

AI INTELLIGENT ROBOTS

# Power Test Systems



2026

AI ARTIFICIAL

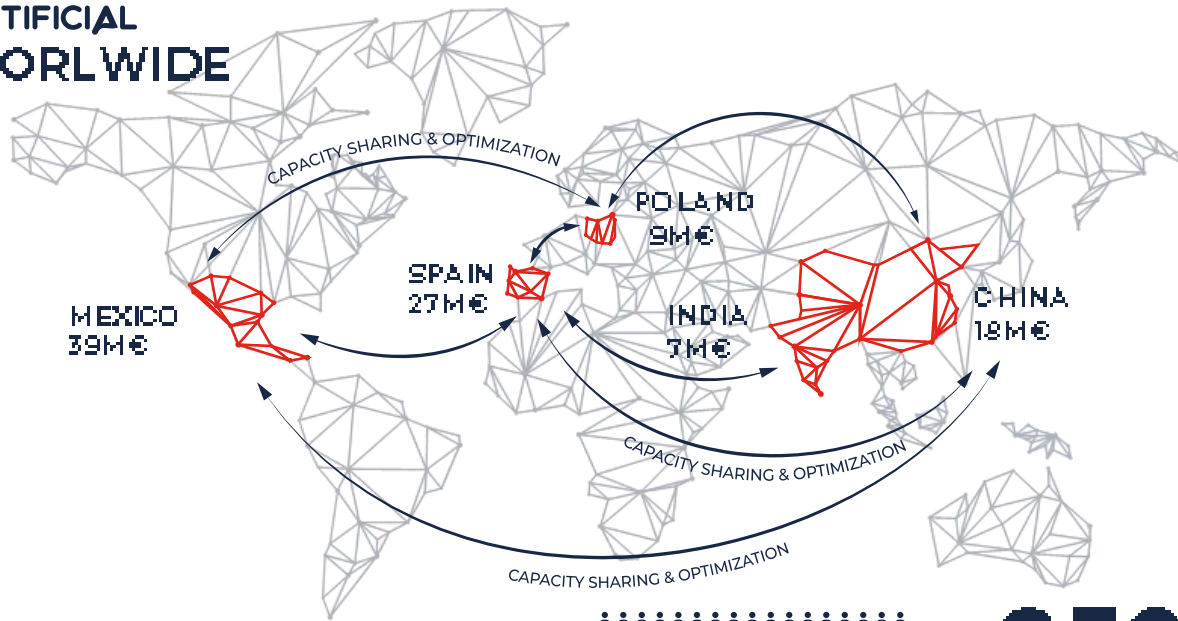
**+28**

years of  
**EXPERIENCE**

**+1000**

SUCCESSFUL  
PROJECTS  
Delivered worldwide

**AIR**ARTIFICIAL  
**WORLDWIDE**



GLOBAL  
CAPACITY **100M€**



**+250**  
HUMAN TEAM  
80% Technical Team

**COMPETITIVE  
ADVANTAGES**



Continuous  
innovation



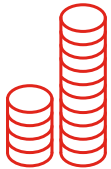
Engineering  
Partnership



Project  
Management

**BUSINESS  
VOLUME**

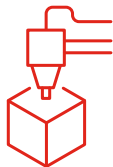
**60M€**



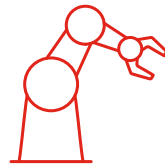
Our main  
CUSTOMERS  
**TOP 20**

Tier 1 Automotive & PROCESSING  
PLATFORM FOR TESTING APPLICATIONS

**PRODUCTS / APPLICATIONS**



Advanced Test  
Technologies



Robotics,  
Vision &  
Assembly  
Technologies



**AITRACE**  
Data Traceability  
Acquisition Analysis  
& Reporting



Smart Factory  
(Automation  
and digital  
transformation)

**OPERATIONAL  
EXCELLENCE**

As a diverto to optimize efficiency  
& customer experience applying  
Lean Six Sigma methodologies.



**AIR**ARTIFICIAL

# Continuous Innovation

## TEAM TALENT

A multidisciplinary global team that applies creativity, analysis, critical thinking, knowledge transmission, and continuously innovation to its engineering work.

## SIMULATION TECHNOLOGIES

We apply all the knowledge to your plant without risks, costs, or mobility.

VR / AR | Process simulator  
Software | Online validations



The scalable traceability SW that will allow you to control and improve the productivity and performance of equipment.

## ADVANCE ROBOTICS

including collaborative robotics

## VISION SYSTEMS

to simplify the assembly and test solutions.

Pick and Place | Assembly |  
Machine tending Dispensing |  
Inspection | Palletizing Screwing  
| Intra-logistics

## PARTNERSHIP PROJECTS

Through PARTNERSHIP PROJECTS we develop the future products and processes

New process feasibility | Process simulation | Critical process validation | Mock-up's | Laboratory's test development | 3D simulation.

## PROBLEM SOLVING SERVICE

We improve equipment performance and solve critic production problems by using methodologies such as lean, 6 sigma, agile in combination with AI algorithms.

## Powertrain Test Benches

### From Development to End-of-Line Production

**Products under test (automotive/defense):** E-motors · Inverters · E-axles · Transmissions · ICE / Hybrid / H<sub>2</sub> powertrains

(Same products across the full development and industrial lifecycle - **Different test depth**, automation level and industrial constraints).

### Laboratory / R&D Test Benches

- Designed to **push powertrains to their limits**  
(*speed, torque, power, temperature, duty cycles*)
- **Durability and endurance** testing aligned with application specific operating profiles
- Flexible and reconfigurable test sequences
- High-accuracy measurement for performance and efficiency analysis
- Support for **development, validation and pre-homologation**
- Adaptable to evolving designs and early prototypes

### End-of-Line (EOL) Test Benches

- **Fully automated** test execution for series production
- Optimized **cycle time, repeatability and robustness**
- **Full traceability per unit**  
(*serial number, results, software & parameter versions*)
- Integration with MES / quality and production systems
- Designed for **24/7 automotive plant operation**
- Compliance with automotive production and quality standards

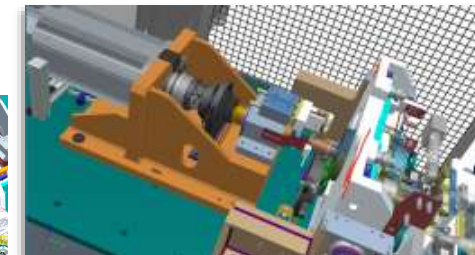
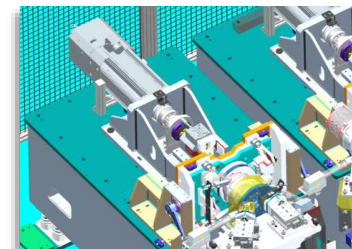
5 x Axes Gearbox (Engine + Gearbox + 4 x Wheels)



1 x Wind Turbine Gearbox Test Bench



1 x Axe Gearbox (Just Engine)



## Laboratory / R&D Test Benches

Designed to explore, validate and push powertrain limits

### What we enable

- **Beyond nominal operation**  
*Overspeed, overload, thermal margins, transient operation*
- **Advanced test control**  
*Speed / torque profiles, dynamic load cases, duty cycles*
- **High-bandwidth measurement & synchronization**  
*Electrical, mechanical, thermal & NVH signals*
- **Durability & endurance testing**  
*Long-duration and accelerated test profiles*
- **Prototype & pre-series support**  
*Non-final HW, evolving interfaces, frequent changes*

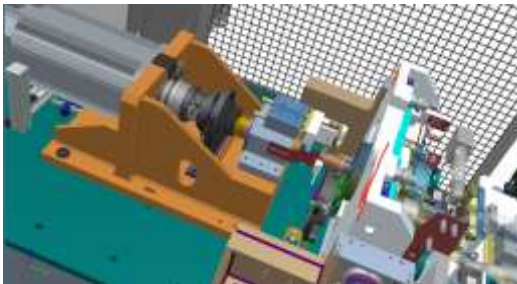


## Powertrain R&D Test Bench Applications

Powertrain systems and sectors covered by our R&D test benches

### Core Powertrain & Energy Systems

- Electric motors
- Inverters & Drives
- e-drive / e-axle
- ICE (combustion) & Hybrid (conventional & alternative fuels)
- Energy storage



### Defense Applications

- Electric & Hybrid
- Propulsion Systems
- High Torque drives
- Mission Critical systems
- Non-standard architectures



### Marine & Naval Applications

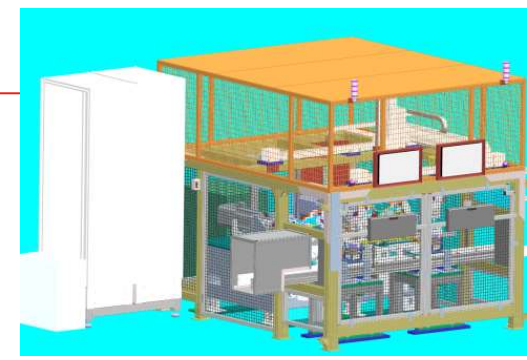
- Electric & Hybrid
- Marine Propulsion
- Diesel engines & marine gearboxes
- Shaft line testing
- Auxiliar power systems



What we enable ?

## End-Of-Line (EOL) Test Benches

EOL test benches engineered for repeatability, robustness and traceability.



### **Determinism & repeatability**

*Fixed sequences and no operator decisions*

### **Production efficiency**

*Cycle-time optimization and parallel testing*

### **Quality & traceability**

*Quality gates and per-unit data integrity*

### **Deterministic test execution**

*Fixed sequences and bounded execution time*

### **Cycle-time driven design**

*Parallel operations and optimized test order*

### **Built-in quality gates**

*Interlocks, limit checks and automatic NOK handling*

### **Production system integration**

*Line control, MES, quality systems and Plant IT*

### **Full unit traceability**

*DUT ID, parameters, results & software versions*

Designed for Continuous Industrial operation    Maintenance, diagnostics and serviceability

**A**IRTIFICIAL

## End-Of-Line (EOL) Applications

Production and acceptance testing for powertrain and energy systems.

### **Core EOL Powertrain Applications**

- *E-motor EOL testing*
- *Inverter EOL testing*
- *Integrated e-drive / e-axle EOL*
- *Transmission & Gearbox EOL benches*



### **Energy & Electrification EOL**

- *Battery pack EOL testing (functional, Insulation, Safety)*
- *DC systems & Power Electronics EOL testing*
- *Battery simulation EOL*



### **Special & Industrial EOL Applications**

- *Acceptance test benches*
- *Palletized / stand-alone EOL*
- *Dual / parallel stations (time optimization)*
- *Custom low-volume EOL*

***EOL solutions adapted to production volume, quality requirements and system criticality.***



# Airtificial Testing Platform

Software Architecture  
Separation of Responsibilities

**Test Sequencing**

*Define Test process & execution Flow*

**NI TestStand**

**Real-Time Control**

*Executes System Dynamics & Control Loops*

**LabVIEW RT, TwinCAT RT, dSPACE, others**

**Data Logging & Traceability**

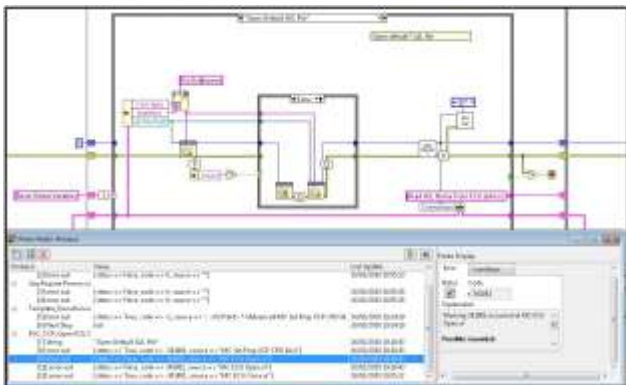
*Ensure test integrity and result traceability.*

**NI LabVIEW, dSPACE, Others**

**HMI / Operator Interface**

*Operator Interactions & Test supervision.*

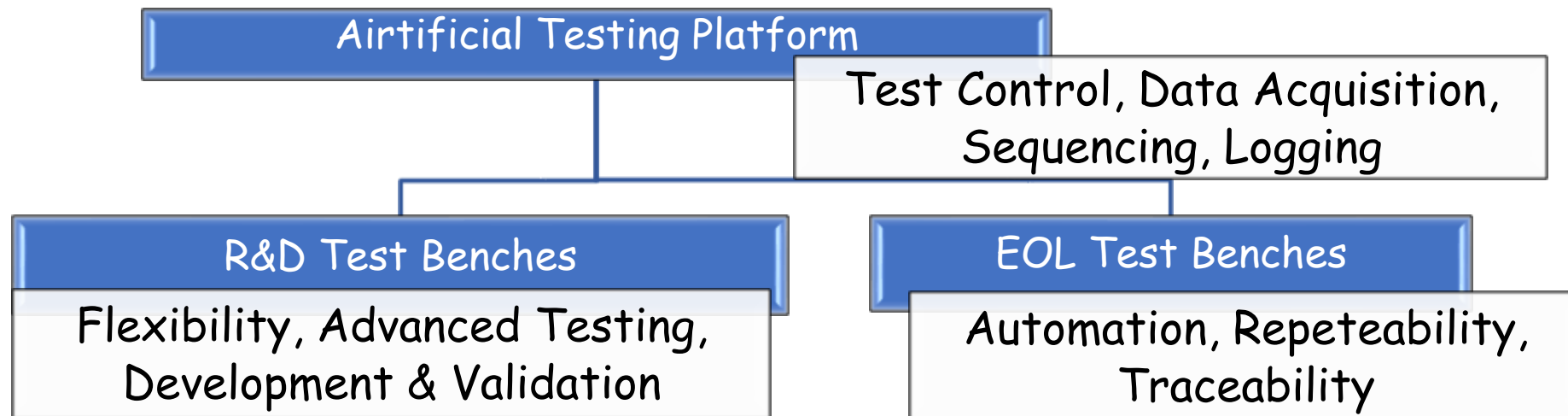
**PC or PLC based applications**



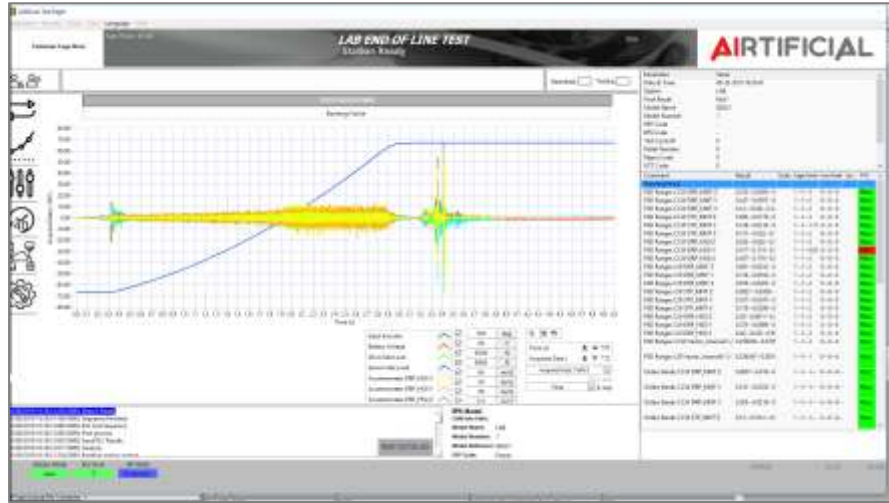
## Airtificial Testing Platform (AITP)

A common and scalable platform for R&D and EOL test benches.

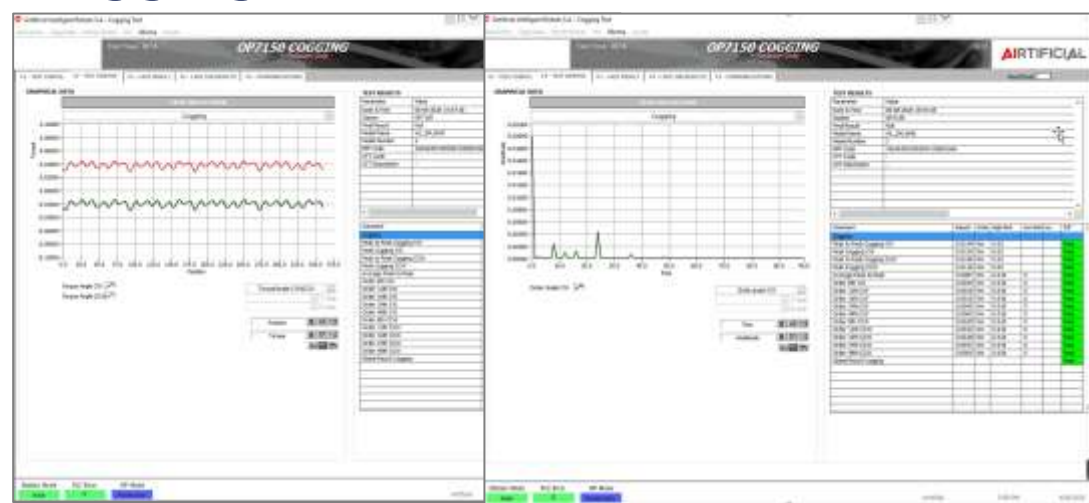
- **Common test control and data acquisition platform** for powertrain and energy systems
- **Configurable for R&D or EOL needs** (*flexibility vs automation, depth vs speed*)
- **PC-based or PLC-based architectures** depending on machine and production requirements
- **Integrated test sequencing, instrumentation and data logging**
- **Foundation for traceability, analysis and reporting**



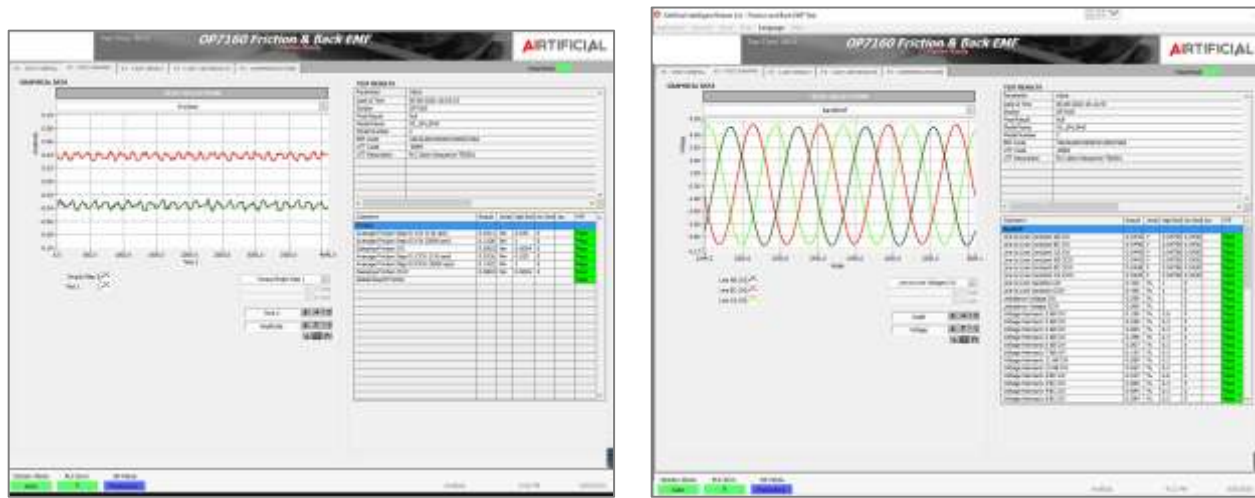
# Noise



# Cogging



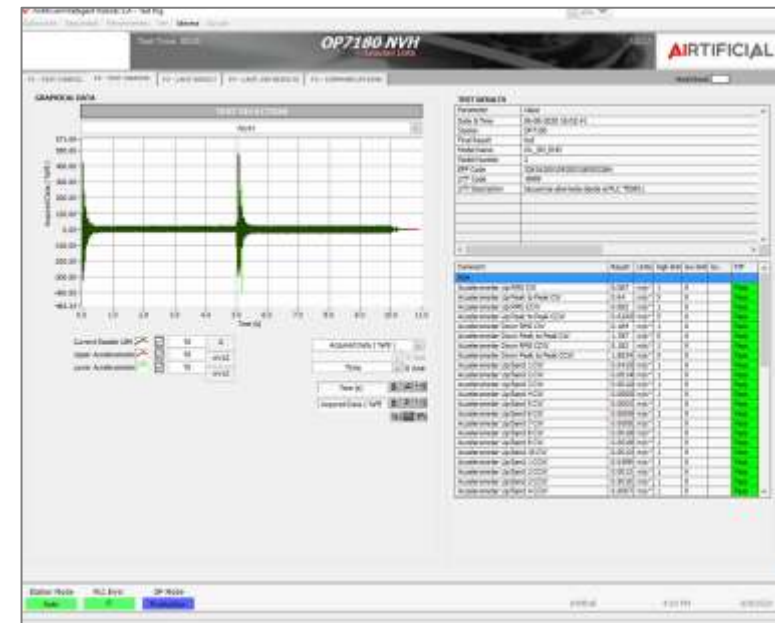
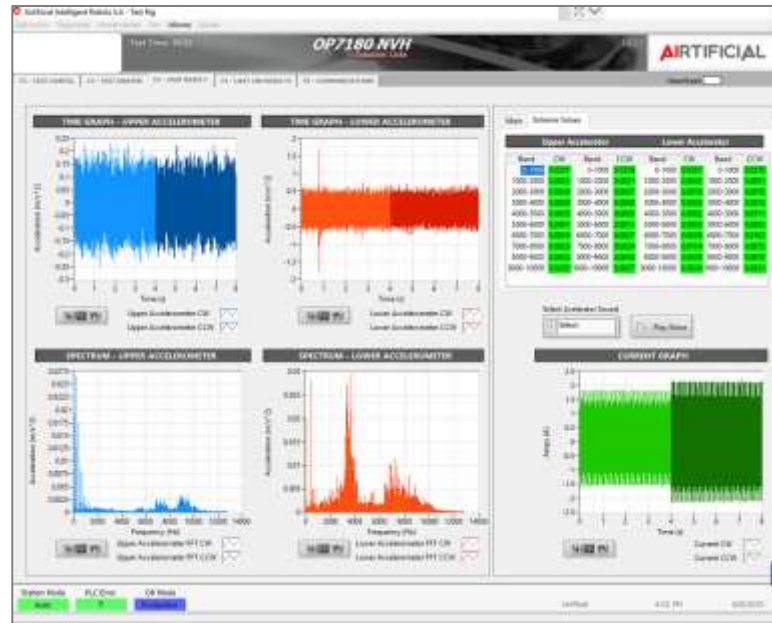
# Friction & Back EMF



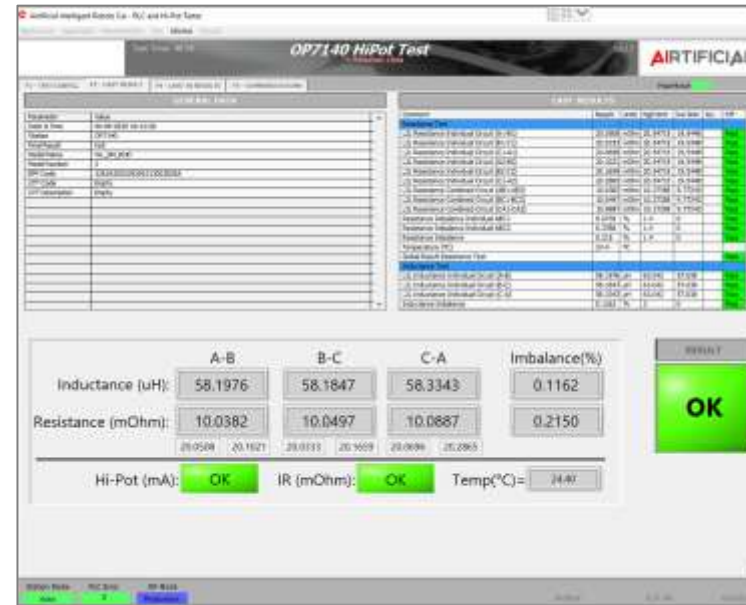
# Axial Lash



# NVH



# Electrical Test



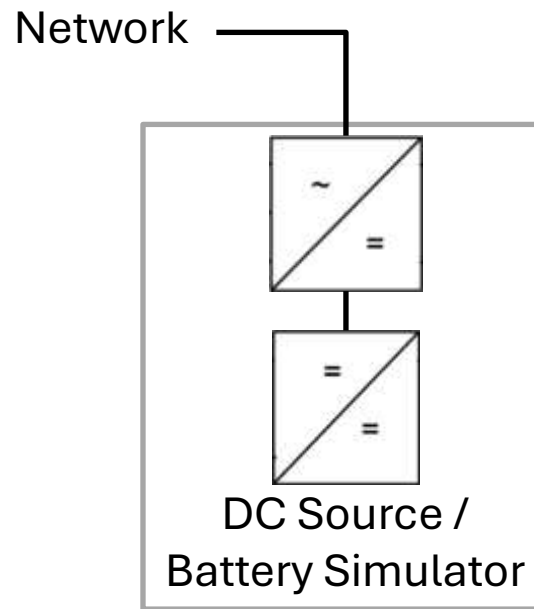


# Airtificial Motoring Platform

# High Power General Schema

## Motoring Options:

- Allowed Supply **400/690 Vac**
- **AFE** network connection (Bidirectional)
- Dyno control in Motoring and Regenerating
- **Torque, Speed & Position** Control up to 4[kHz] (**250[μs]**) control, motor **20kHz**
  - Ramps, PID, **Torque linearization**, Inertia compensation, inertia simulation, variable switching Frequency (optional), etc

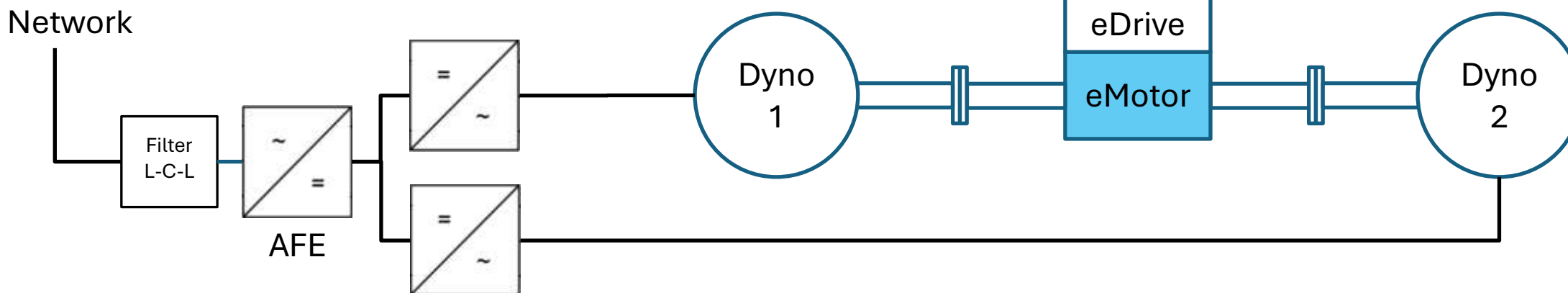


## DC source Options:

- Classical with Trafo & IGBT
- Without Transformer: Resonant converter (IGBT or SIC)
- Up to 1500 [Vdc] – 500kW

## Battery Simulator Options:

- Different simulation Options



## High Power General Schema – Optional Shared DC bus

### Motoring Options:

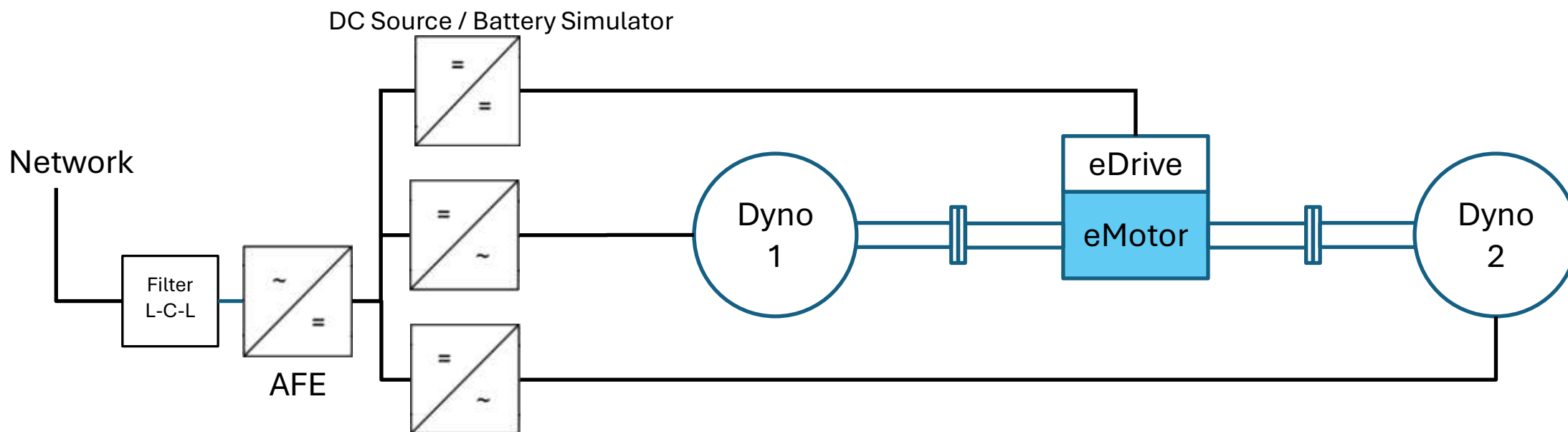
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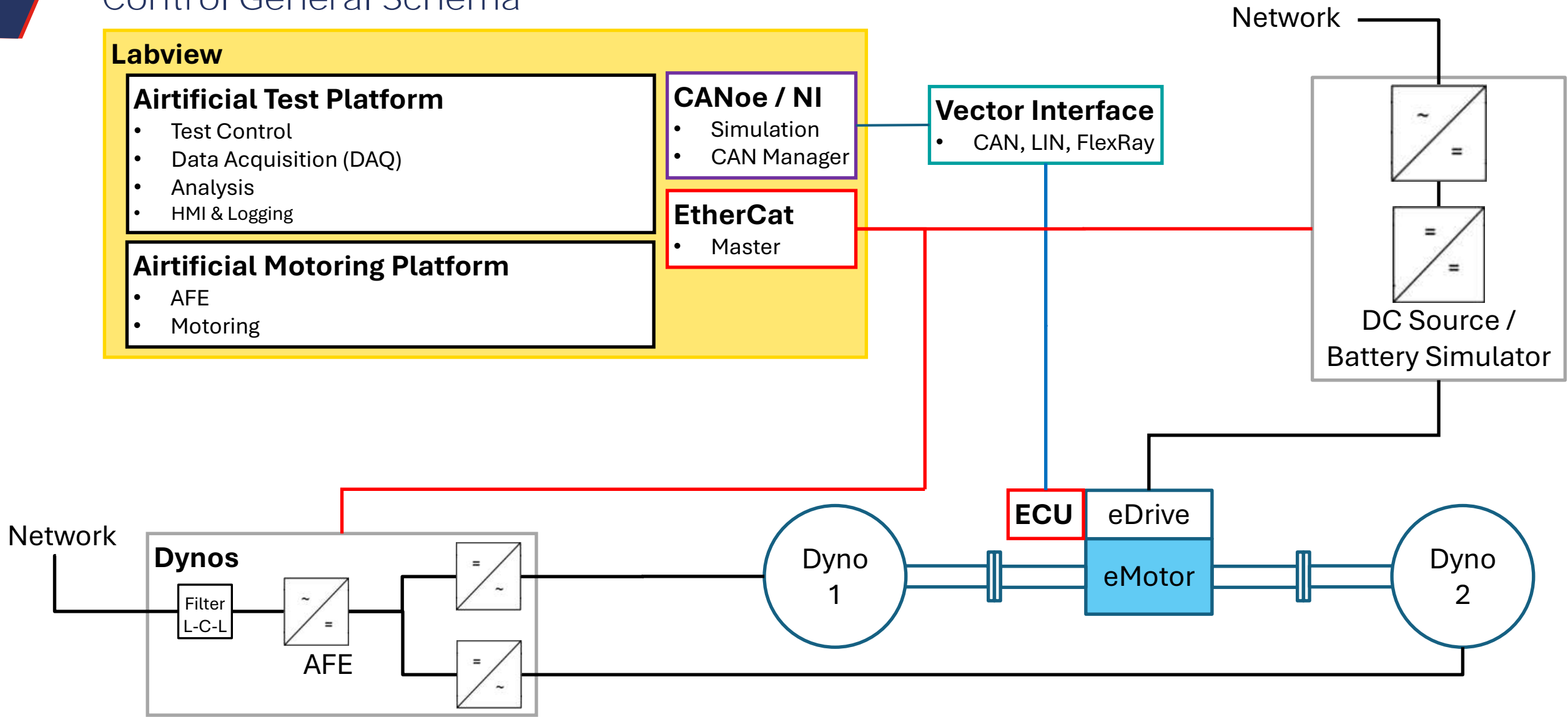
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### Battery Simulator Options:

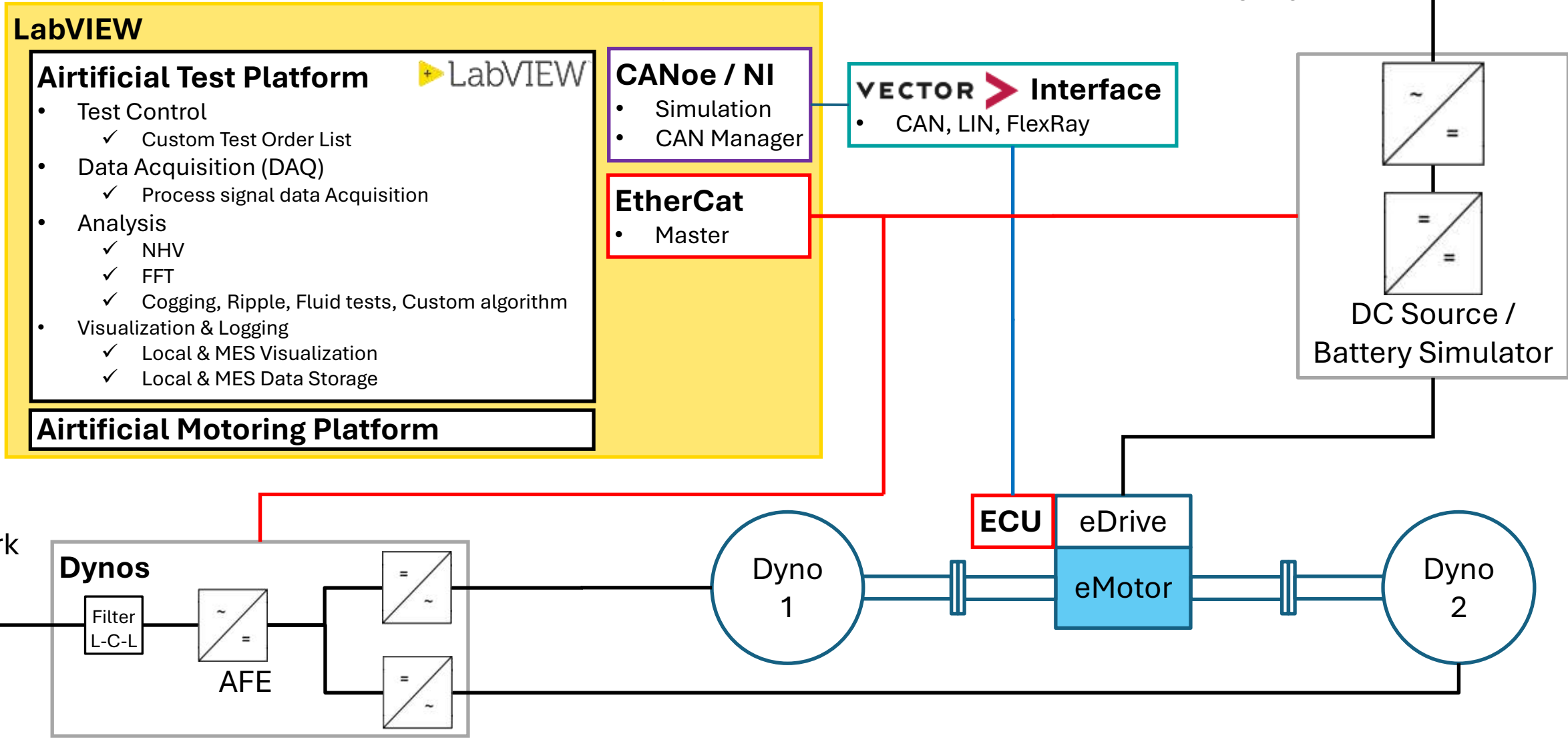
- Different simulation Options



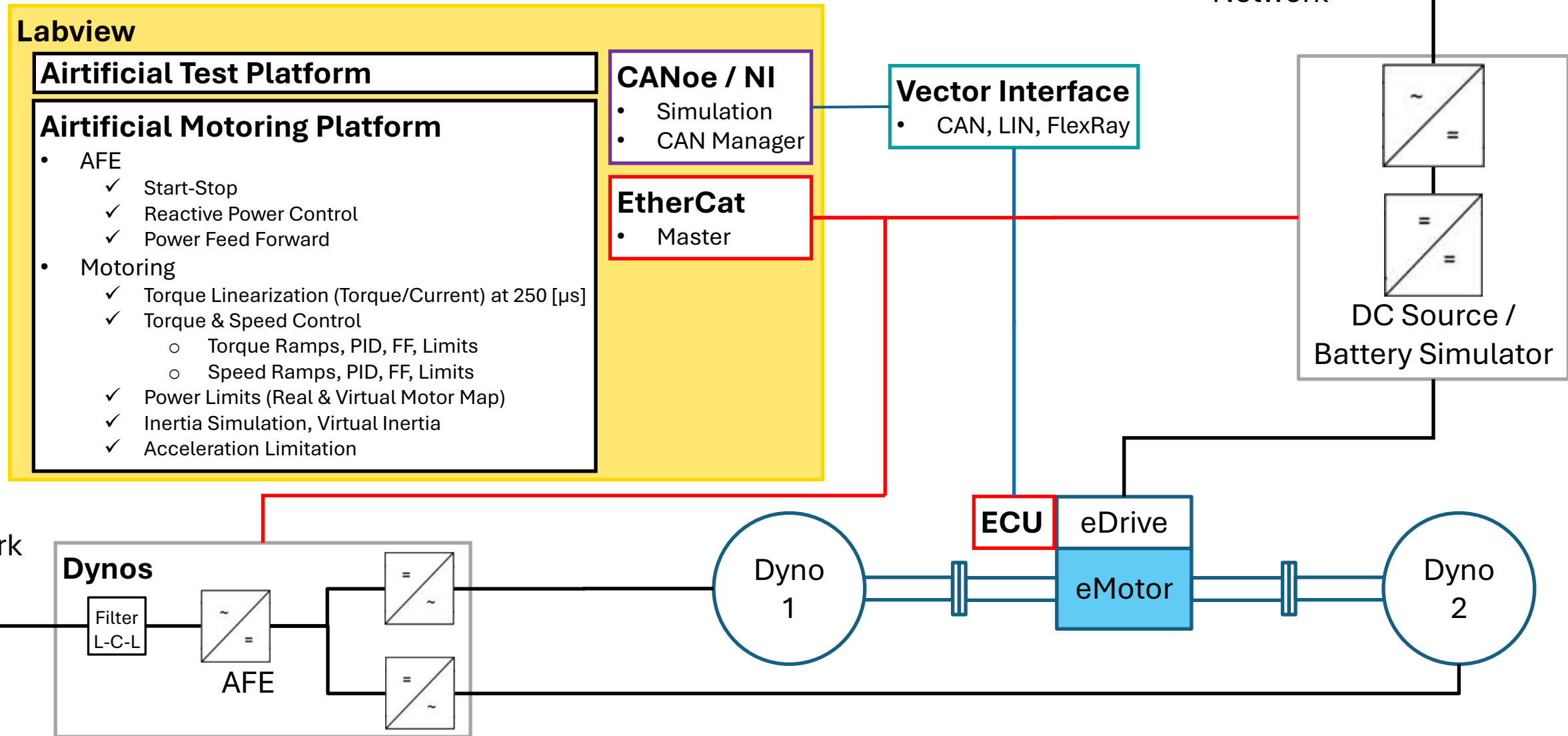
# Control General Schema



# Control General Schema

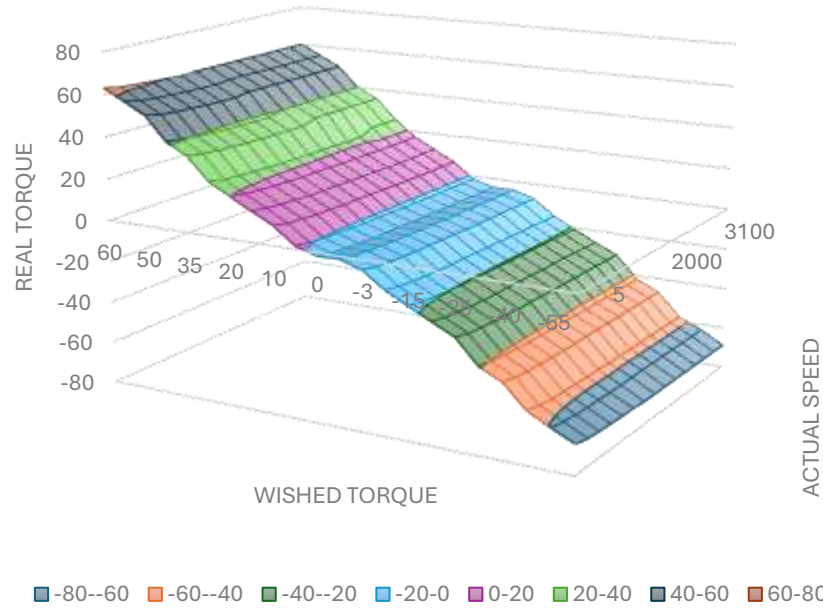


# Control General Schema



# Torque Linearization Details

Lux Lab Torque Linearization Surface



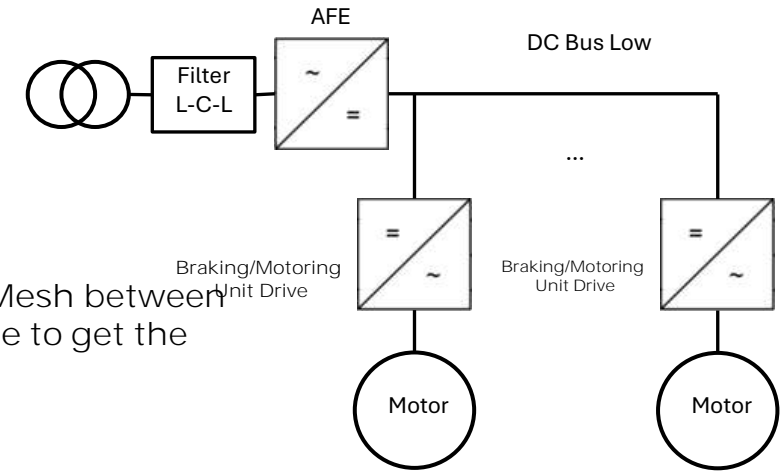
Auto SF Torque Linearization:  
 Drive Switching Frequency and Torque Linearization Surface changes automatically with the Speed to the proper one.

The process of changing the Switching Frequency and the Surface is synchronized to avoid "Gaps".

These surfaces are overlapped by a Threshold to ensure a hysteresis depending on the Dynamics to ensure a safe change also when accelerations are high.

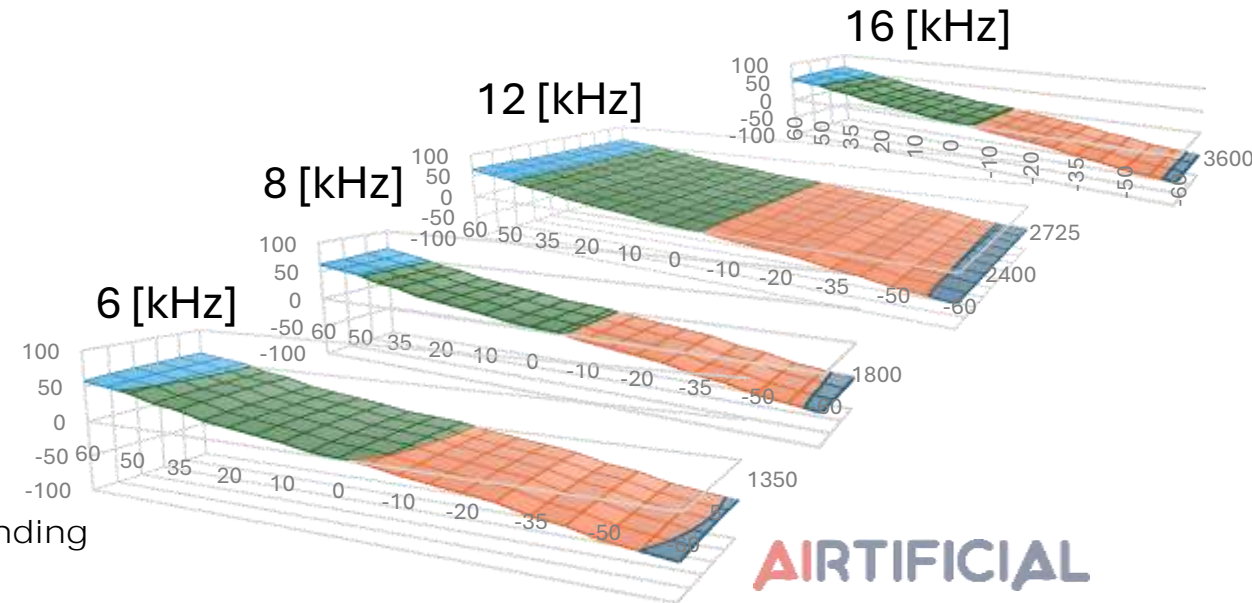
Standard Torque Linearization  
 (For a fixed Switching Frequency)

It's created an Interpolated surface Mesh between the Actual Speed and Wished Torque to get the Real Torque.



## Multiple Switching Frequency

Motors that allow more than one Drive switching Frequency. The motor current at low speeds is higher for some motors than at high speeds. If lower switching frequencies are used at lower speeds, the number of power units required is reduced.

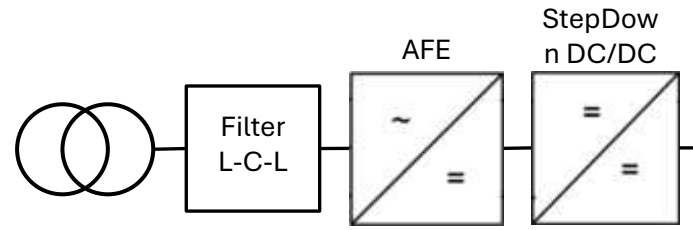




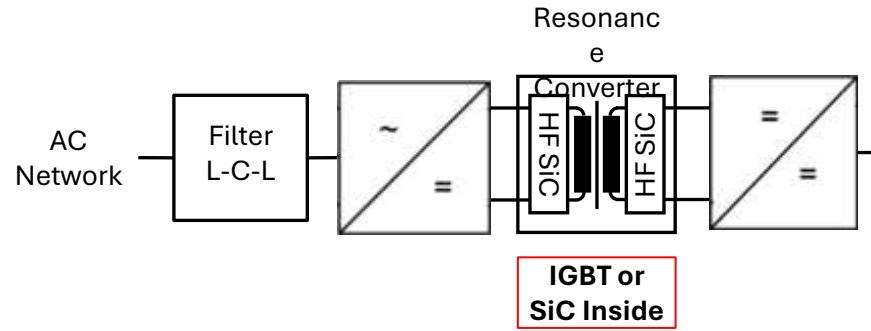
# DC Sources

DC Source

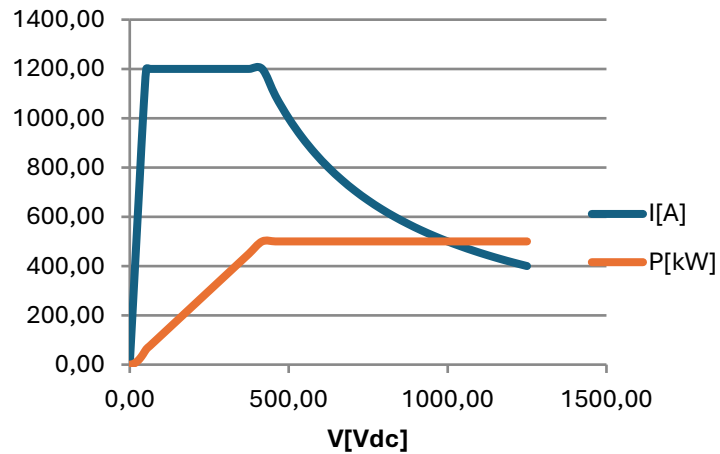
Classical Option with input transformer



Resonant converter Option



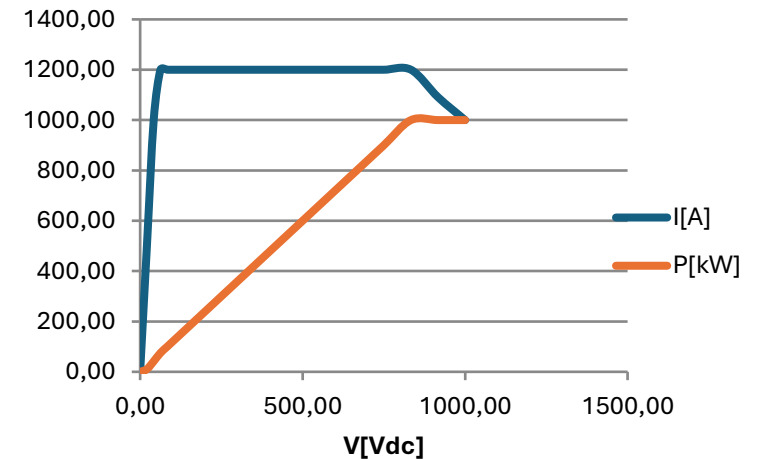
I[A], P[kW] DC/DC for batteries



500[kW], 1000[V], 1200[A]

Options for Battery Testing of for Battery simulation (supply eDrives)

I[A], P[kW] DC/DC Drive Supply

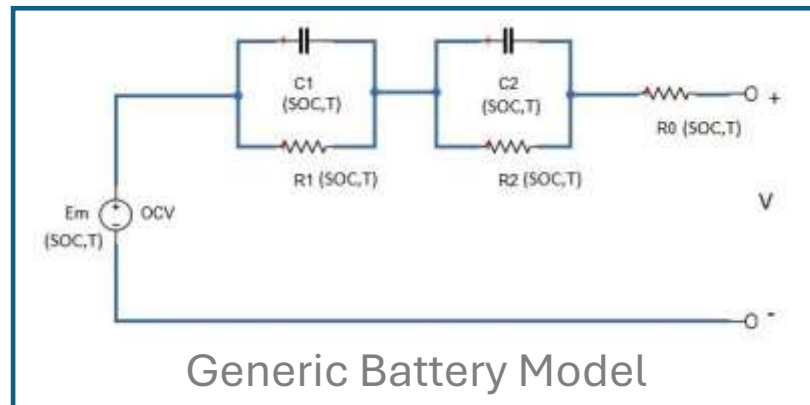


1000[kW], 1000[V], 1200[A]

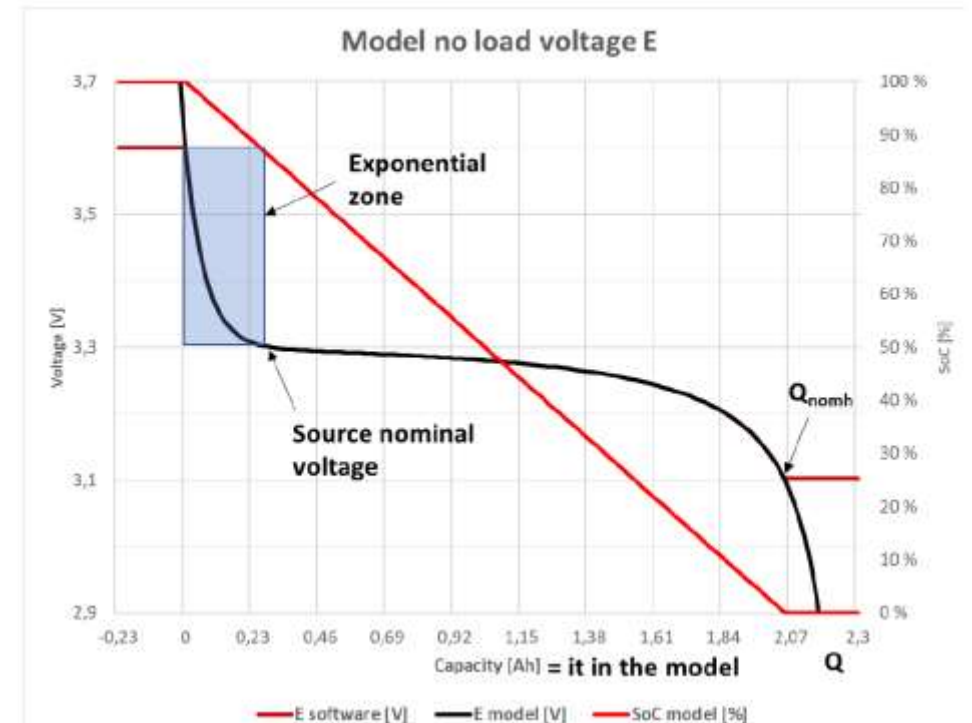
# Battery Simulation

For the **Battery simulation** model we can:

- Just Constant DC Source
- Simulate only R0 (inside DC source)
- Simulate R0, R1, C1, R2, C2 (external control)
- Complex Models (external control)



The resulting no load voltage of a Li-Ion cell is presented in the following graph.

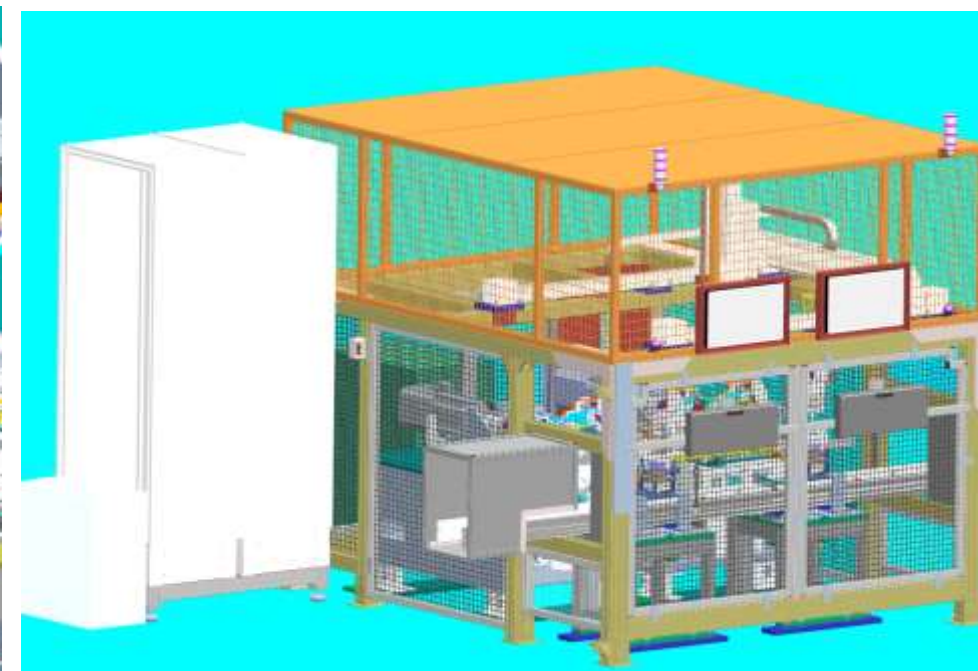
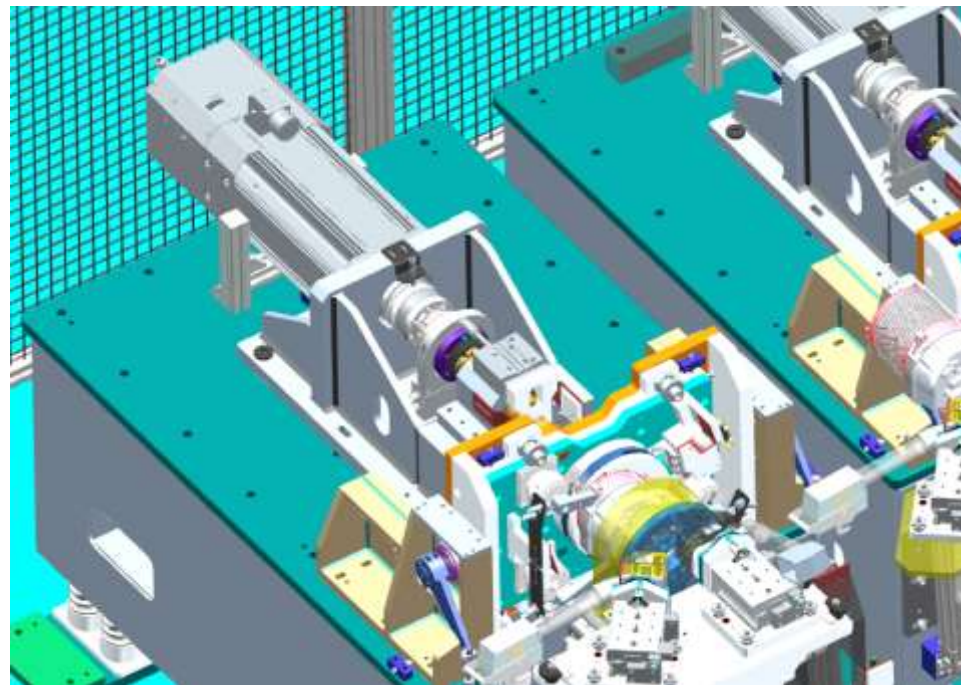




# References

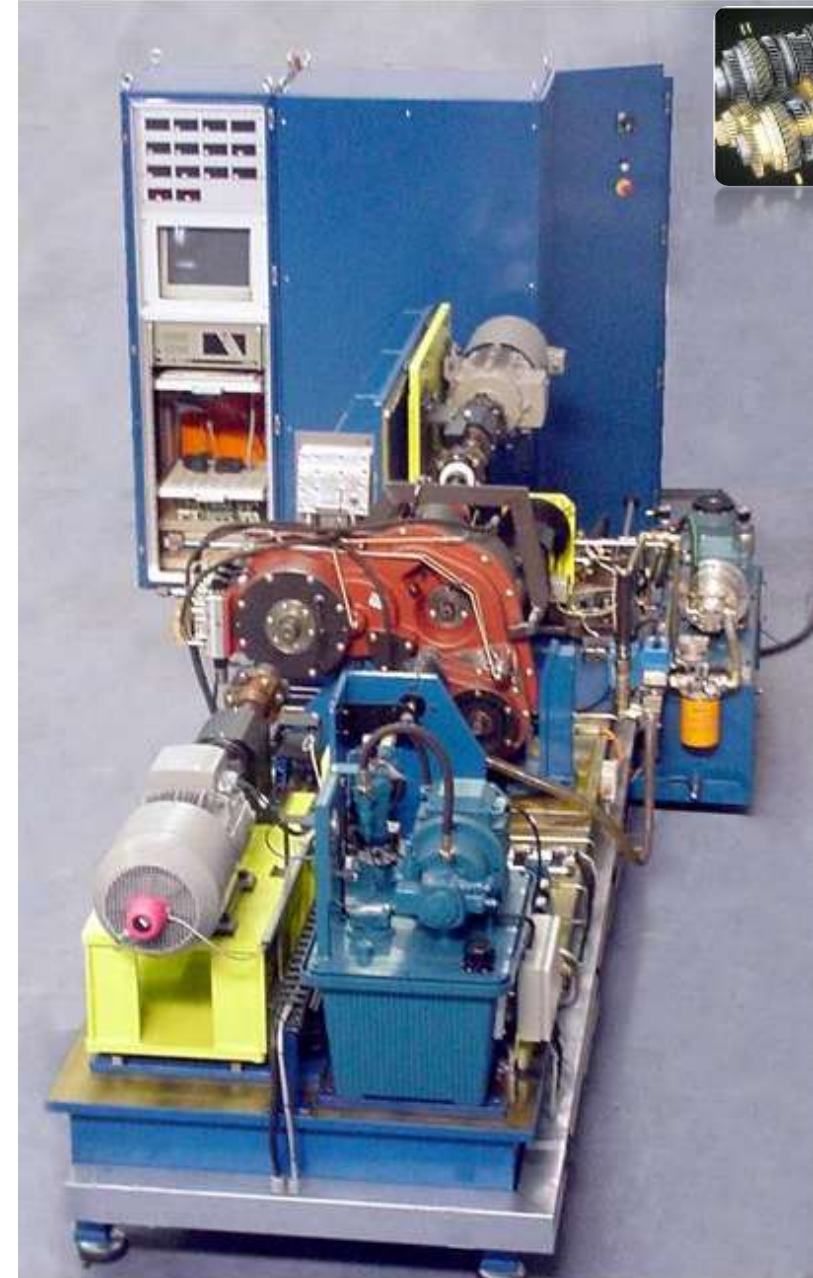
Market	Product / Sub-Product	Application	Project	Responsible	Customer
Automotive	Powertrain / e-drive	Motor & inverter	Production test	Adrià Molino	Borgwarner

- **EOL: Test & Calibration, Dynamic performance test, Noise Test**
- Production equipment for performance test of electrical motor **HEV with inverter** (14,500rpm-70Nm-20kW peak power)
- Dual test station for cycle time with **auto loader** manipulator. Auto rotation to horizontal and connection
- Load test motors Bosch-Rexroth 6000rpm - 20kW. Motors in 4 quadrant operation
- Motor Power units with regenerative power supply
- Customer Inverter DC power supply 48V-20kW peak power
- Integration of customer **inverter vehicle simulation & CAN** communications
- **LabView** application for speed setpoint, test acquisition and data storage



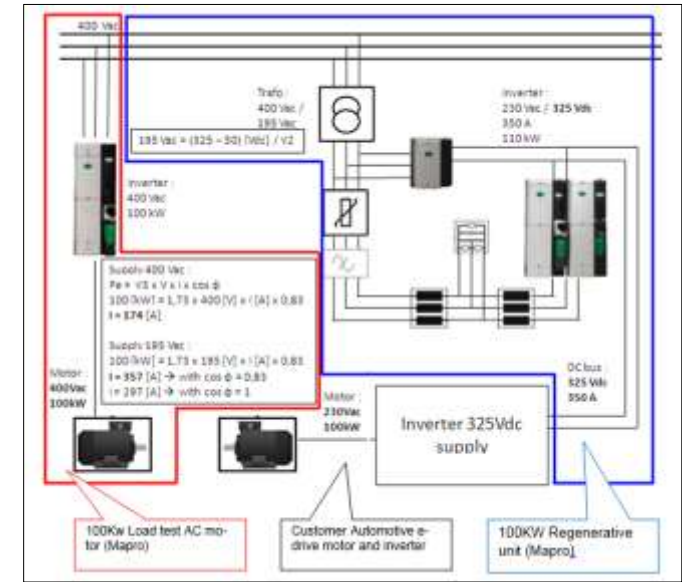
Market	Product / Sub-Product	Application	Project	Responsible	Customer
Trucks	Powertrain / transmission	Gearbox	Production Test	O. Serrano	JOHN DEERE

- Palletized test bench with flexibility for different models of **Gearboxes**
- Hydraulic supply for oil filling and temperature stabilization
- Servo motor control of the power to input shaft- Torque measure
- AC motor for braking system of the output shaft- Torque measure
- ABB Regenerative electrical unit system



Market	Product / Sub-Product	Application	Project	Responsible	Customer
Automotive	Powertrain / e-drive	Motor & inverter	Laboratory test	J. Solà	LEAR E

- Laboratory equipment for performance test of **electrical motor EV** (100kW)
- Load test motor Emerson inverter & 100kW motor
- Motor in 4 quadrant operation
- Power unit with regenerative power supply
- Integration of customer inverter (same as used in car)
- LabView application for speed setpoint, torque test acquisition and data storage





# Other References

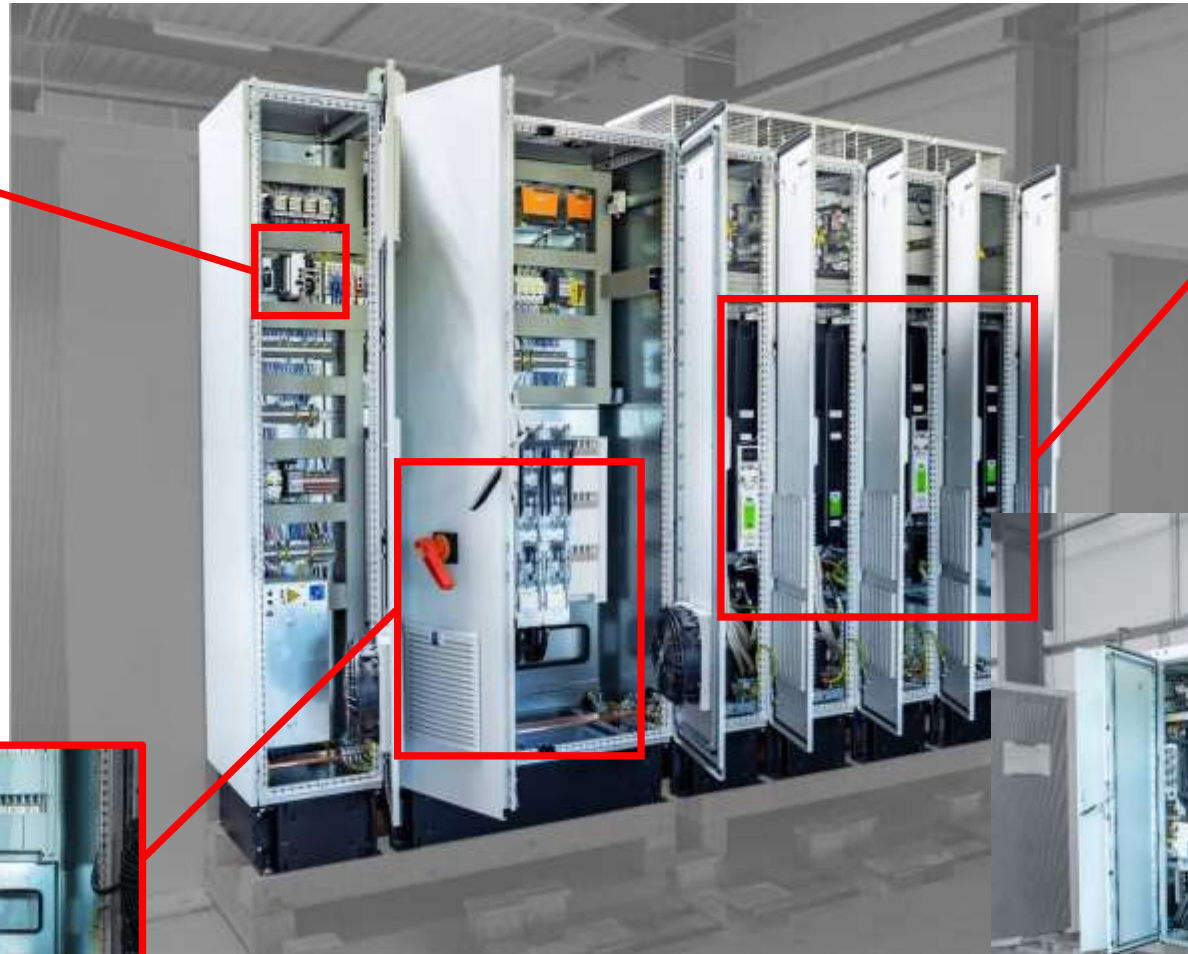
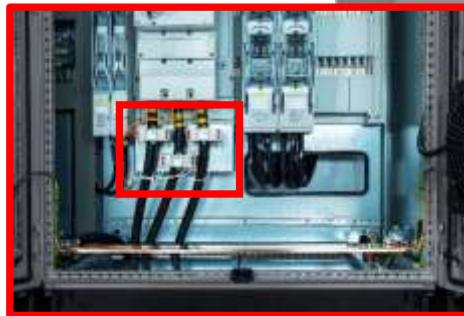
# Motoring



The PLC allow us to be Brand Drive Independent.

- *Interface* with Upper Control
- *Control* AFE (Start/Stop, Power FF, Reactive Current , ...)
- *Control* Motors (Logic, Torque Linearization, Auto-Switching frequency, Limits, ...)

Sensors to control the *Real Reactive Current*



Sample with *Different Drive Brands:*

- *Air-cooled* Drive up to 16[kHz] Switching-Frequency.
- *Water-cooled* Drive up to 32[kHz] Switching-Frequency.



Sample Cabinets

# Motoring



# Motoring

## 3 x dyno gear testbench

Drive Brand	Control Techniques
Voltage Supply	400[Vac]
Speed	3.300[rpm]
Current	up to 625[A]
Torque	up to 5.100[Nm] - S6
Switching Frequency	3[kHz]
Cooling	Air cooled
Special features	Smart Maintenance over Remote
Highlights	3 Dyno differential gear testbench



Sample Cabinets

# Motoring

## 2 x dyno heavy duty test bench

Drive Brand	Control Techniques
Voltage Supply	690[Vac]
Speed	3.950[rpm]
Current	1700[A]
Torque	up to 17.000[Nm] - S6
Switching Frequency	3[kHz]
Cooling	Air cooled
Special features	Smart Maintenance over Remote
Highlights	Heavy Duty



# Motoring

EV – differential gear test bench	
Drive Brand	UNICO
Voltage Supply	400[Vac]
Speed	20.000[rpm]
Current	1470[A]
Torque	655
Switching Frequency	12[kHz]
Cooling	Water cooled
Special features	Smart Maintenance over Remote
Highlights	High Dynamic test bench



# Motoring

turbine test bench	
Drive Brand	Control Techniques
Voltage Supply	400[Vac]
Speed	14.300[rpm]
Current	713[A]
Torque	336[Nm]
Switching Frequency	6[kHz]
Cooling	Air cooled
Special features	Smart Maintenance over Remote
Highlights	500[kW] continuous power



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