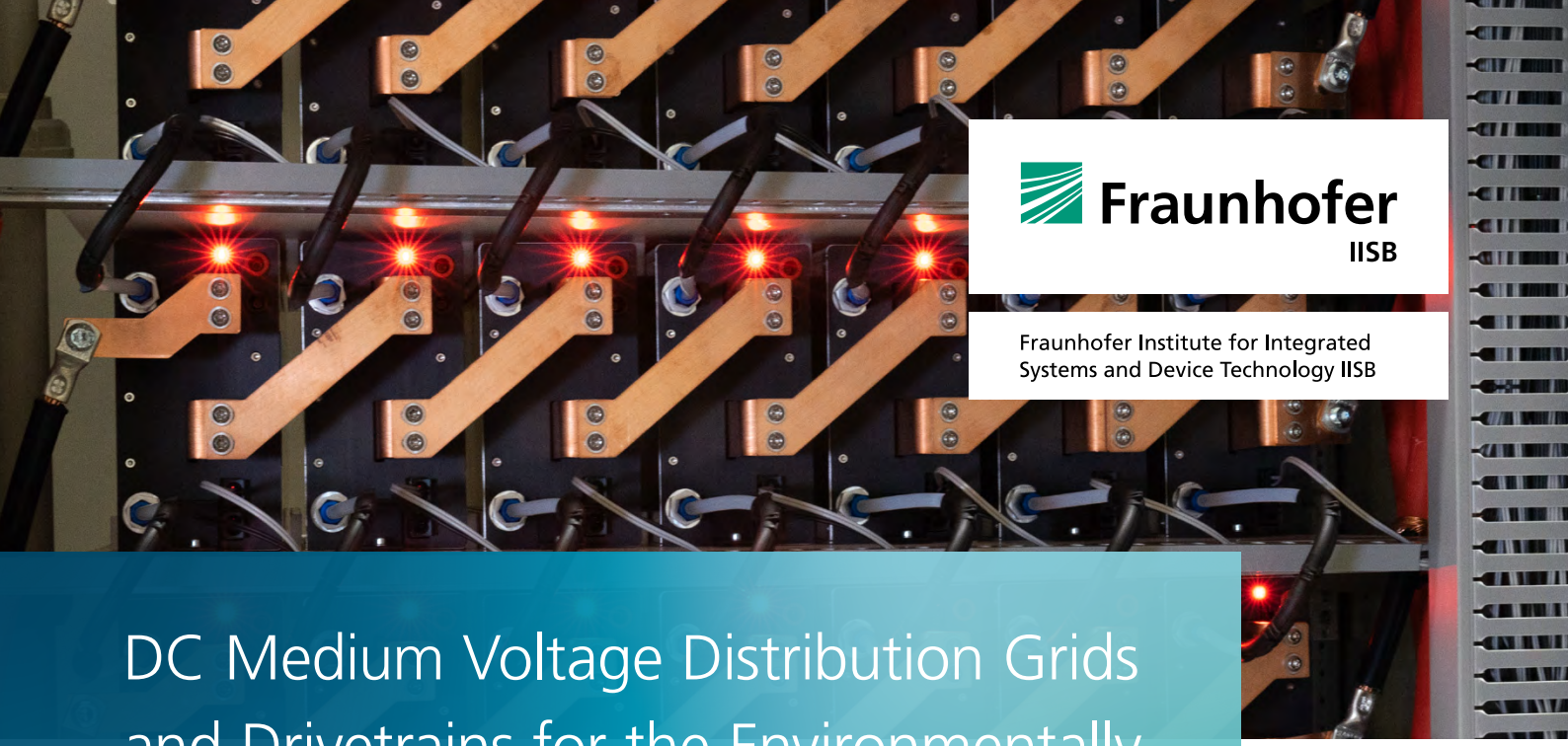


Fraunhofer IISB

Fraunhofer Institute for Integrated Systems and Device Technology IISB

DC Medium Voltage Distribution Grids and Drivetrains for the Environmentally Friendly Operation of Cruise Ships

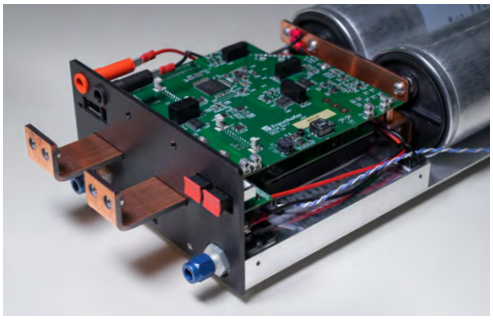
Modular Multilevel Converter (MMC) with 42 full bridge cells © Elisabeth Iglhaut / Fraunhofer IISB

Motivation

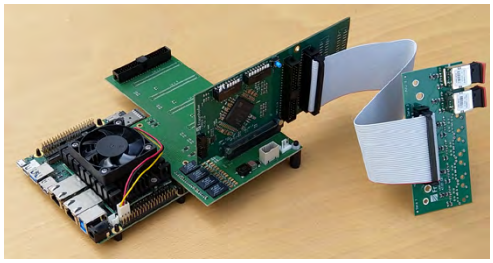
- Reduction of pollution and CO_2 emissions of cruise ships
- MVDC grid instead of MVAC grid: Easy integration of batteries and fuel cells
- Reduction of installation space by 30 % and materials by 10 %
- Energy consumption down to 85 % at partial load, down to 97 % at full load

Project Partners in MVDC4S

- Siemens AG: Safety systems and isolated MV DC/DC converters
- Siemens Energy: Overall drivetrain and energy distribution design
- Meyer Werft: Systems integration and benchmark; end user
- Semikron Danfoss: Efficient semiconductor power modules
- AQ Inductive Components: Compact transformers for MV DC/DC conversion
- Fraunhofer IISB: MV drive inverter and system benchmark in MV test lab



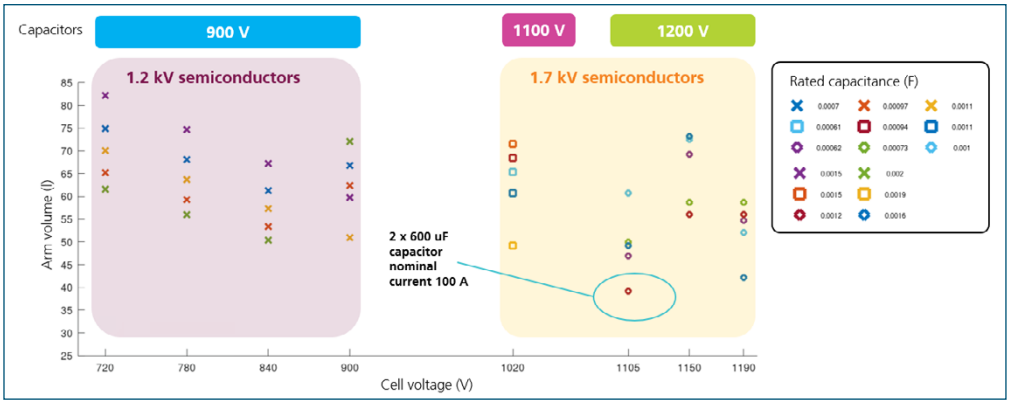
Full bridge cell with optimized volume including 1.7 kV IGBT modules and 1.2 mF capacitance © Elisabeth Iglhaut / Fraunhofer IISB



FPGA master control unit with redundant optical Gbit interface to MMC cells with transmission times as low as 2 µs © Christian Braschwitz / Fraunhofer IISB

MVDC4S

Bundesministerium für Wirtschaft und Klimaschutz



Iterative volume optimization of MMC cells for 6 kV ship traction inverter © Fraunhofer IISB

Our Knowledge for your Benefit

- Broad experiences in power electronics development from PCB to full systems
- In-house hard- and software design as well as motor design
- 200 m² medium voltage lab with megawatt drive test bench
- Battery and hydrogen test benches
- Close cooperation with the University of Erlangen-Nuremberg (FAU) and LZE Bayern
- Installation of megawatt motor test bench to be finalized in 2024

Scope of Fraunhofer IISB

- MV drive inverters for ships
- Higher redundancy compared to conventional 3-level NPC topology
- Lower output voltage THD
- Short circuit resistant due to full bridge cell design
- Setup of MVDC distribution grid system demonstrator at Fraunhofer IISB test lab
- Benchmark tests of system demonstrator with partners at Fraunhofer IISB
- Toolchain / Key Advantages
- Design and simulation of Modular Multilevel Converters (MMCs) with measured device losses for accurate results
- Iterative volume optimization of overall system development process
- Monitoring and self shutdown system for submodules and system
- Test and evaluation of communication and control systems with HIL setup
- Test and evaluation of MMC converter in own medium voltage lab
- Test and evaluation of full system demonstrator to emulate cruise ship
- Characterization of components and operating supplies
- MMC submodules with cost-efficient silicon 1700 V / 600 A IGBTs, 1200 V capacitors, easily scalable for higher output power
- Volume reduction due to coupled arm inductors
- Monitoring and self shutdown system for submodels and system
- Communication and redundant safety system for fibre optic system

Modular Multilevel Converter (MMC) with 42 full bridge cells © Elisabeth Iglhaut / Fraunhofer IISB

Technical Data of the Drive Inverter

Topology	MMC converter
Cell Configuration	42 full bridges
Input Voltage	6000 V_{DC}
Rated Power	1.2 MVA
Output Voltage	4.2 kV_{AC}
Phase current	170 A_{RMS}
Dimensions	Built in standard housing for ship application, easily scalable for higher power
THD	Reduction by 70 %

Contact

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