Efficient power electronics enabled by 3.3kV Silicon Carbide Switches

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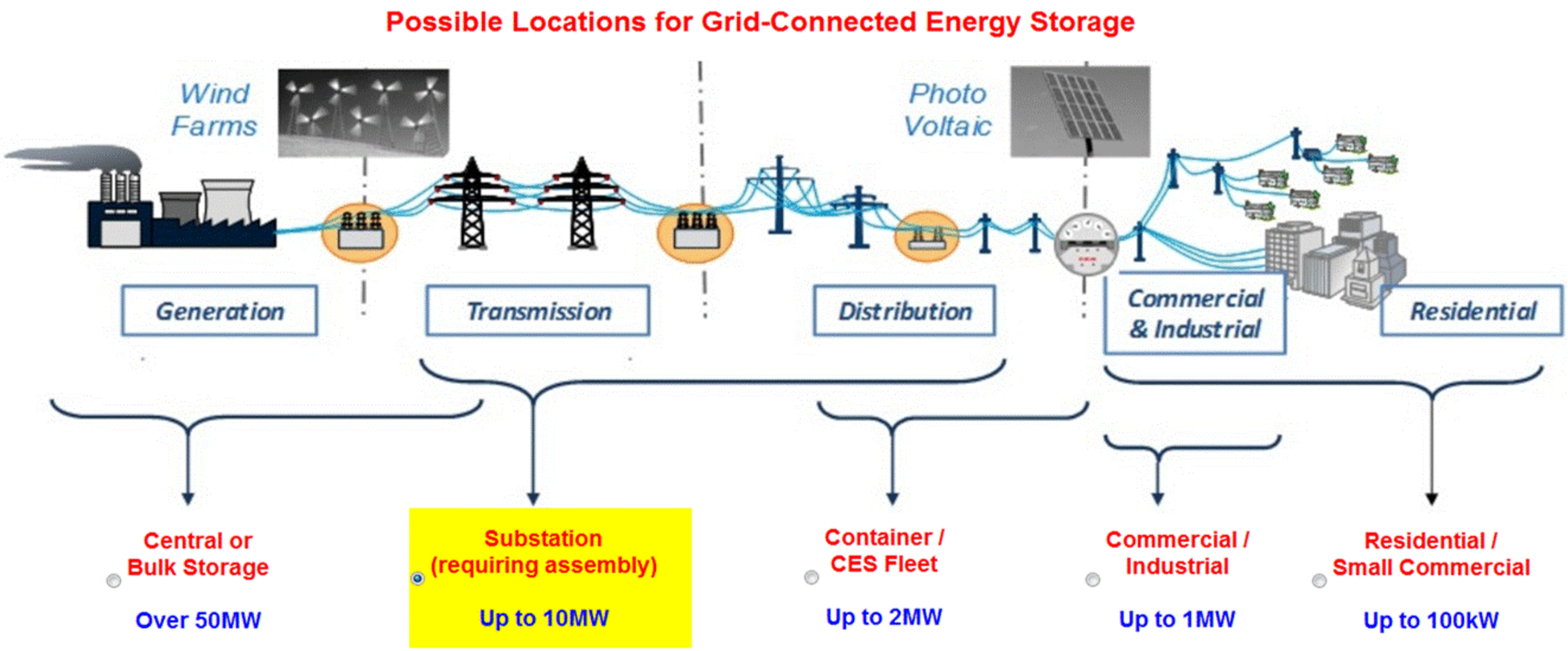
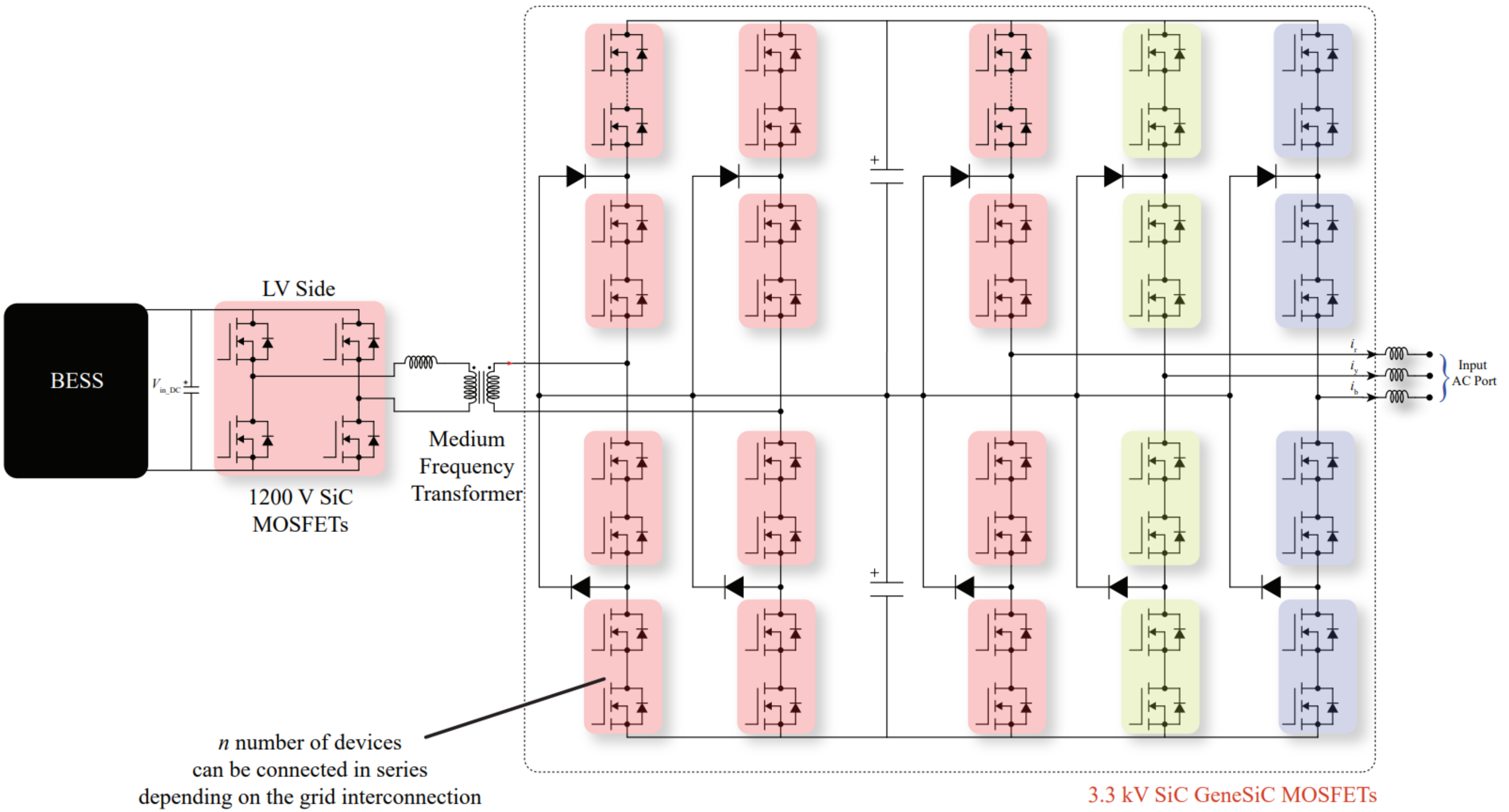
Energy Storage Opportunities at Medium Voltages (3-20 kV)



- Many Energy storage opportunities require power electronics that can enable conversion efficiencies needed for making energy storage viable
- Silicon Carbide high voltage devices will play a pivotal role

Direct Grid Connection of BESS



Calculated Loss Comparisons at 1 MVA

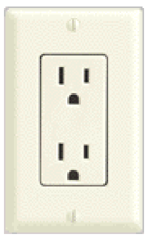
Table 1: Medium Voltage/Low Current Side loss even at 1 MVA operation.

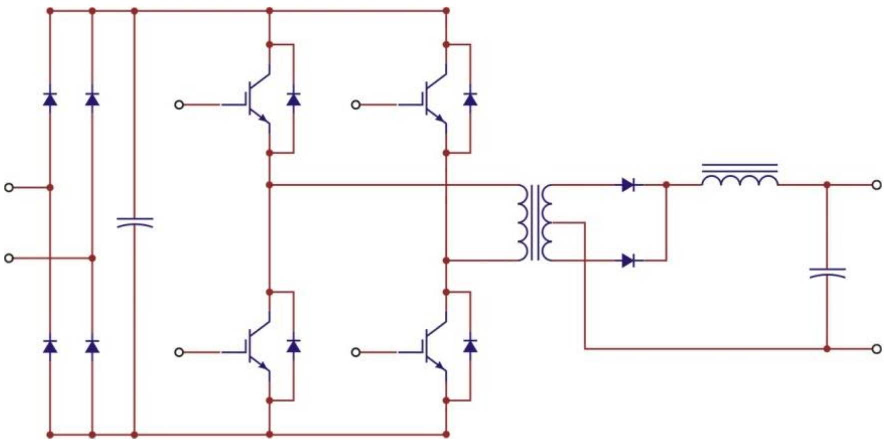
Active Power (MW)	Reactive Power (MVAR)	Loss (W)
1	0	3064
0.8	0.6	4175
0.6	0.8	5330

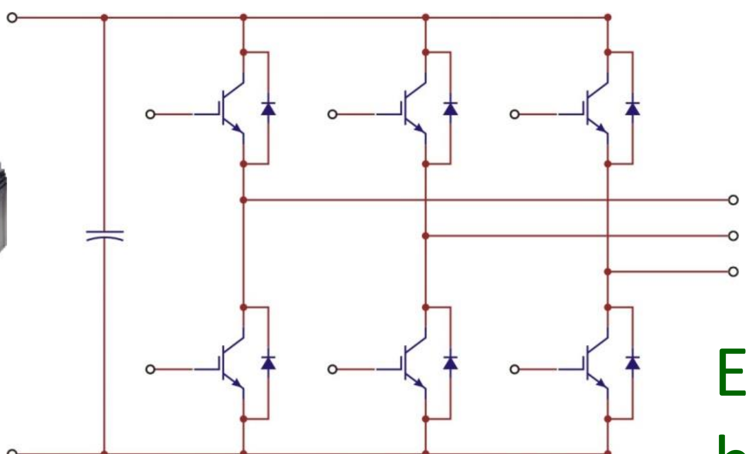
Table 2: Low Voltage/ High Current Side Loss

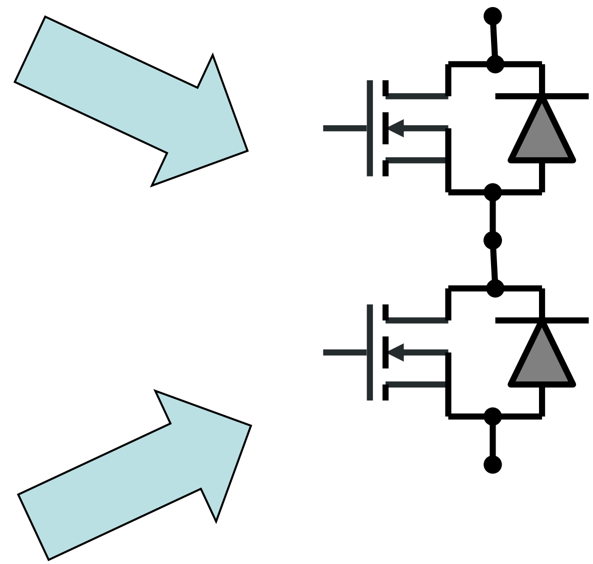
Active Power (MW)	Reactive Power (MVAR)	Loss (kW)
1	0	32
0.8	0.6	27
0.6	0.8	23

Phase Leg forms fundamental building block for AC/DC AND DC/AC Conversion









Each switch and diode must be capable of bus voltage

6

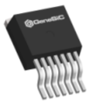
Awards and Recognitions

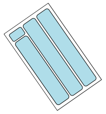
2016 → GeneSiC named among Top-30 Power Semiconductor Companies by EETimes

2016 → EETimes recognized GeneSiC's Founder as "Forty of the Top Innovators Changing the Face of Electronics"

2019 → R&D100 Award : SiC-based Monolithic Transistor-Rectifier Semiconductor Switch

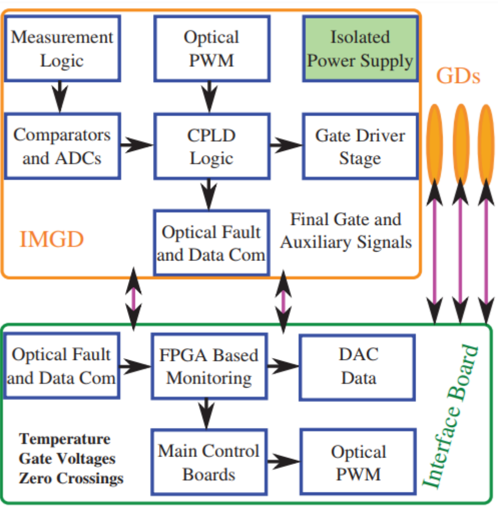
3300V – SiC MOSFETs

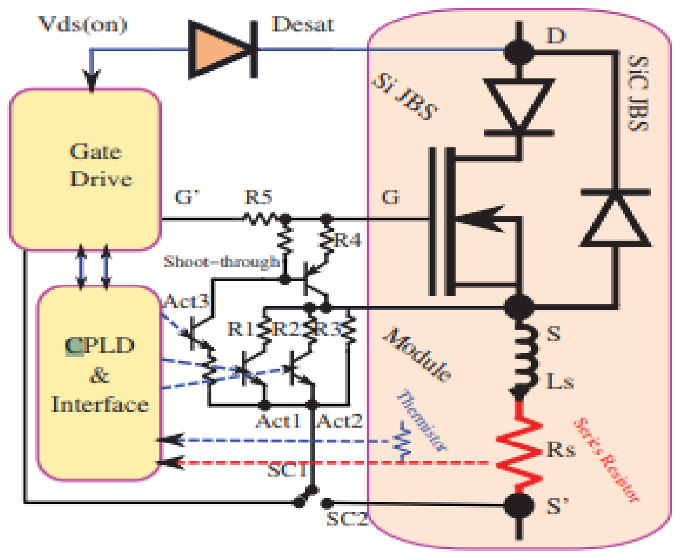


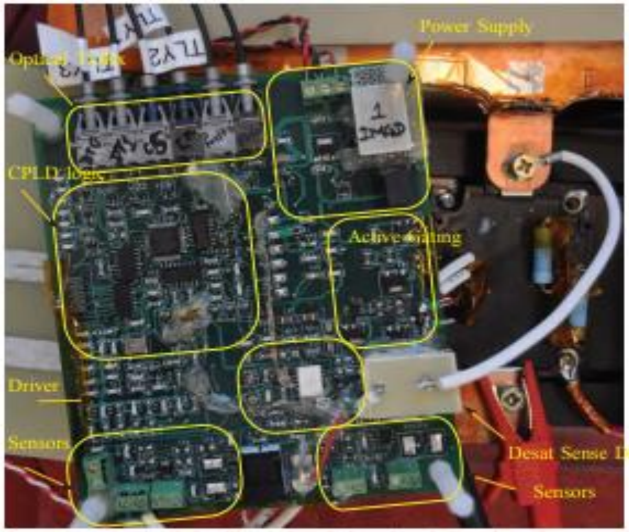


		TO-263-7 (D2PAK-7L)	SOT-227	Bare Chip
SiC MOSFETs (MT Series)	**50 mΩ**			G3R50MT33-CAL
	100 mΩ	G3R100MT33J		G3R100MT33-CAL
	450 mΩ	G3R100MT33J		
	1000 mΩ	G2R1000MT33J		
SiC Integrated-Schottky MOSFETs (MS Series)	**60 mΩ** *(Engineering Sample)*		G3R60MS33N	
	100 mΩ *(Engineering Sample)*	G3R80MS33J		

Active Gating and Protection Circuits

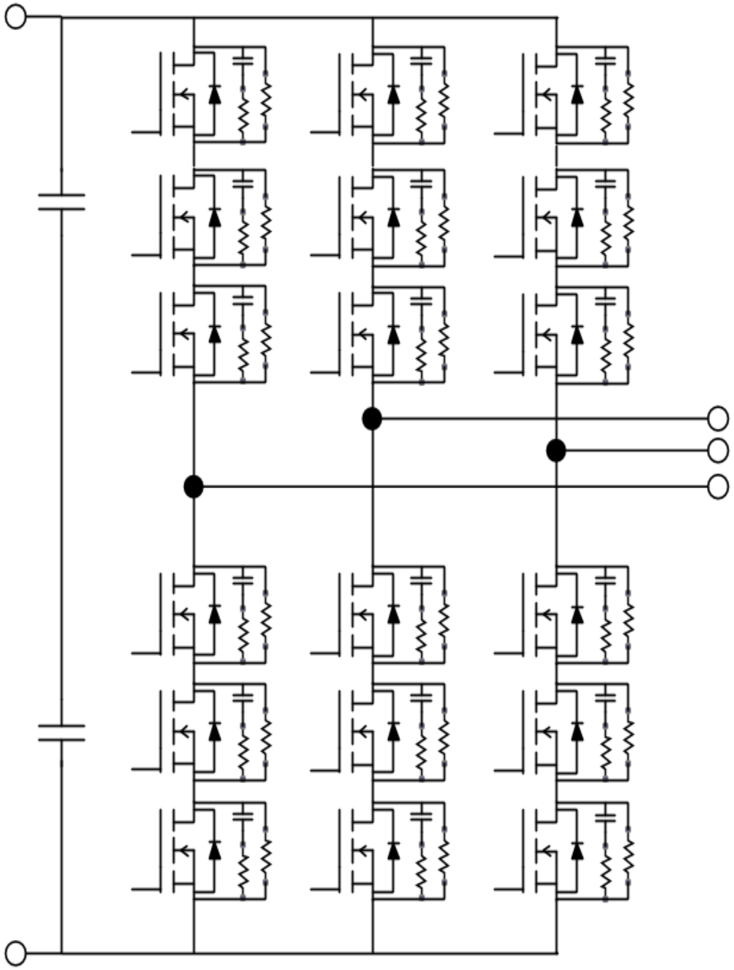


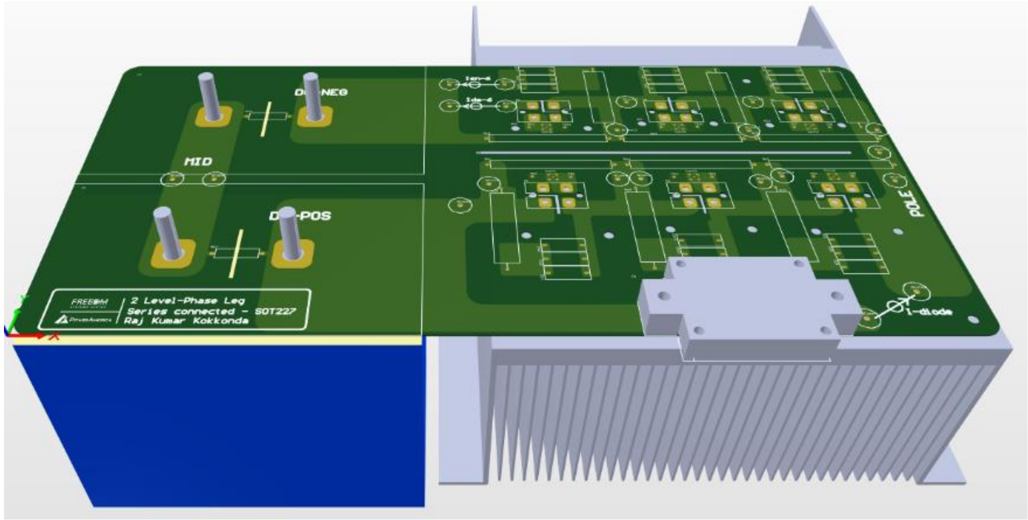




Block Diagram of Intelligent MV Gate Driver; Active gating and protection circuits; Intelligent Gate Driver Circuit Board

Board Layout Completed





Conclusions

GeneSiC-NC State Team will demonstrate:

- 3.3kV/50 A MOSFET-diode Integrated Device
- Intelligent Gate Driver with active sensing and control algorithms for stable performance
- 400 MVA circuit demonstration and system in Phase II

Status and Future Efforts

- Current Status
  - Project Started in July 2019 (Phase II on Aug 2020)
  - 3.3kV Monolithically Integrated SiC MOSFET-Schottky Diodes commercialized
  - Gate Driver circuits completed at NCSU/FREEDM
  - Modeling of Circuit Losses being conducted
- Future Efforts
  - Complete SPICE Modeling of Devices to be used
  - Demonstrate 3.3kV MOSFET-Diodes in BESS
  - Quantigy the impact of Monolithic 3.3kV MOSFET-Diode in power electronics on grid-tied energy storage systems

Grant Details

- Principal Investigator: Dr. Ranbir Singh and Prof. Subhashish Bhattacharya
- Program Manager: Dr. Ranbir Singh
- Grantee:

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