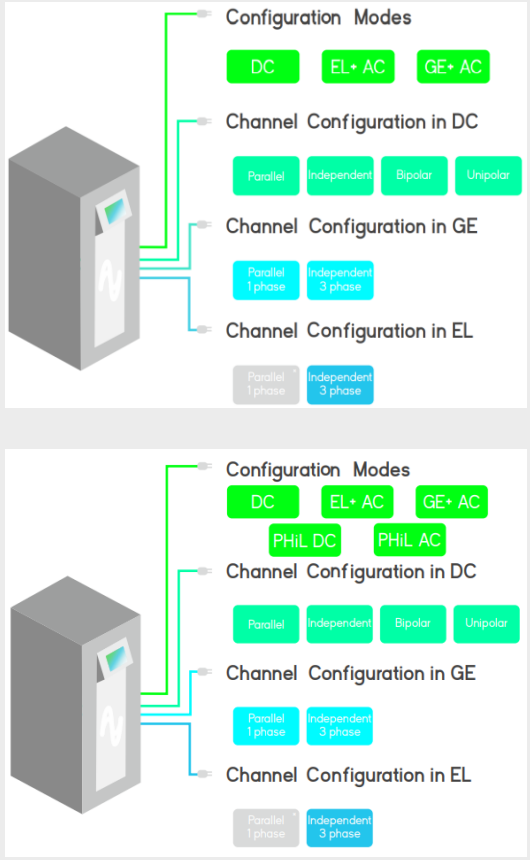
Grid emulator & Electronic Load (AC & DC)

Cinergia GEL AC&DC + HV

- Rated Power: 50kVA
- Rated Phase Current: 73A
- Rated Current: 219A
- Voltage Range: 0V → 800V
- THDi < 3%

Capabilities

- Complete DC Load & Source
- 4Q AC Grid Emulator
- Power amplifier for Power HiL
- 4Q AC Electronic Load
- Battery Emulation and Testing
- PV Panel Emulation



Grid emulator & Electronic Load (AC)

Cinergia GEL AC + HV

- Rated Power: 50kVA
- Rated Phase Current: 73A
- Rated Current: 219A
- Voltage Range: 0V → 400V
- THDi < 3%

Capabilities

- 4Q AC Grid Emulator
- Power amplifier for Power HiL
- 4Q AC Electronic Load
- Disturbance Generation
- Harmonics Control

Full automated Power Electronics testbed with AVL PUMA2 automation and measurement system

Power electronics testing Cell – e.g. Inverter & DC-DC tests

1
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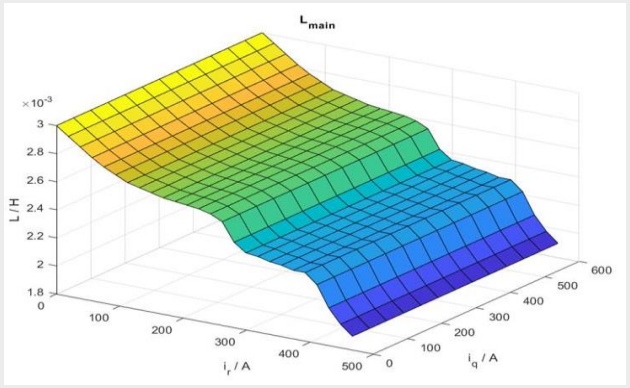
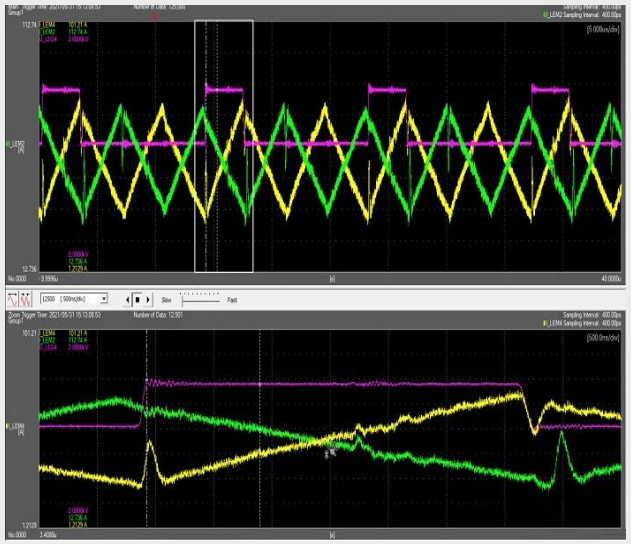
Inverter testing

Inverter testing capabilities

- Calibration tests:
  - Current Maps fine tuning
  - Rotor Temperature Estimation
  - RLS fine tuning
  - Autocalibration routine verification
  - Low Power Current Control testing
  - Low Power Speed Control testing
  - Voltage & Current Sensing calibration
  - Input Voltage Derating measurement
  - Interlock time & Switching definition
  - Position estimator check
- Performance tests:
  - Efficiency map
  - Peak Current measurement
  - Active Short Circuit test
  - Dead Time Compensation Test
- Verification tests:
  - Harmonics Robustness Test
  - Interlock Time & Switching Definition
  - Current & Voltage Ripple analysis





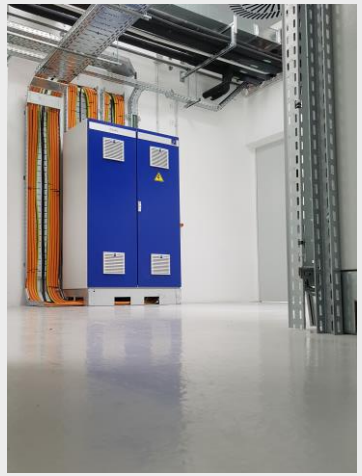
DC-DC testing

DC-DC testing capabilities

- System Tests
  - Mid & Full Power Current Control testing
  - Voltage, Current & Temperature Calibration
  - Full Power Voltage Control Testing
- Verification Tests
  - Efficiency measurement
  - Peak Current measurement
  - Line regulation Accuracy & Transients
  - Load regulation Accuracy
  - Slew Rate and Step response
  - Output Voltage regulation accuracy
  - Current & Voltage ripple measurement
  - Input & Output Voltage Derating
  - Temperature Derating

Full automated Power Electronics testbed with AVL PUMA2 automation and measurement system

Battery testing equipment: Walk – In Chambers



Technical specifications

Weiss Technik Walk-In Chambers (30m³) & (18m³)

- Hazard Level 6 safety Level
- Temperature range from -60°C to +100°C
- Humidity range: 10% to 95% r.H (10°C →70°C)
- Cooling gradient 2°C/min
- Heating gradient 2°C/min

HV Power Supply Battery Pack Cyclers – Up to 1MW

- Configuration modes:
  - 4 Channels → 1200V – 600A – 250kW
  - 1 Channel → 1200V – 1200A – 500kW
    2 Channels → 1200V – 600A – 250kW
  - 2 Channels → 1200V – 1200A – 500kW
  - 1 Channel → 1200V – 2400A – 1MW

Weiss Technik Walk In Chambers controlled by AVL LYNX automation & measurement system

Battery testing equipment: Cell & Module Cyclers

Technical specifications

Chroma 17020 – Battery Cell Cyclers

- Max. Current (Parallelable) → 1200A
- Max. Power (Parallelable) → 60kW
- Voltage range → 0V to 100V
- Current → 50A per channel
- Power → 2.5kW per channel
- Channels → 64 Channels available in total
- Test rigs → 3

Chroma 17011 – Battery Cell Cyclers

- Voltage → 1.5V to 6V
- Channels → 420 Channels available in total
- Test rigs → 13

- All Battery Cell Cyclers are equipped with climatic chambers from Weiss Technik and CTS, including the availability of an **Altitude Chamber** from Weiss Technik model Sky Event 500TAH.

Cell & Modules testing laboratory view

Battery testing equipment: Cell & Module Climatic Cyclers

Technical specifications

CTS CS-40/1000 Climatic Chamber

- Hazard Level 4 safety level
- Temperature range from -40ºC to +180ºC
- Humidity range from 10% to 98% relative humidity (+10ºC to +95ºC)
- Cooling gradient 5 ºC/min
- Heating gradient 6 ºC/min
- 3 units available

Weiss TempEvent T/1000 Climatic Chamber

- Hazard Level 4 safety level
- Temperature range from -42ºC to +180ºC
- Cooling gradient 3.1 ºC/min
- Heating gradient 4.1 ºC/min
- 5 units available

Cell & Modules testing laboratory view

Shaker testing equipment: Dual Shaker Test bench

Technical specifications

Dual Shaker IMV

- Frequency Range 5-2500Hz
- Rated Sine Force 40kN
- Rated Shock Force 80kN
- Maximum Sine Acc. 1142m/s²
- Maximum Shock Acc. 2284m/s²
- Max Velocity of Sine force 2,4m/s
- Max. velocity of Shock force 4,6m/s
- Max. Sine displacement: 51mmp-p
- Maximum Disp. Maximum Travel: 68mmp-p

The shaker testbench is formed by 2 shakers of 40kN each operating between 5-2500Hz. They can work in dual mode phase synchronized in real time. One of the shakers can be moved, so the dimensions can be adjusted to the DUT's geometry.

Synchronized Dual-Shaker test rig

¡Gracias! Eskerrik asko! Thank you!

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