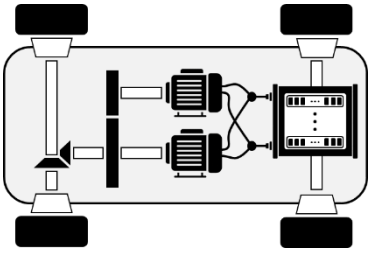
DRIVETRAIN TESTING

FLANDERS MAKE
DRIVING INNOVATION IN MANUFACTURING

HARDWARE-IN-THE-LOOP (HIL) TEST INFRASTRUCTURE WITH FPGA IMPLEMENTATION FOR DUAL DRIVE APPLICATIONS

Location: FlandersMake@UGent

DESCRIPTION



With our Hardware-in-the-Loop (HiL) test infrastructure for dual-drive propulsion systems (for example in electric vehicles) you can assess the performance of dual-drive control strategies, virtual sensing and power flow management systems in terms of operational range and energy efficiency. This both at a real-time machine-level control and at the supervisory level..

Machine level control of the dual drive is realized using Field Programmable Gate Arrays (FPGAs), which allow profound parallelization of processing calculations by providing a reconfigurable interconnection of logic blocks. The processing core is then configured for the application but might be altered by reprogramming the interconnections between the distinct hardware blocks. A high degree of flexibility is hence attained. Due to the massive parallelization, FPGA-technology allows for extremely fast calculations, which are required e.g., for implementing Direct Torque Control (DTC).

The experimental setup consists of a series arrangement of a dual-drive topology. Both electric motors are off-the-shelf induction motors (5.5kW-3000rpm and 1.1kW-3000rpm) connected on a single shaft without intermediate transmission.

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TECHNICAL SPECIFICATIONS

- Load motor: emulation of variable and realistic driving scenarios, which allows validation under dynamic load conditions
    - Connected at outer end of the shaft
    - Speed controlled
    - Two-pole 5.5 kW induction motor
    - Efficiency class IE3
    - Motor drive: Siemens Sinamics S120
- Mechanical sensors
    - Incremental rotary encoder (1024 lines)
    - Torque sensor: Lorenz DR-2112 (20 Nm, 0.1% f.s. accuracy)
- Dedicated Dual Drive system
    - 5.5 kW – 3000 rpm induction motor (class IE3), 230/400V
    - 1.1 kW – 3000 rpm induction motor (class IE3), 230/400V
    - Dedicated control logic and inverter boards
        - dSPACE MicroLabBox with RTI and Xilinx Kintex-7 XC7K325T FPGA for generation of control signals to inverter gates
        - Inverter: specialized three-phase full-bridge platform, Infineon FS50R12KT4 B15 IGBT modules
        - DC link voltage and current measurement
        - Phase current measurements of both motors: LEM LA 55-P, rating 50A
- Power source
    - Delta Elektronika SM 500-CP-90
    - bi-directional programmable DC source: supply and sink energy for regenerative braking option

Research developments on this platform include the use of digitization to facilitate the transition to vehicle electrification, where a data-driven sensing-control architecture was developed for energy-efficient actuation of an all-electric dual-drive powertrain. More specifically, this involves the application of dual Kalman filtering (DKF) for virtual sensing, Approximate Dynamic Programming (ADP) for real-time close-to-optimal machine control, adaptive regression for reliable data-driven loss models and Model Predictive Control (MPC) for online power flow management.

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OUR OFFER

We offer the following services on our dual-drive HiL test infrastructure with FPGA implementation:

- A **dual-drive HiL platform** to develop and test your own machine-level or supervisory-level control proof-of-concepts in a safely controlled environment.
- An **FPGA module** which allows implementation of a wide variety of control that requires extremely fast calculations, for example Direct Torque Control (DTC).
- A **wide library of operational datasets** with varying operating conditions (different driving cycles, loads, speeds etc) for benchmarking and validation. We can provide newly generated experimental datasets as well, based on your specific needs.
- An **opportunity for knowledge transfer** and collaboration based on our developments on virtual sensing, ADP, adaptive regression and MPC for online power flow management applied on your specific case.

INTERESTED?

Contact contact_EEDTMP@flandersmake.be for more information.