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# Enhancing Inverter Performance through C-HIL Testing and Ensuring Grid Compliance

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Enerzinx LLC

ATC RTDS APPLICATIONS & TECHNOLOGY CONFERENCE

APPLICATIONS & TECHNOLOGY CONFERENCE 2025

CHICAGO, ILLINOIS, U.S.A.

RTDS Technologies

AMETEK

# OUTLINES

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**01** | Who are we?

**02** | New Kid on the Block

**03** | HIL Test Setup and the process

**04** | Comparison of PSCAD/RMS/HIL simulations

**05** | Recommendation

**06** | Key Takeaways

# ENERZINX, LLC

**Engineering Services For Renewable Energy Industry, a texas corporation - 2014**

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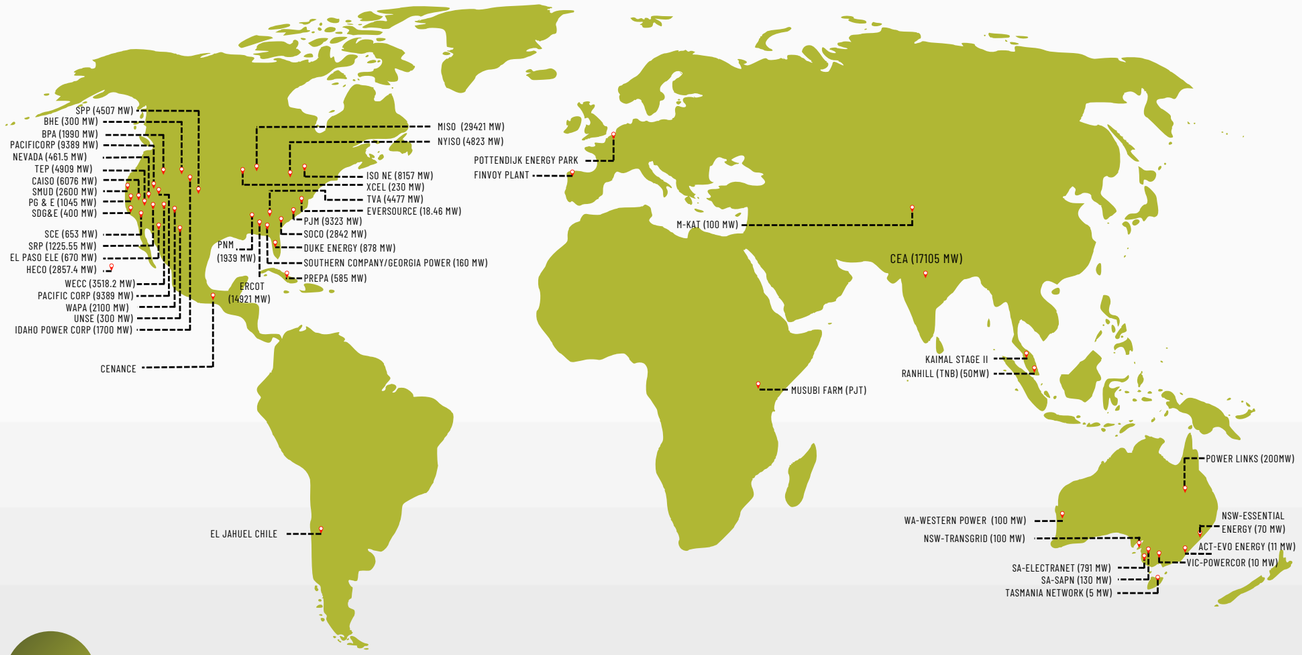
## Enerzinx Global Footprint




## Office Locations

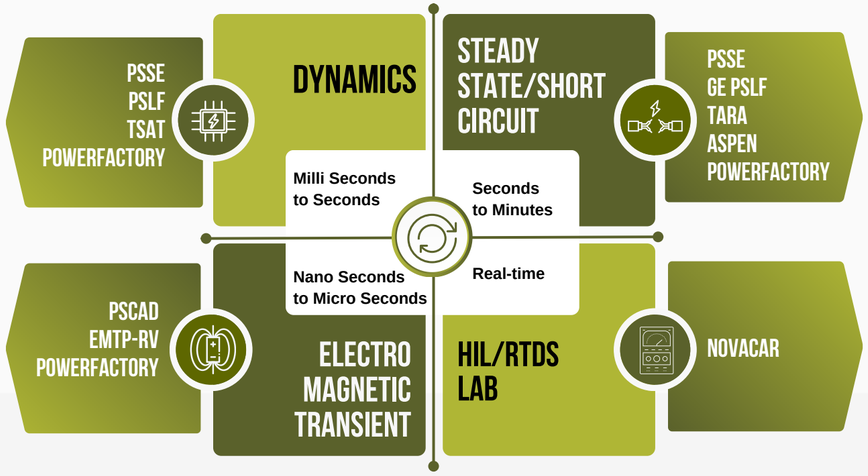
**U.S.A**
Texas

**CANADA**
Ottawa

**AUSTRALIA**
Melbourne, Sydney, Brisbane

**INDIA**
Bangalore, Gurugram, Hyderabad

## Renewable modeling approaches




SIEMENS PSS/E · PSCAD · ENVISION · AUTOCAD · PVSYST · ABB PROMOD IV · TARA · EMTP-RV SIMULATION SOFTWARE · ASPEN · PLANT PREDICT · etap Powering Success · MATLAB & SIMULINK · SILENT DIG · RTDS Technologies AMETEK · CONCORDA PSLF · DSATools · PVcase

142 GW

1500+ PROJECTS

2.00 MILLION MILES OF TRANSMISSION LINES

15+ COUNTRIES

# New Kid on the Block.....

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**Initial Goal**: Compliance with NOGRR245 and IEEE2800-2022 Standards for solar facility

**During this process, we encountered several challenges**:

- The OEM had changed hands multiple times, leading to inconsistencies and gaps.
- Dearth of critical technical information.
- Unreliable Models and Insufficient Data
- Control was designed before 2010

**We got thrust into HIL (Nowhere to go).**
We did not choose to be here, we were cornered.

**Sequence of events**

**Drivers:** Technical Excellence, Client focus

# Test Setup

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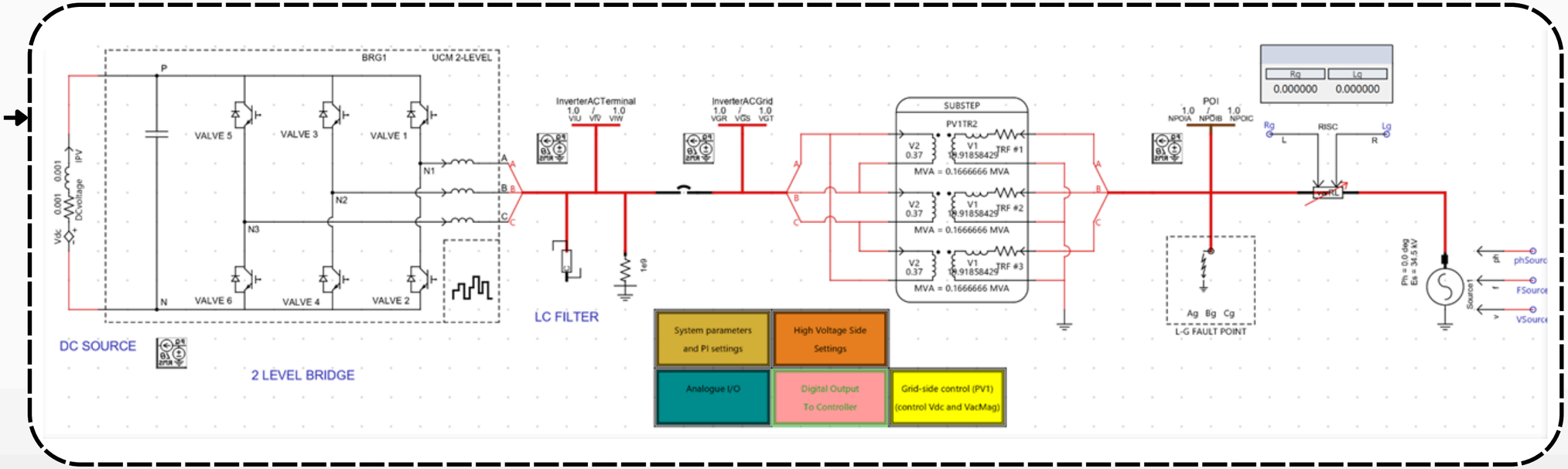
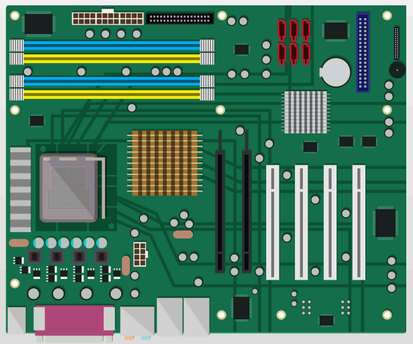


Analogue & Digital I/O interface



Parametrization and Firmware update

# Enerzinx Lab Test set up

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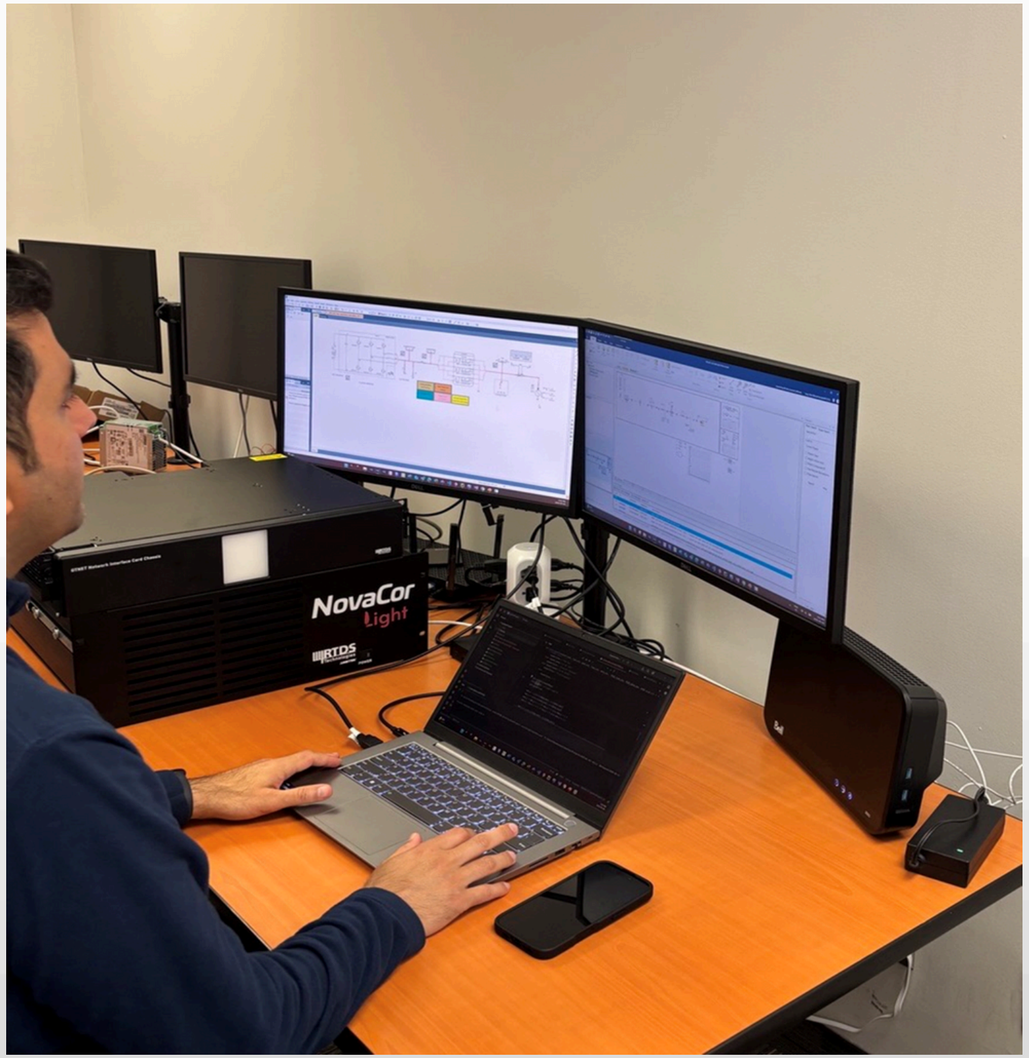


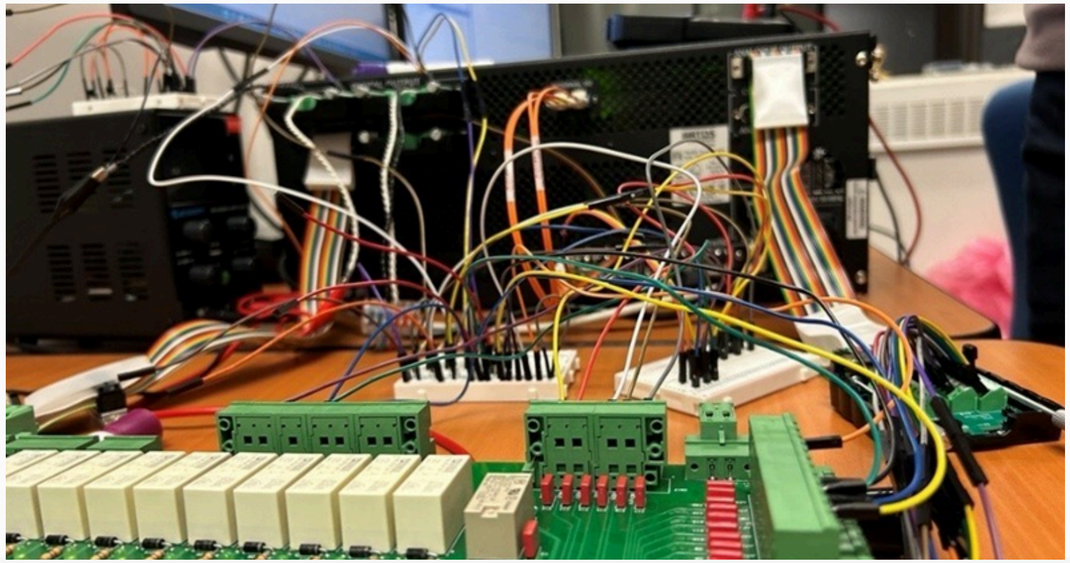

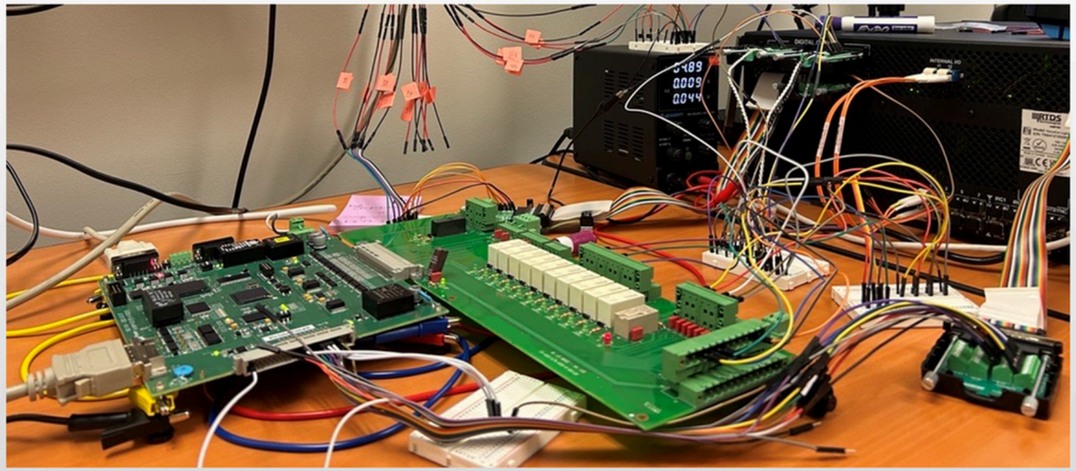

# Process and structure

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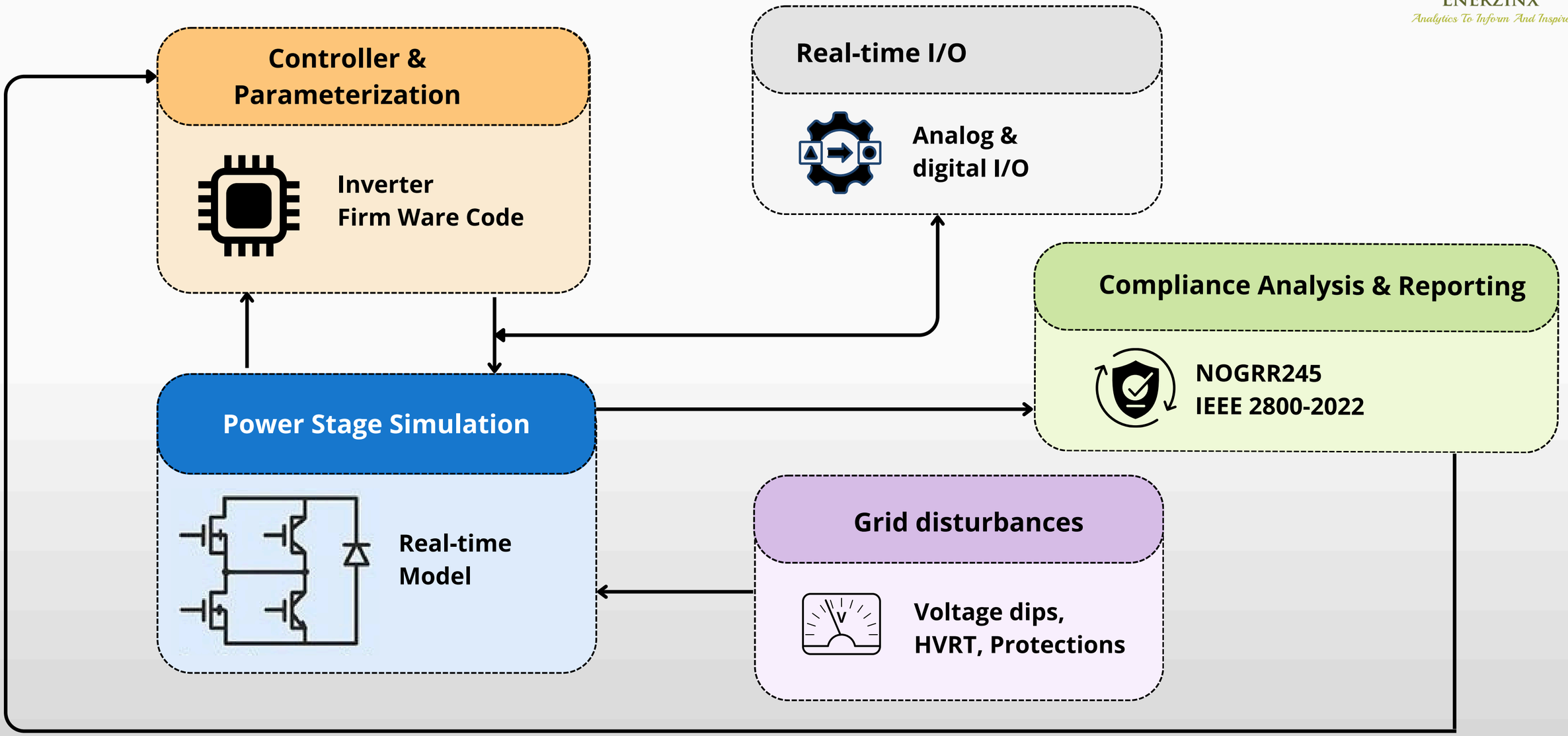

# Performance improvement - LVRT

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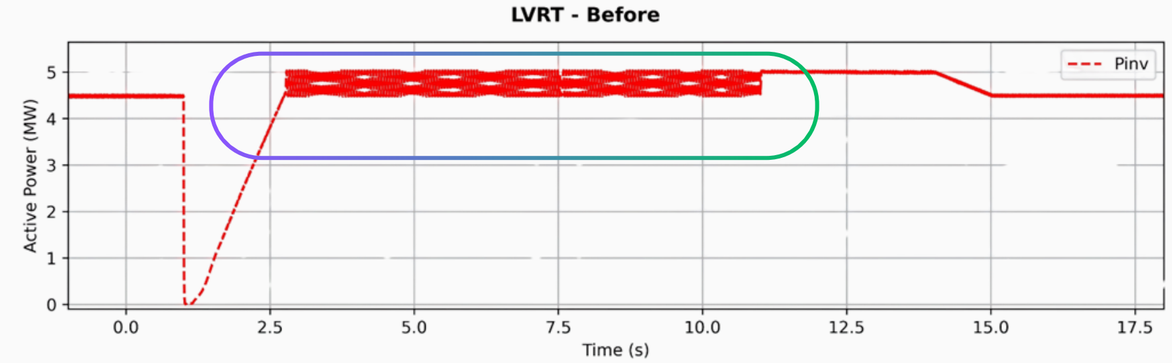


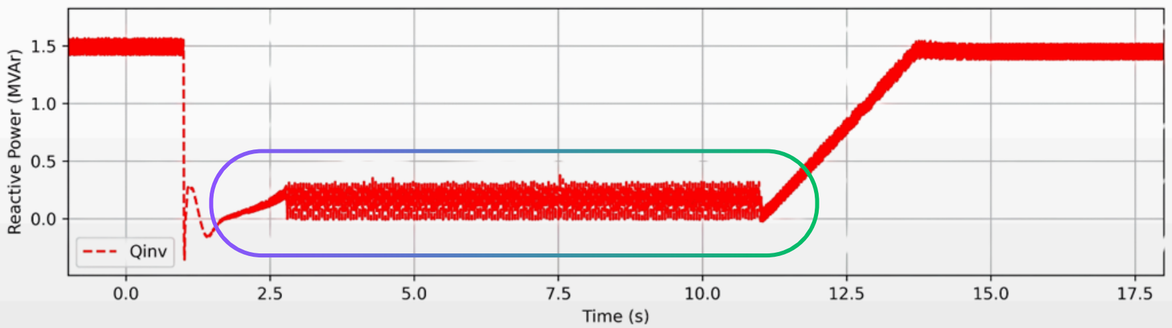


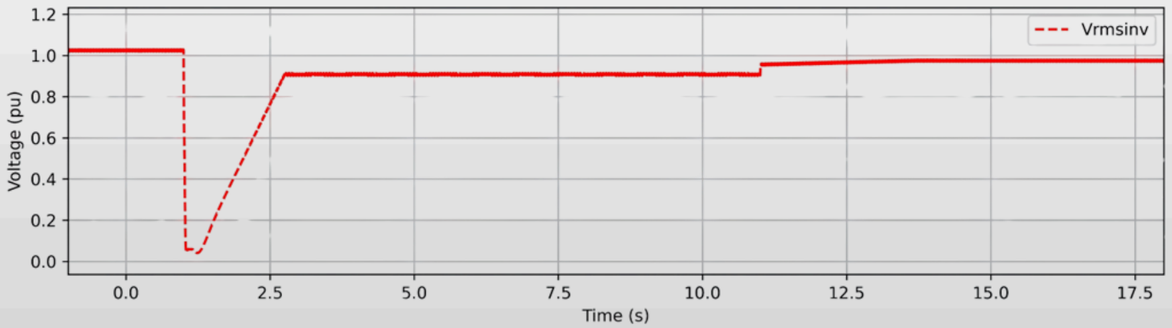


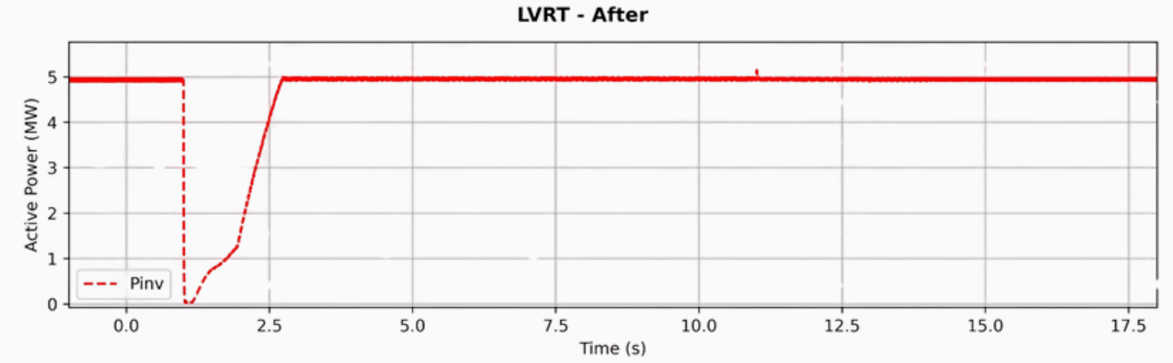


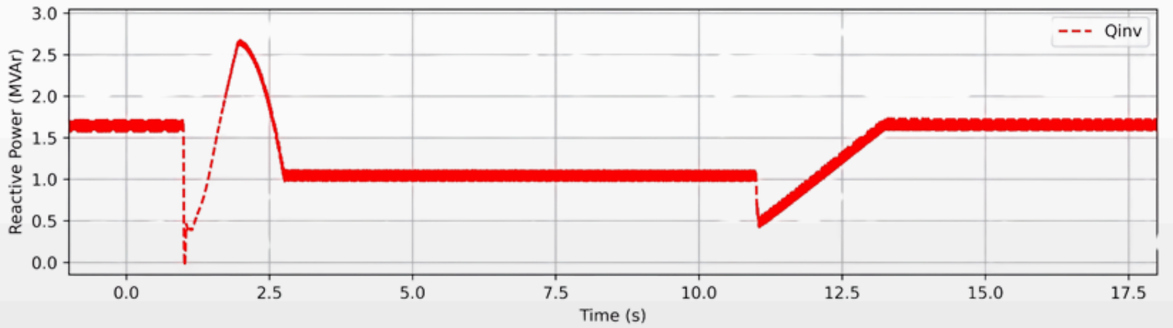


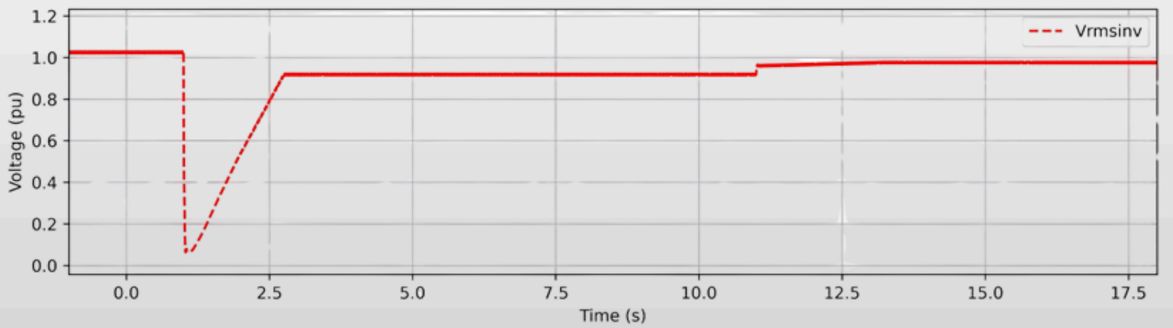

# Performance improvement - MULTI LVRT

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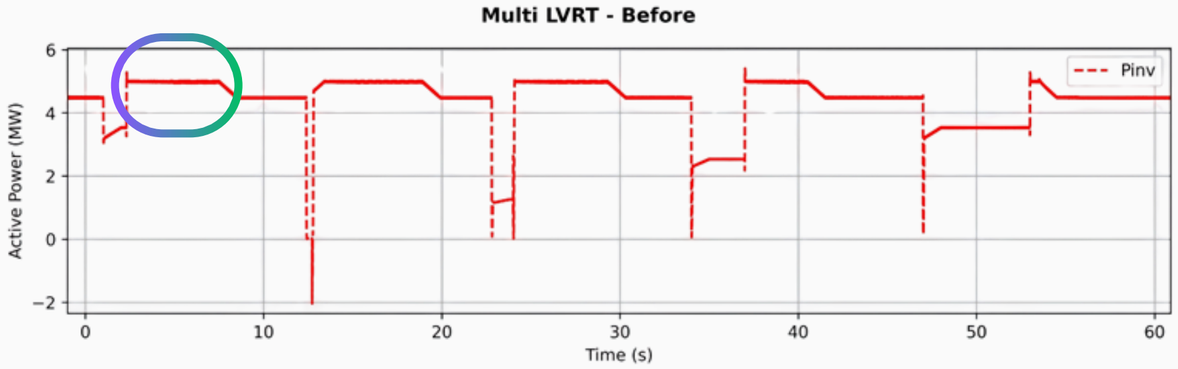


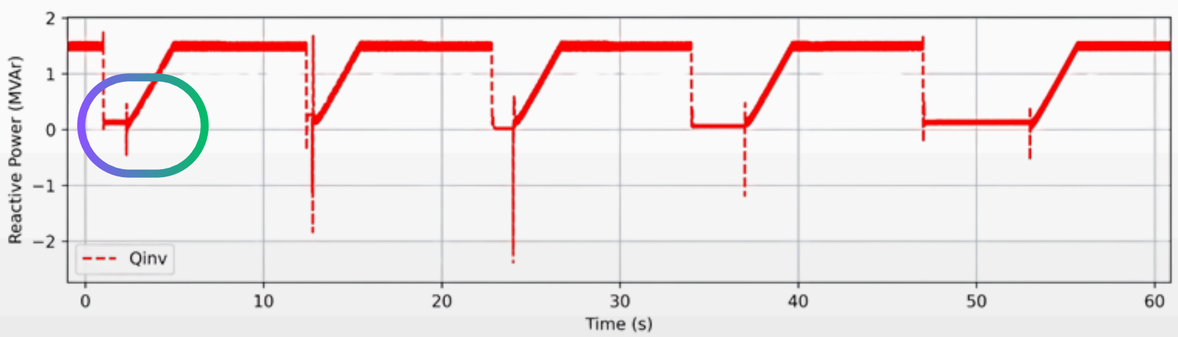


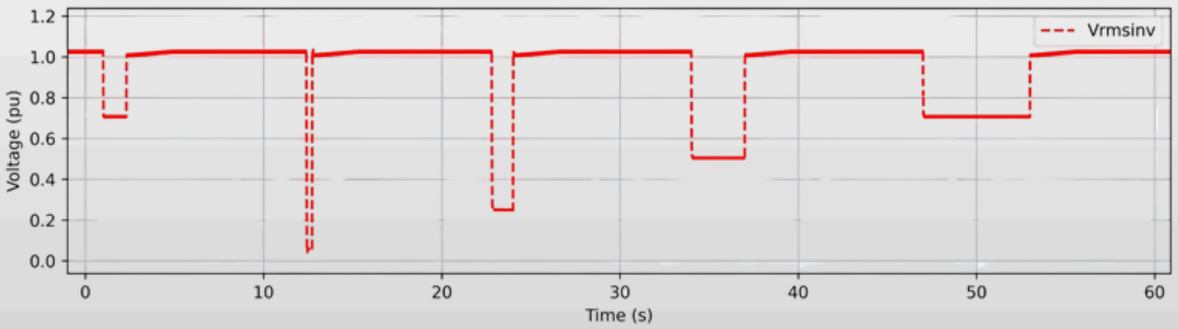


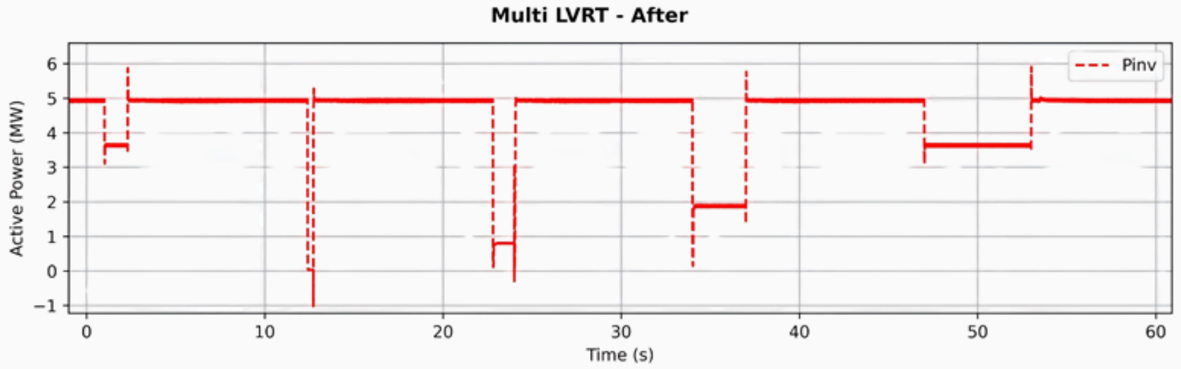


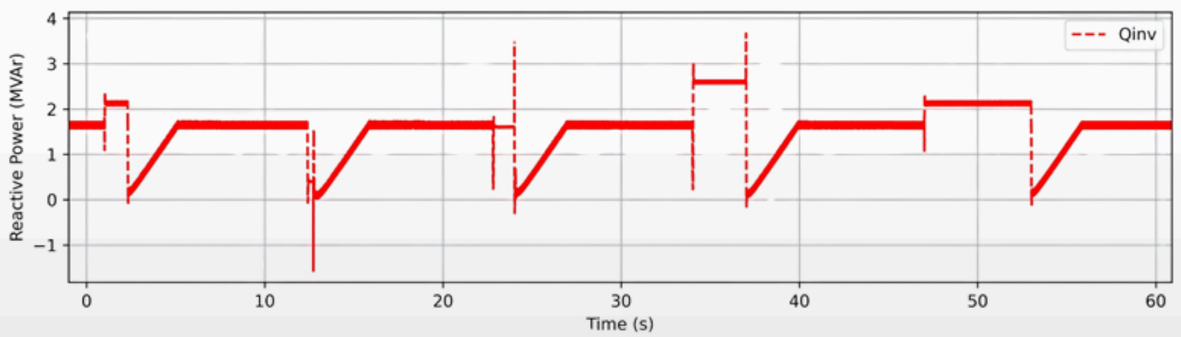


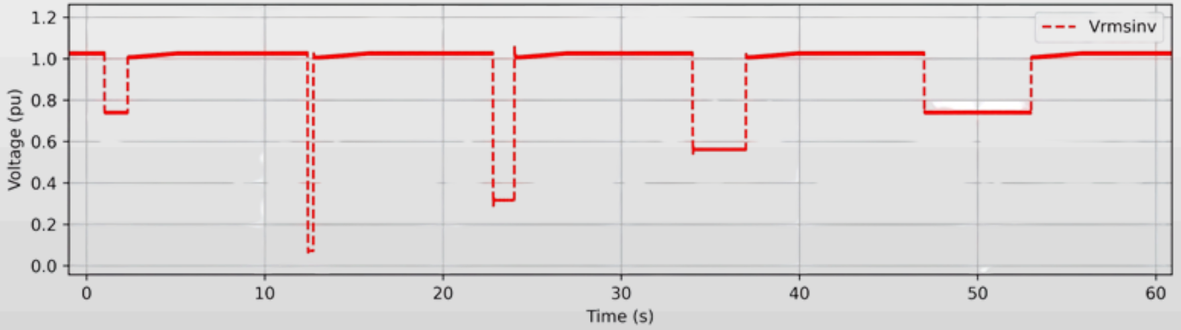

# Performance improvement - HVRT

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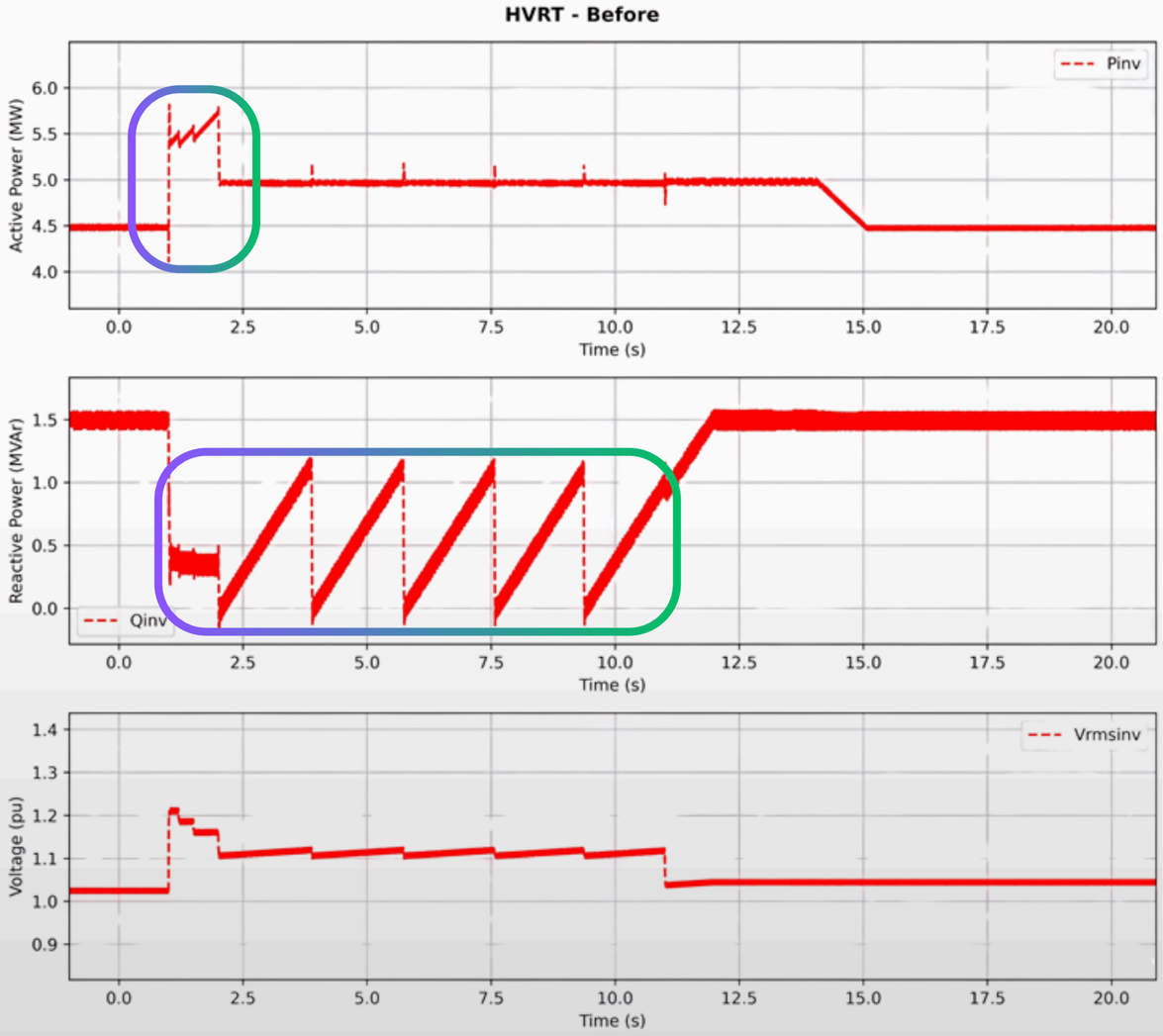
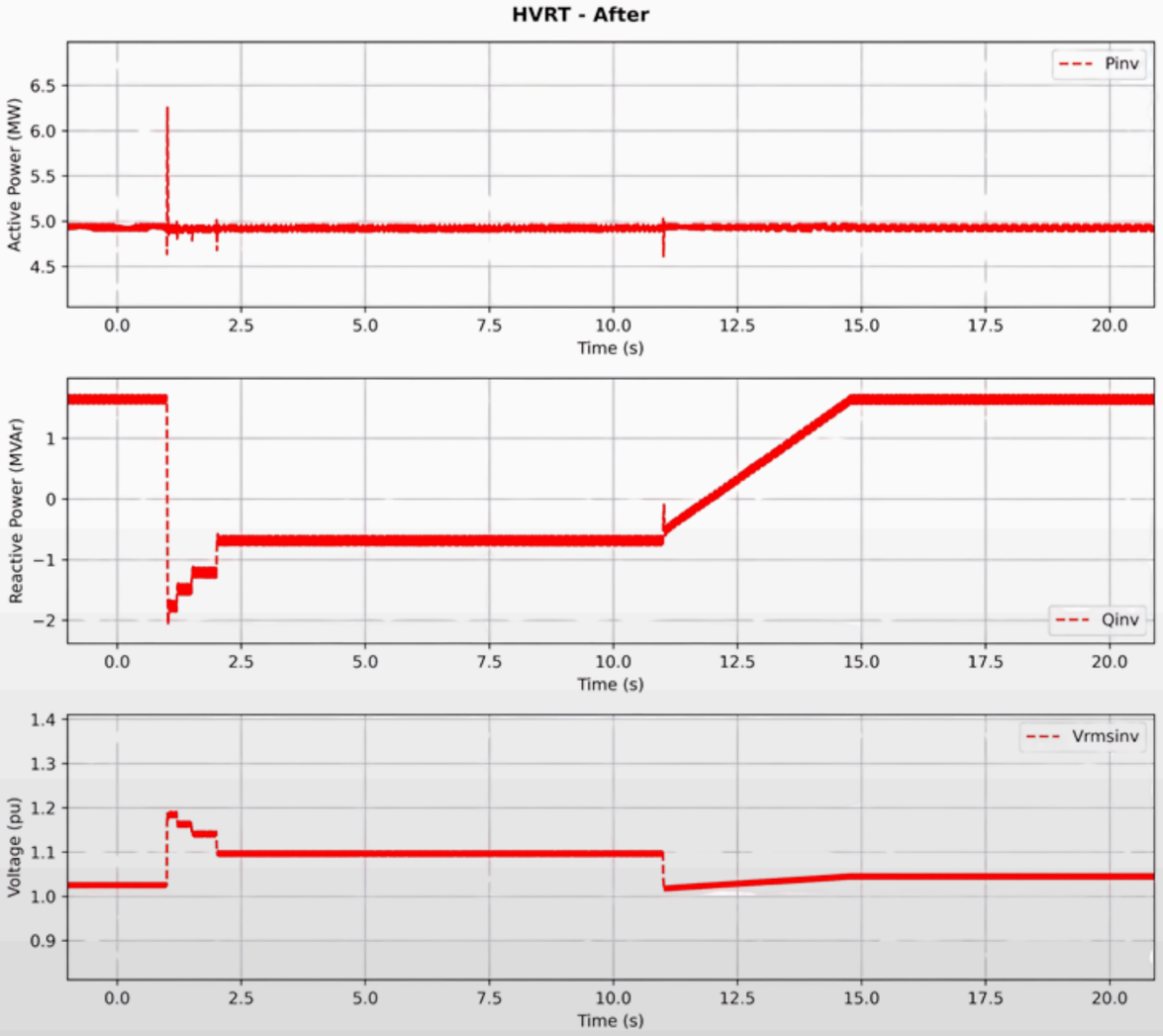
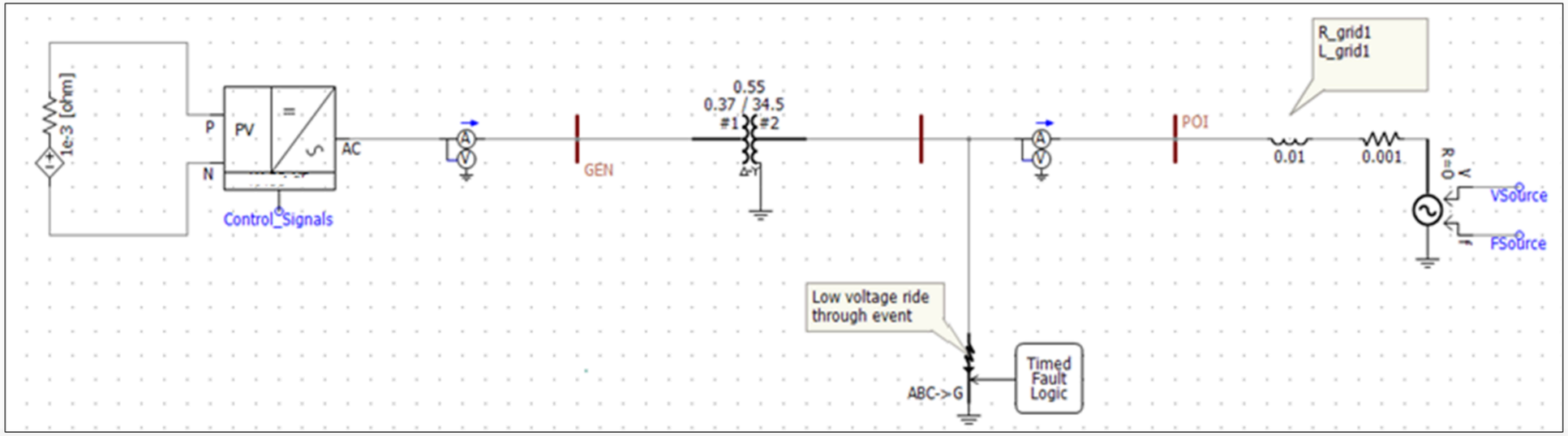


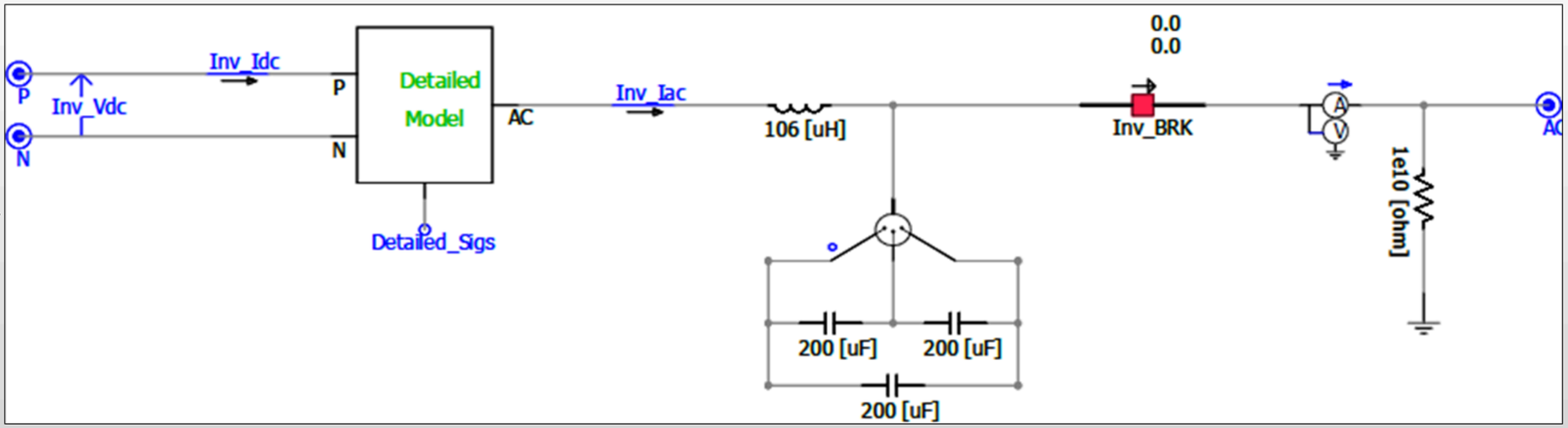
# PSCAD Model Comparison with HIL




**PSCAD Model Exact Firmware –DLL based model**

**RSCAD Model:**

**Real Hardware Controller**



# PSCAD Model validation against HIL Data

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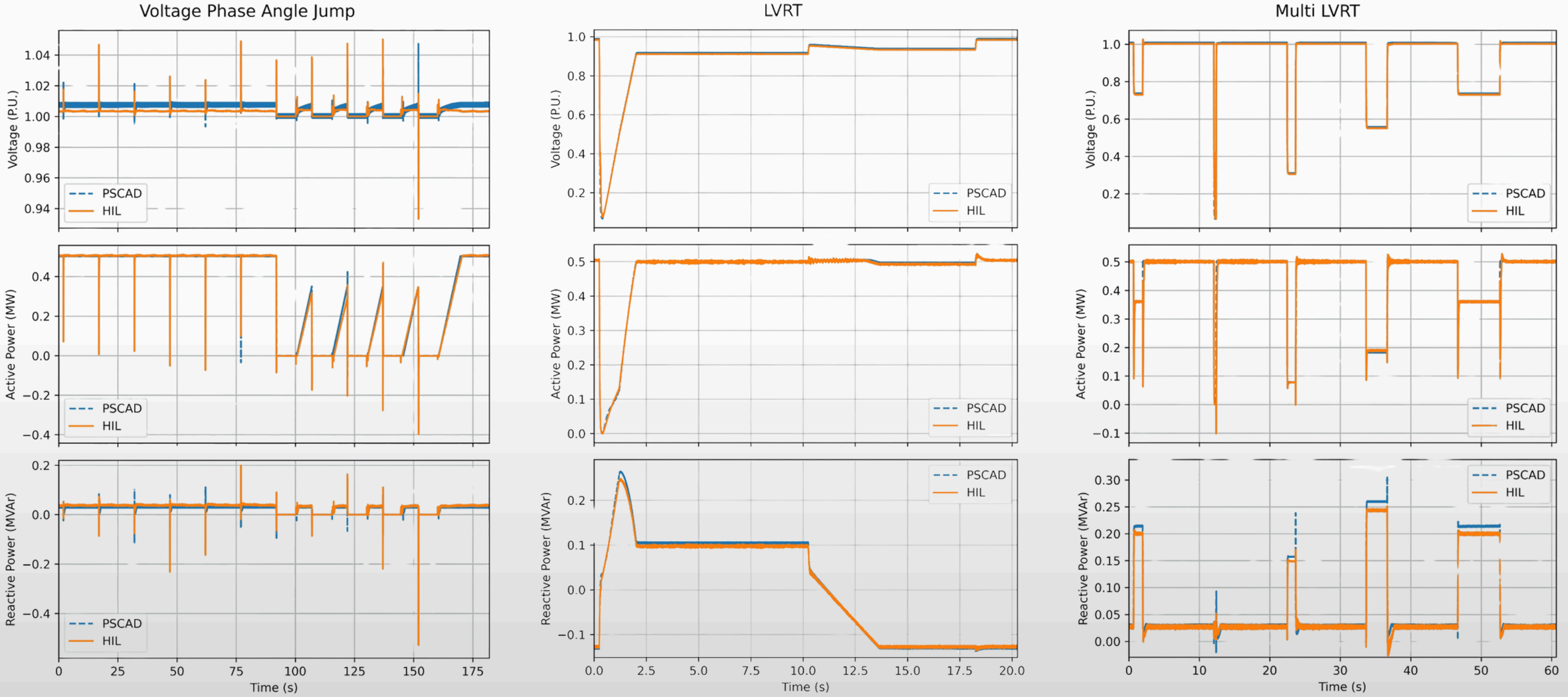

# Significant difference between RMS/PSCAD/HIL

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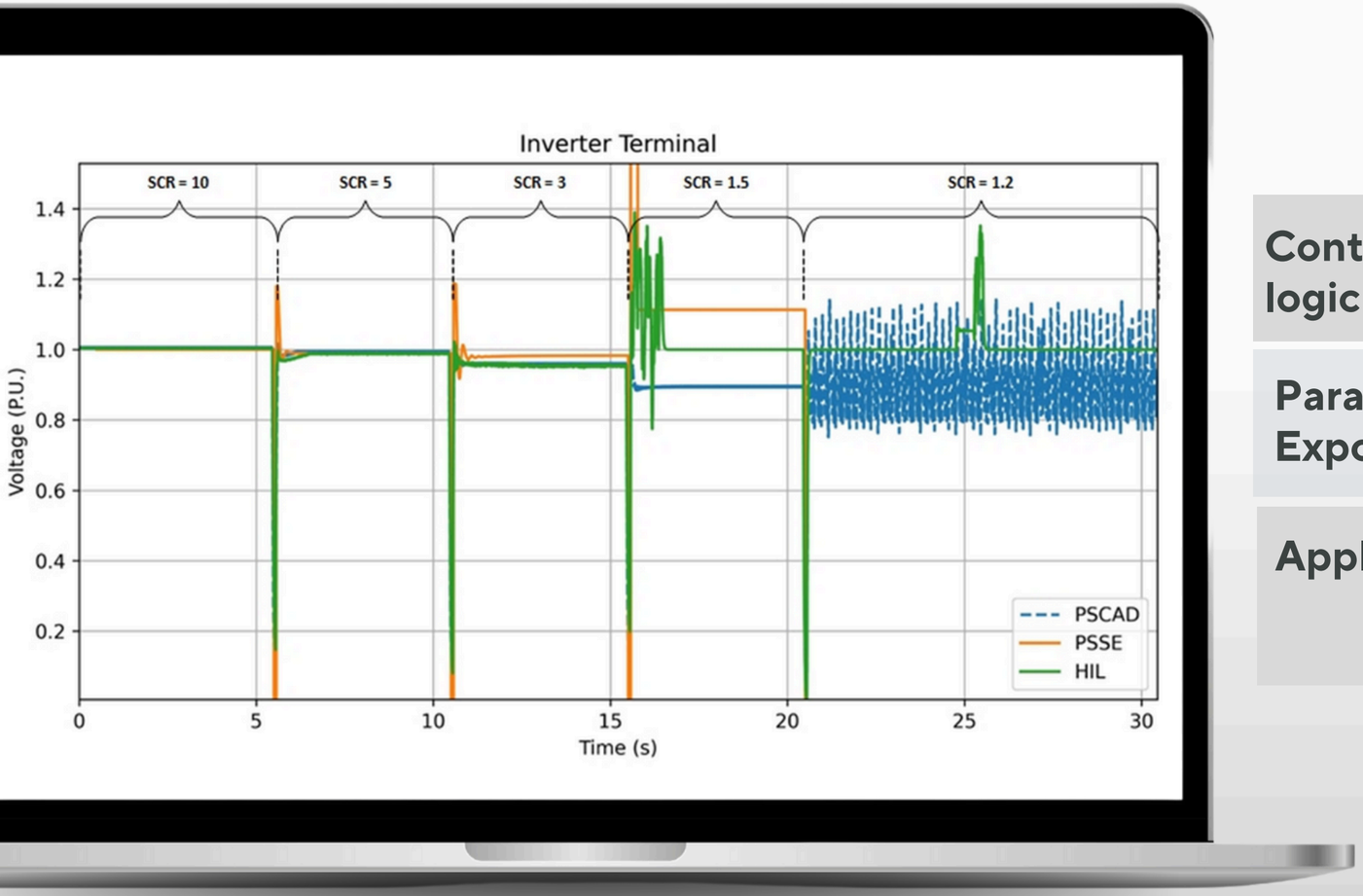
## Short circuit ratio TEST




| | RMS (Phasor) | EMT (Time-Domain) | HIL (Real-Time) |
|---|---|---|---|
| Control logic | Simplified | Detailed | Real controller in loop |
| Parameter Exposure | Limited | More exposed | Fully exposed (RT OS level) |
| Application | Stability, Load Flow | Protection, Transients | Controller validation, protection |

# Key Takeaways

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- IBR’s performance is critical for integrating renewable energy sources into the grid

- CHIL (Controller-Hardware-in-the-Loop) testing helps:
  - Improve inverter performance
  - Ensure grid compliance
  - Reduce development time and cost

- CHIL enables real-time, high-fidelity testing of control systems under realistic grid conditions can play vital role in grid transition

# Recommendation

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- Utilities should enforce strict adherence to standardized procedures for Hardware-in-the-Loop (HIL) validation reports, particularly in relation to PSCAD and PSS®E model submissions.

- Utilities should publish clear guidelines outlining accepted HIL procedures and test cases.

- Developer should prioritize implementing CHIL testing as part of the equipment selection process to ensure reliability and compliance.

# Enabling Our HIL testing Journey.....

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Recognizing the urgency of our situation:

- The **RTDS Group** promptly shipped essential equipment, enabling us to begin in-house Hardware-in-the-Loop (HIL) testing without delay.

- Special thanks to **Kati Sidwall** (RTDS Group) for her on-site visit and hands-on training, which was instrumental in getting our team up to speed with HIL methodologies.

- Appreciation to **Sumek Elimban** for providing on-demand technical support throughout the setup, troubleshooting, and validation phases.

# THANK YOU