EDUCATIONAL LABORATORY DEMONSTRATOR FOR TEACHING DUAL ACTIVE BRIDGE CONTROL PRINCIPLES

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SIELA 2022

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June 3th 2022

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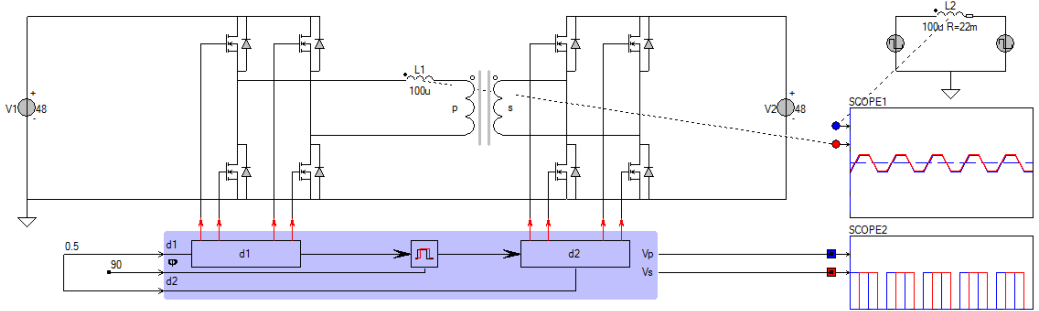
Introduction: Dual Active Bridge

Control of Power flow in DC grids

- Galvanic Isolation
- Bidirectional power flow
- Wide voltage range
- Short circuit protection
- Earth leakage protection

DAB Principle and Modulation



Two full bridges and dutycycle and phase shift control

Lecture outline

Full model and simplified model

- Replace full model with two sources and only leakage inductance
- Understand the voltage across $L_{leakage}$
- Analyze the various modulation methods

Teaching Objectives

Understand and Analyze

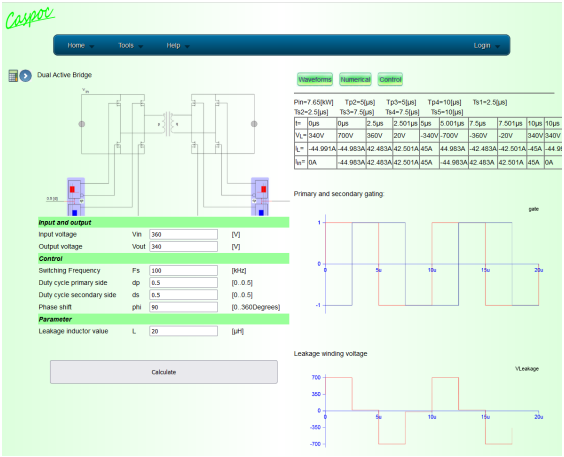
- Bidirectional power transfer via the coupled inductors
- Control the power transfer via phase and duty-cycle variation
- Importance of the leakage inductance
- Compromise between increasing switching losses in the Mosfets versus reduced losses in smaller magnetic cores for increasing switching frequency

Tools and Methods

Theory and practice

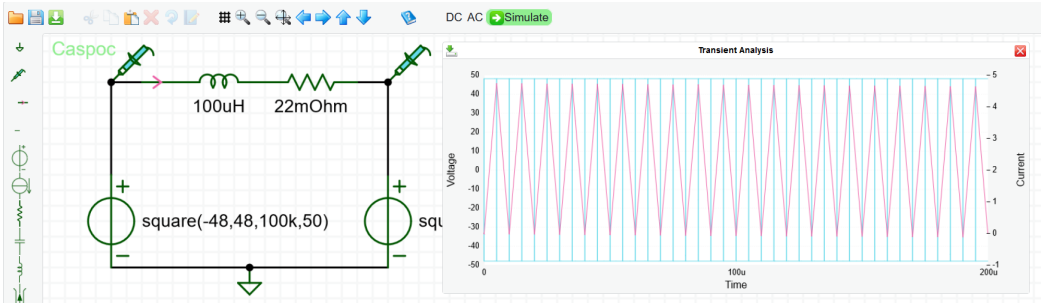
- Online design tool
- Online simulation tool for simplified model
- Simulation/Animation tool for complete model
- Experimental demonstrator

Design tool



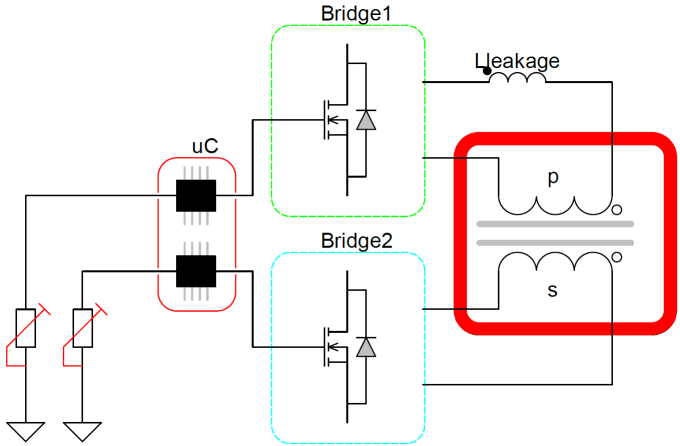
Design tool to estimate leakage inductance and waveforms

Simulation of principle



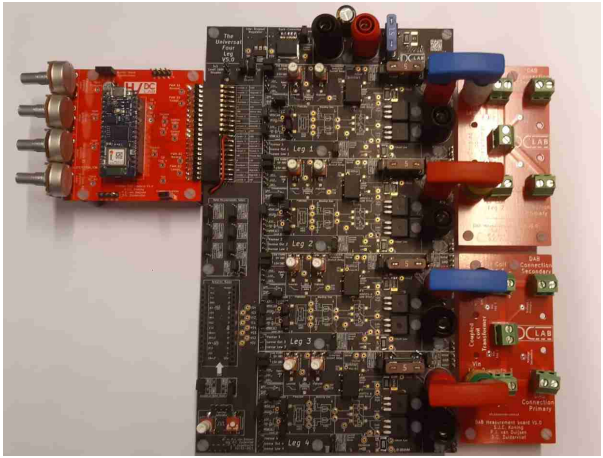
Online Simulation tool to estimate leakage inductor waveform

Principle diagram



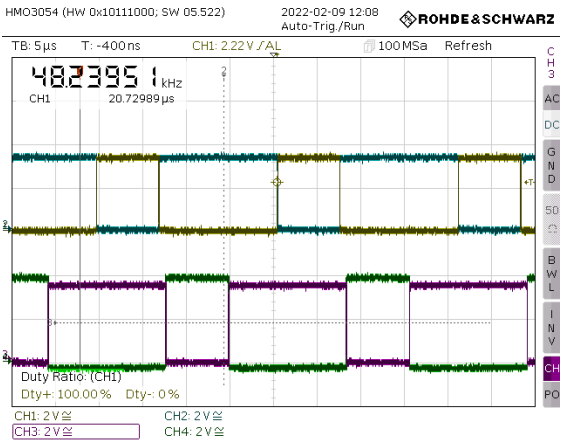
Experimental set up diagram

Experimental demonstrator



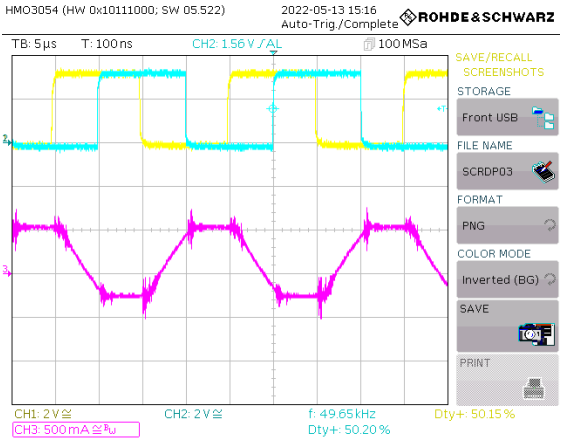
Experimental set up using Universal Four Leg

Control signals



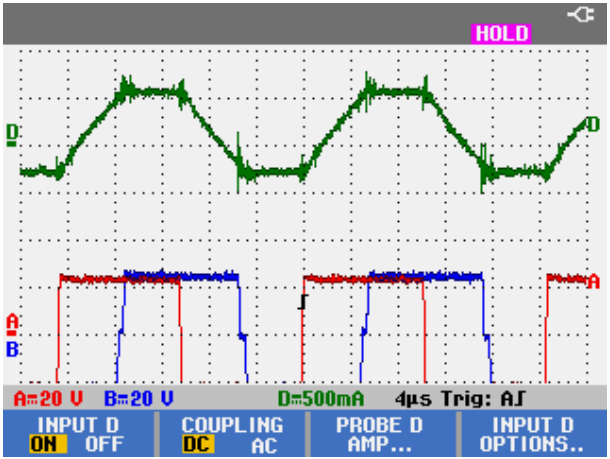
Arduino controller output signals

Experimental demonstrator



Upper traces are the left and right bridge gate control signals, with a phase difference of 90 degrees. The lower trace is the periodic current through the leakage inductance(Offset 300mA, Peak-Peak = 600mA).

Experimental demonstrator



Upper trace, leakage inductor current (Ipp=0.9 Ampere), and bridge output voltages(Vpp=40v), of the DAB with phase difference of 90 degrees, operating at 75kHz, Vdc=20v.

Conclusion

- Dual Active Bridge
- Galvanic Isolation & Protection
- Laboratory demonstrator
- Easily change frequency, duty cycle and phase shift

Thank you!
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