

# Technical Challenges in Medium Voltage Solid State Transformer (SST)

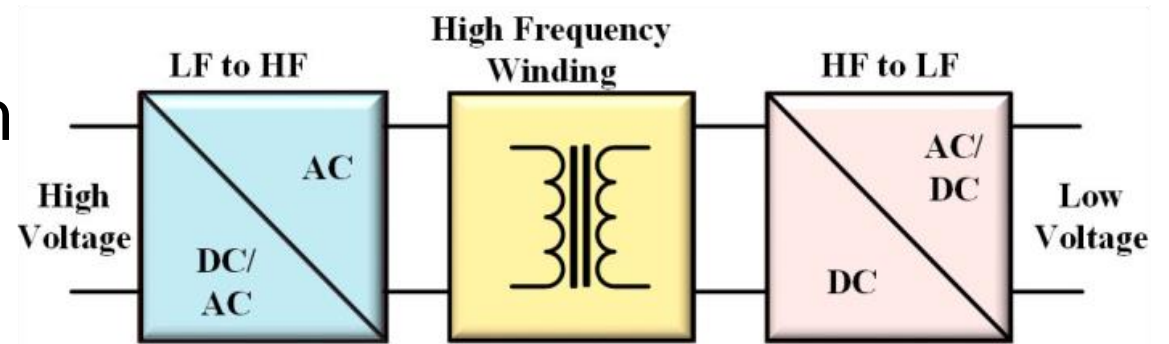
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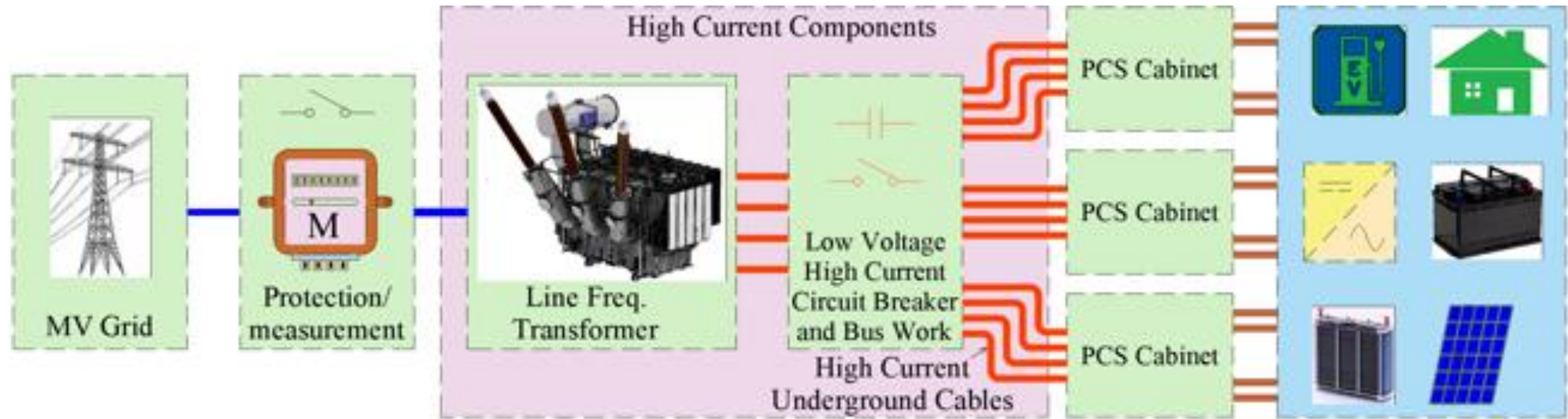
# WHY MV SST

- Integration and penetration of power electronics into electric grid for flexibility and controllability
- DC distribution
- High power renewables, EV charging (DCFC and MCS)
- Data centers
- Grid level energy storage
- Power at 480VAC is not enough

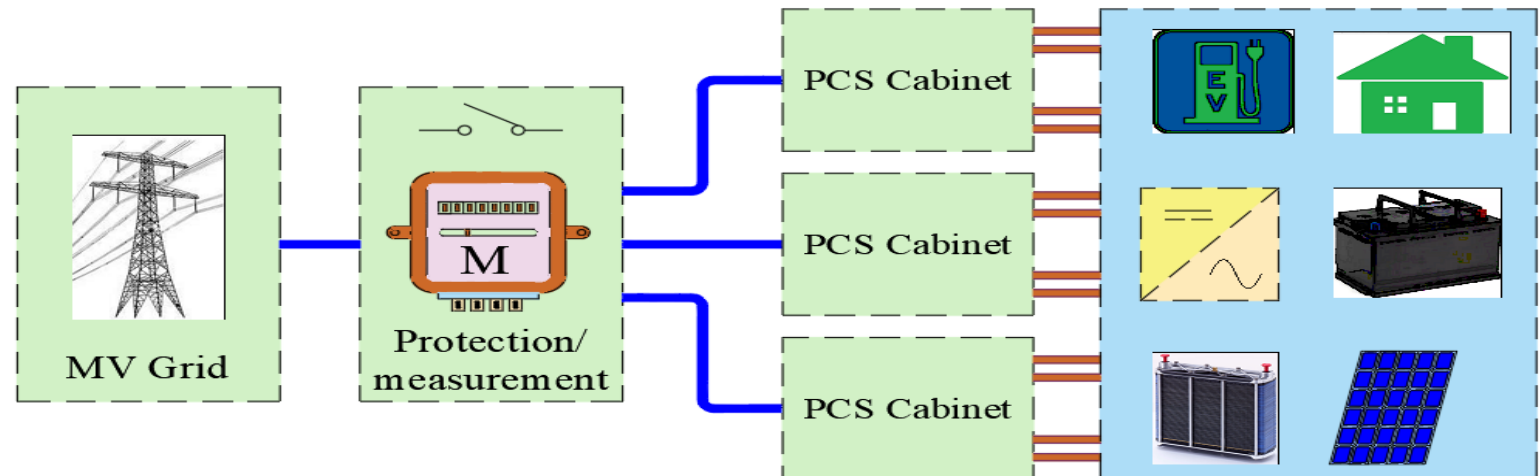


SST Concept

# COMPARISON OF MV SST AND LV SST

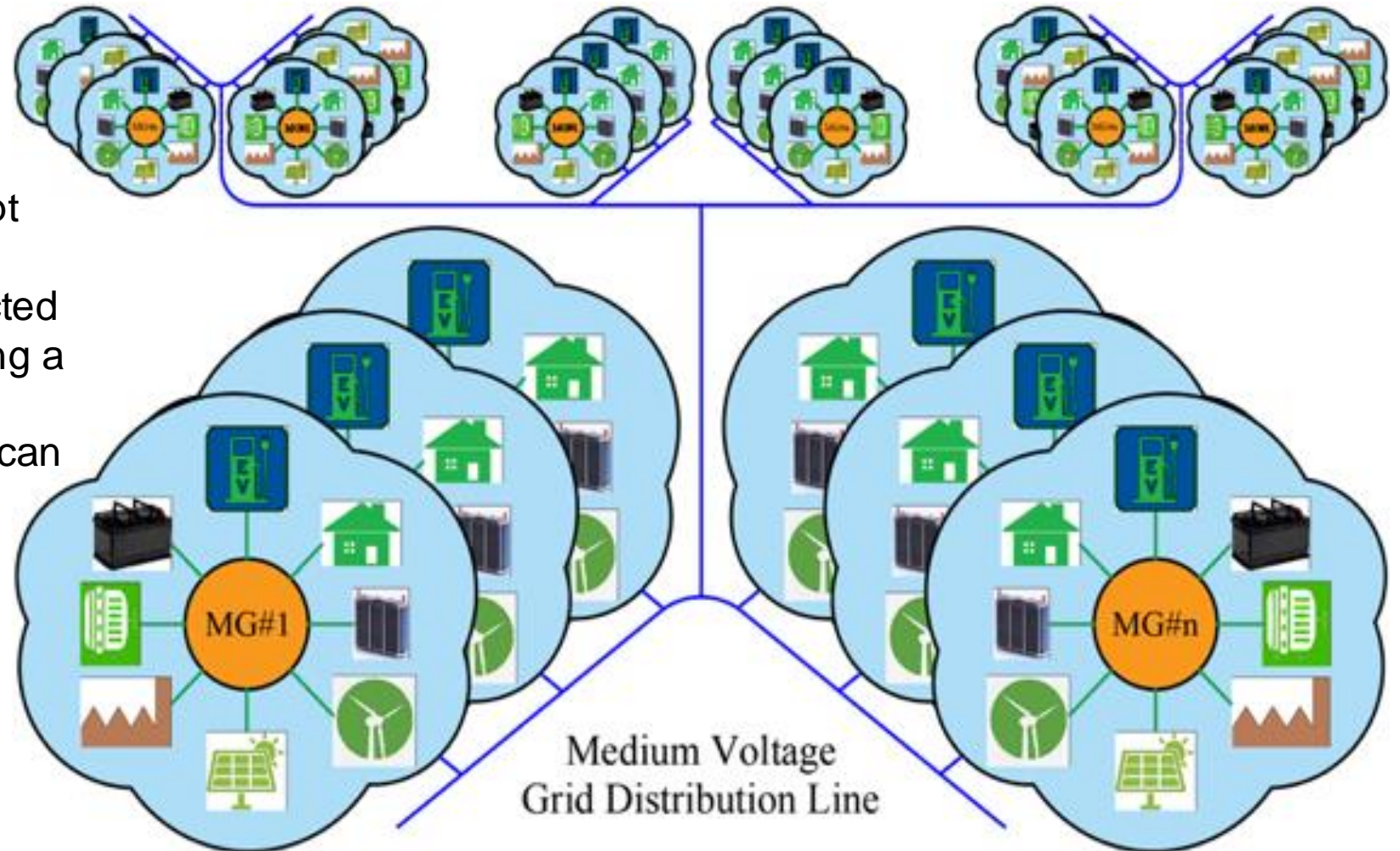


**MV SST eliminates large line frequency transformers, high-current AC switchgear, and expensive cabling, and reduces system's balance cost, leading to streamlined installation and commissioning processes.**



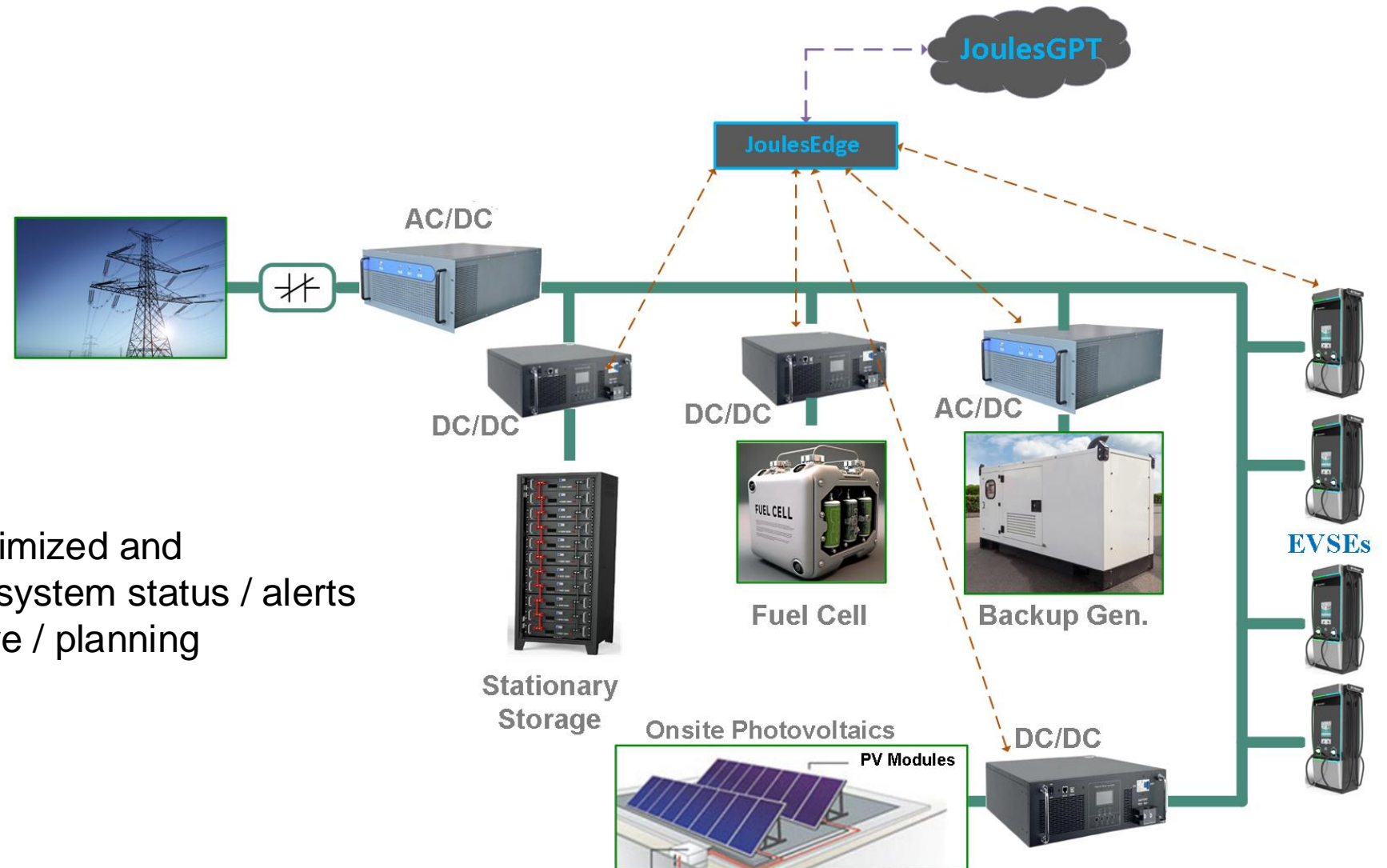
# MV SST ENABLING RESILIENT GRID

Networked DC distribution concept enabled by MV SST for electricity resiliency. Each system is connected to grid AC distribution system using a MV power converter and each system, in case of a disturbance, can manage its load, support other systems, and support grid





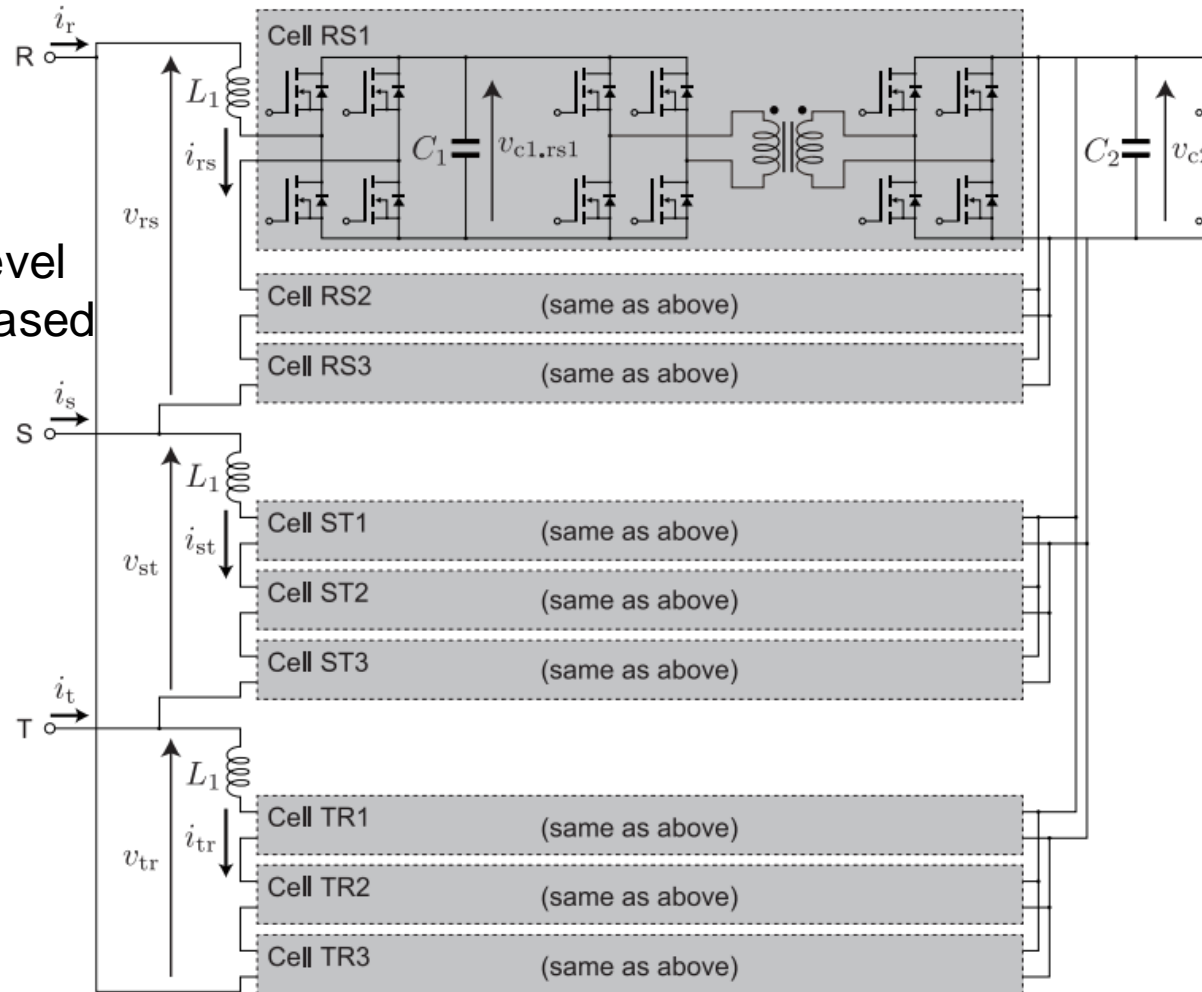
# MV SST ENABLING DC MICROGRID



Outputs are intelligently optimized and dispatched control signals, system status / alerts / visualization, and predictive / planning information

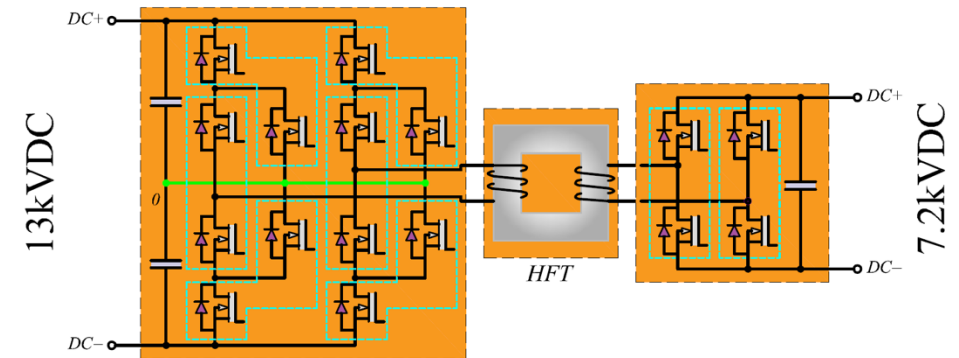
# MV SST TOPOLOGIES

Multi-level  
DAB-based



Takanori Isobe, et al, IEEE JOURNAL OF EMERGING  
AND SELECTED TOPICS IN POWER  
ELECTRONICS, VOL. 8, NO. 3, SEPTEMBER 2020.

Using MV switches

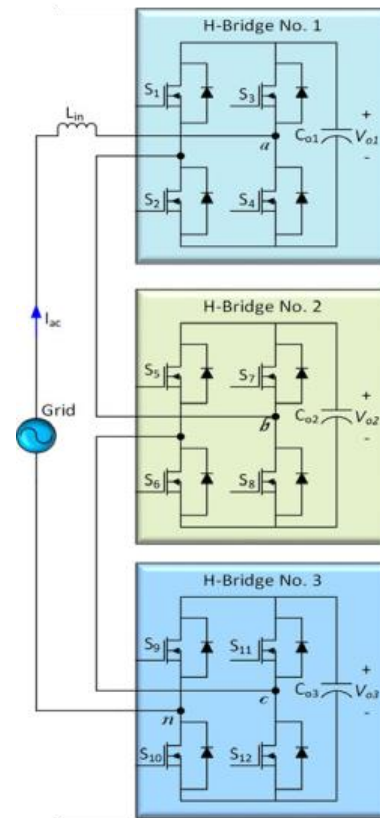
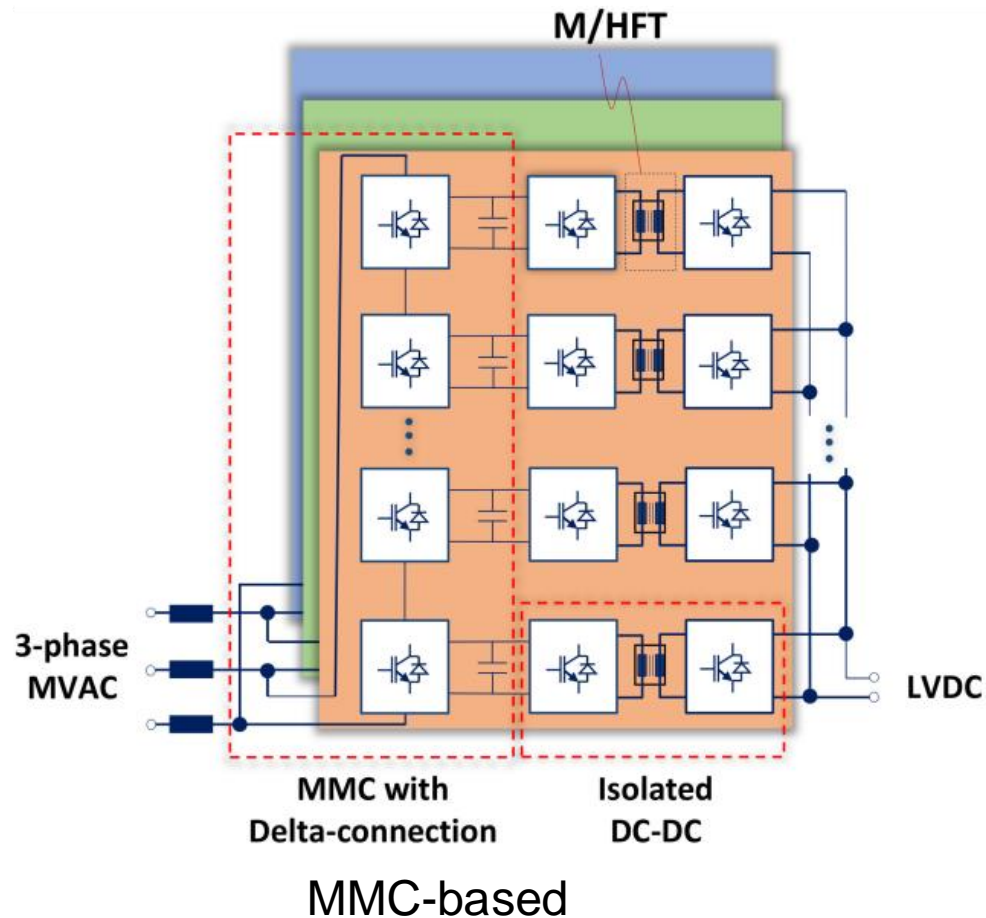


**Challenges:**

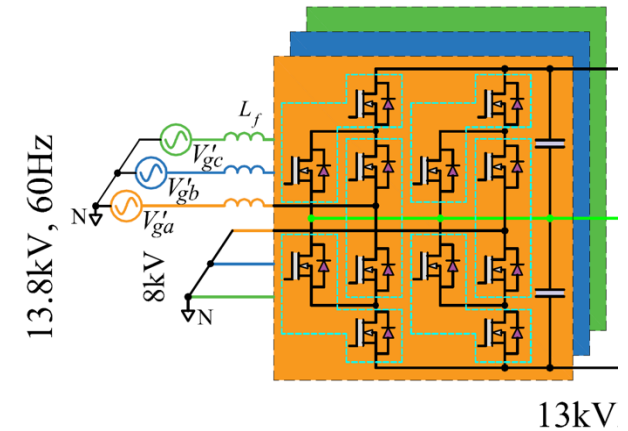
- 1- Cost
- 2- Reliability
- 3- Fault protection
- 4- Transformer standards
- 4- Grid requirements
- 5- MV insulation (creepage/clearance)

# GRID INTERFACE

**Challenges:** BIL requirements, one-minute voltage test requirement, switch synchronization, balancing capacitors, grid disturbance, fault protection/survival/recovery, EMI.



Cascaded H-bridge

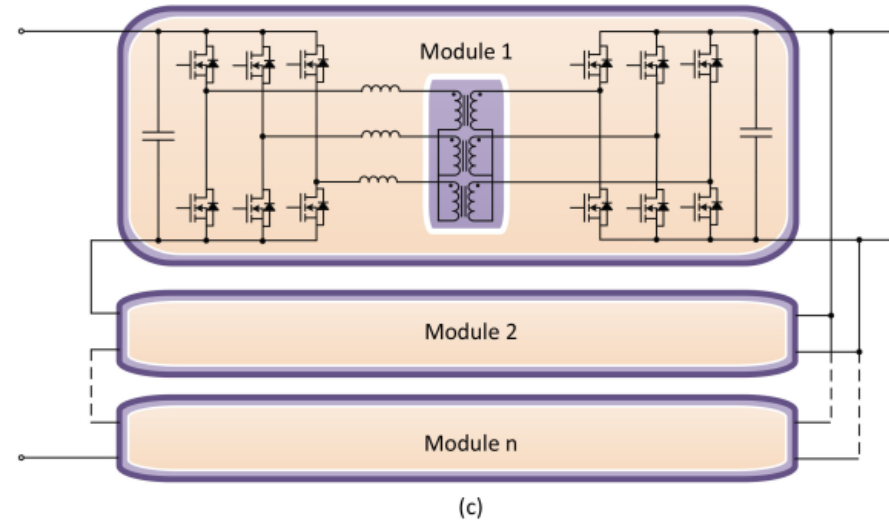
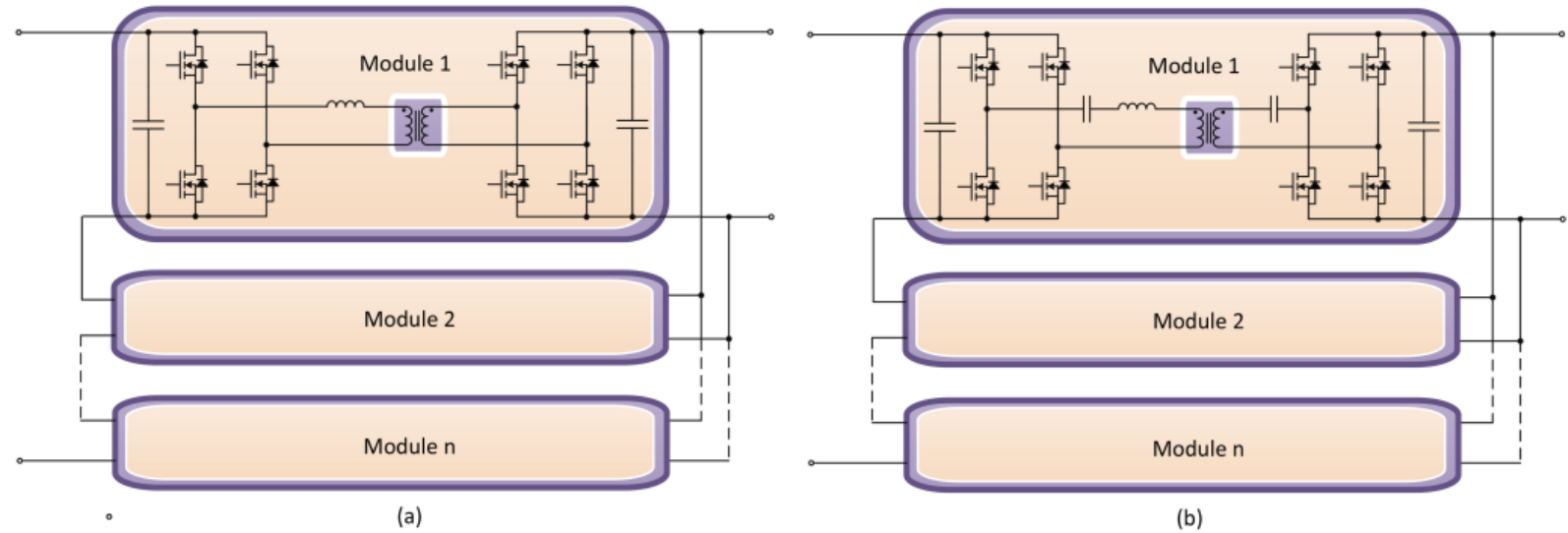


High voltage device-based

# DC/DC STAGE

## Challenges:

- Transformer loss
- Transformer PD
- Efficiency
- EMI ( $dv/dt$ )
- Switch stress

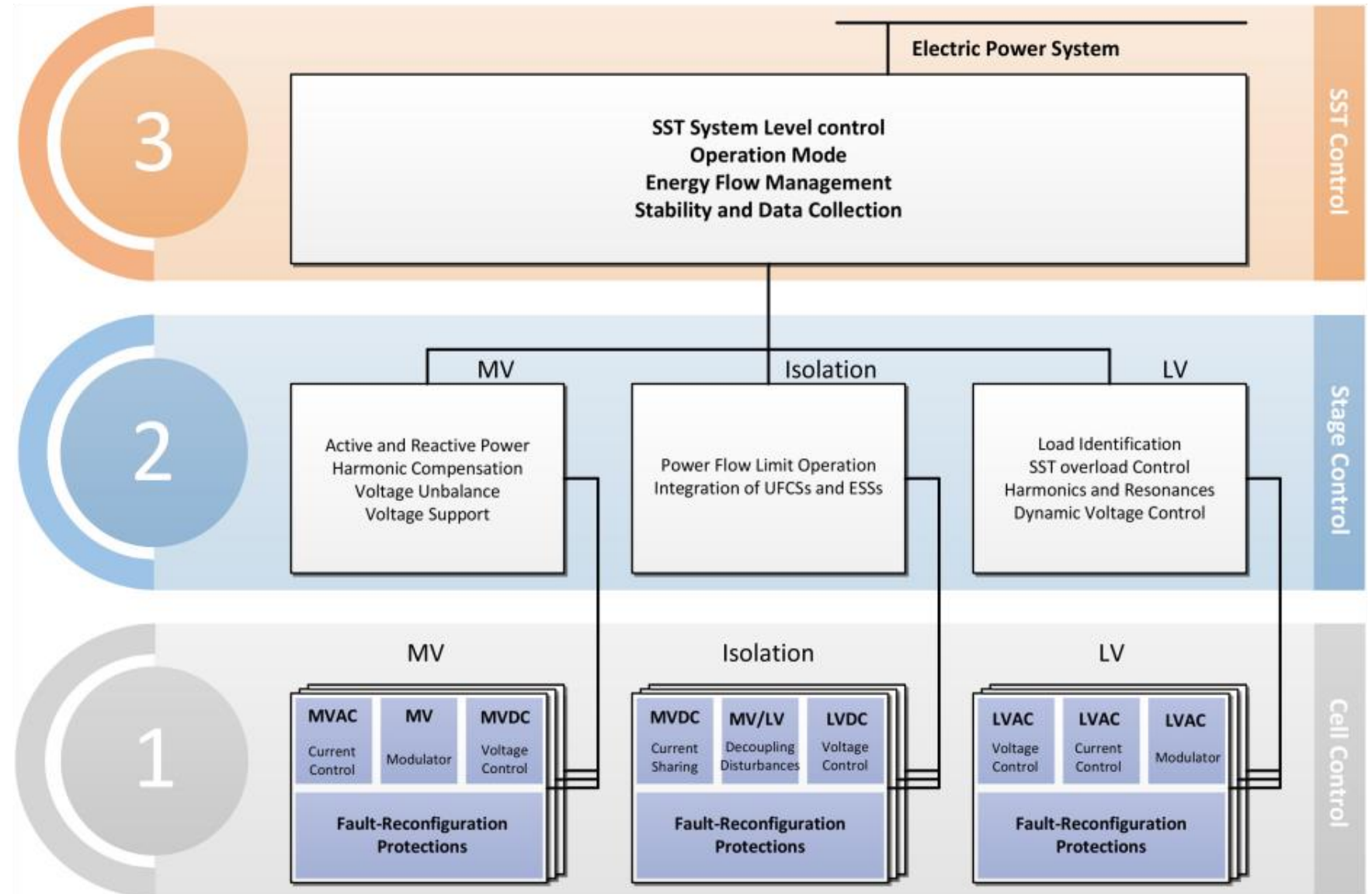




# MV SST CONTROLS

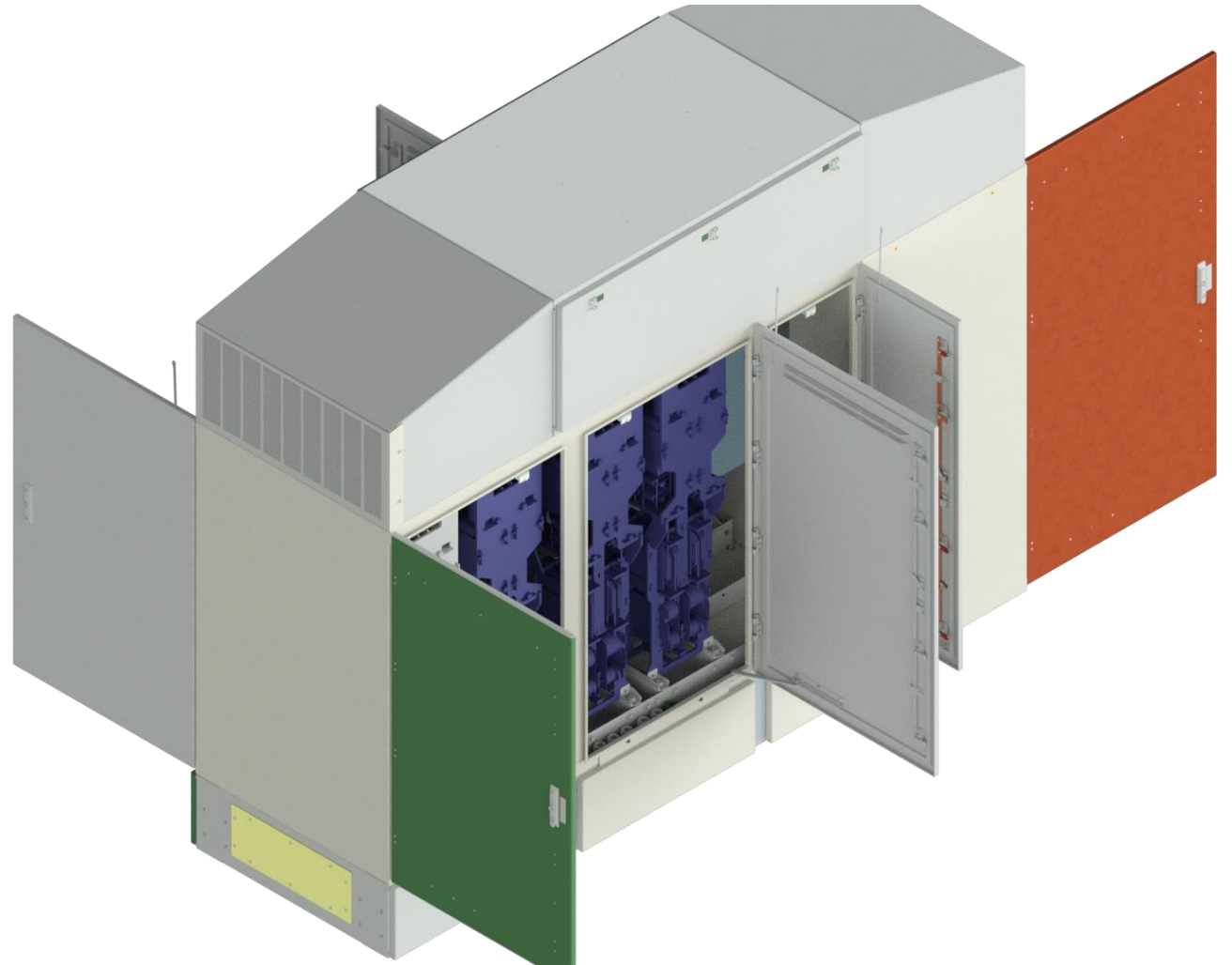
## Challenges:

- Grid disturbance
- N-1 operation
- DC side fault protection

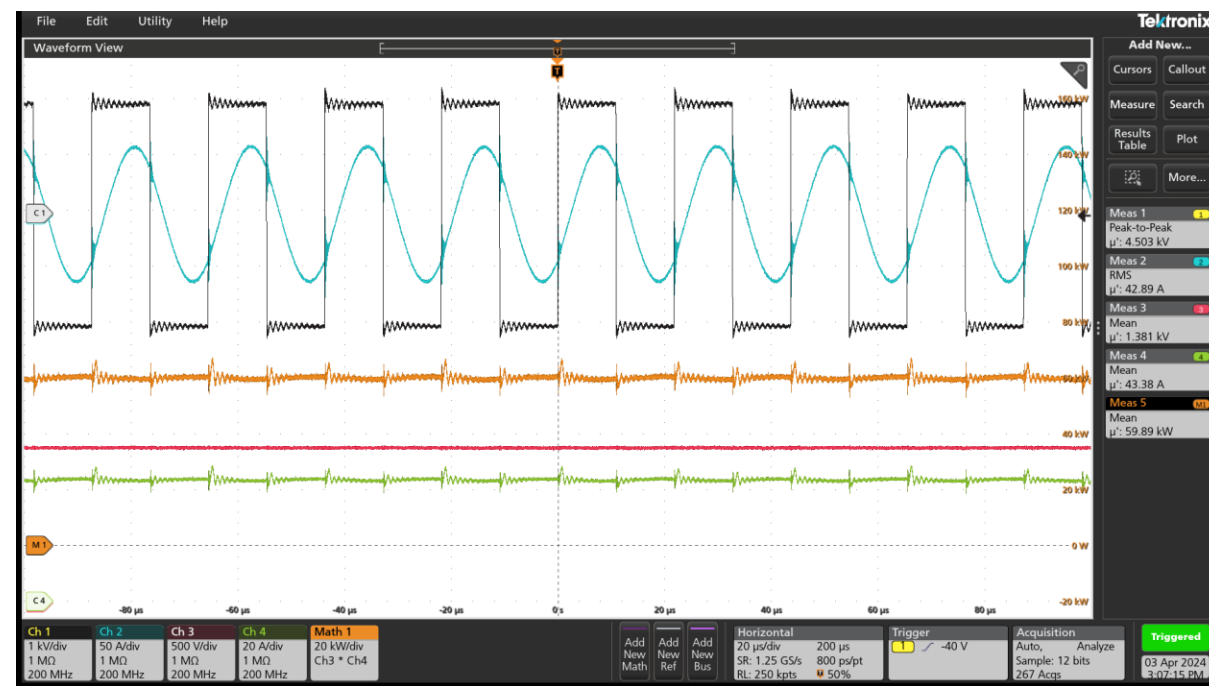
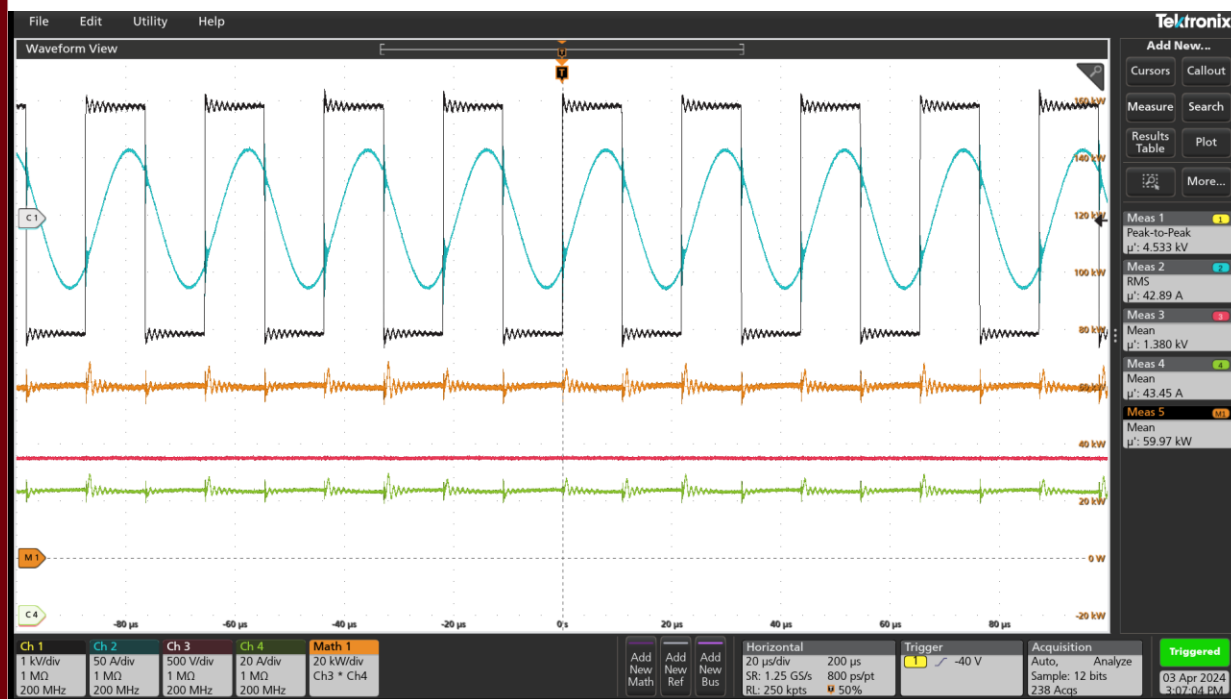


# ALL-IN-ONE SST-BASED MCS

- Input is 15kV AC class
- Output is variable DC 400V-1250V
- Integrates MVAC switchgear
- Integrates DC protection
- Modular structure



# HIGH POWER TEST



# THANKS!

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