Power Grid Engineering

ATS
Leading Integration

SmartPPC™: Power Plant Controller Solution

For Renewable Power Plants

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02 Hardware-in-the-Loop Testing of SmartPPC™

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Challenges of Power Plant Controller

01 Vendor-dependence

Each vendor uses their own PPC technology in different hardware platforms and communication protocols.

02 Single PPC

One PPC controls a single Inverter-based Resource (IBR) technology, requiring an additional Master PPC in power plants that have more than one IBR technologies.

03 PPC Simulation Models

PPC computer simulation models may not accurately capture the dynamic behavior of their physical system.

Discrepancies between PPC simulation models across different platforms (PSSE, PSCAD, PowerFactory) can lead to inconsistent results, undermining reliability and potentially causing project delays.

04 Grid Code Non-compliance

Any grid code non-compliance will cause significant project delays. In addition to pure simulation, there must be alternatives to verify the compliance of physical PPC, such as Hardware-in-the-Loop testing.

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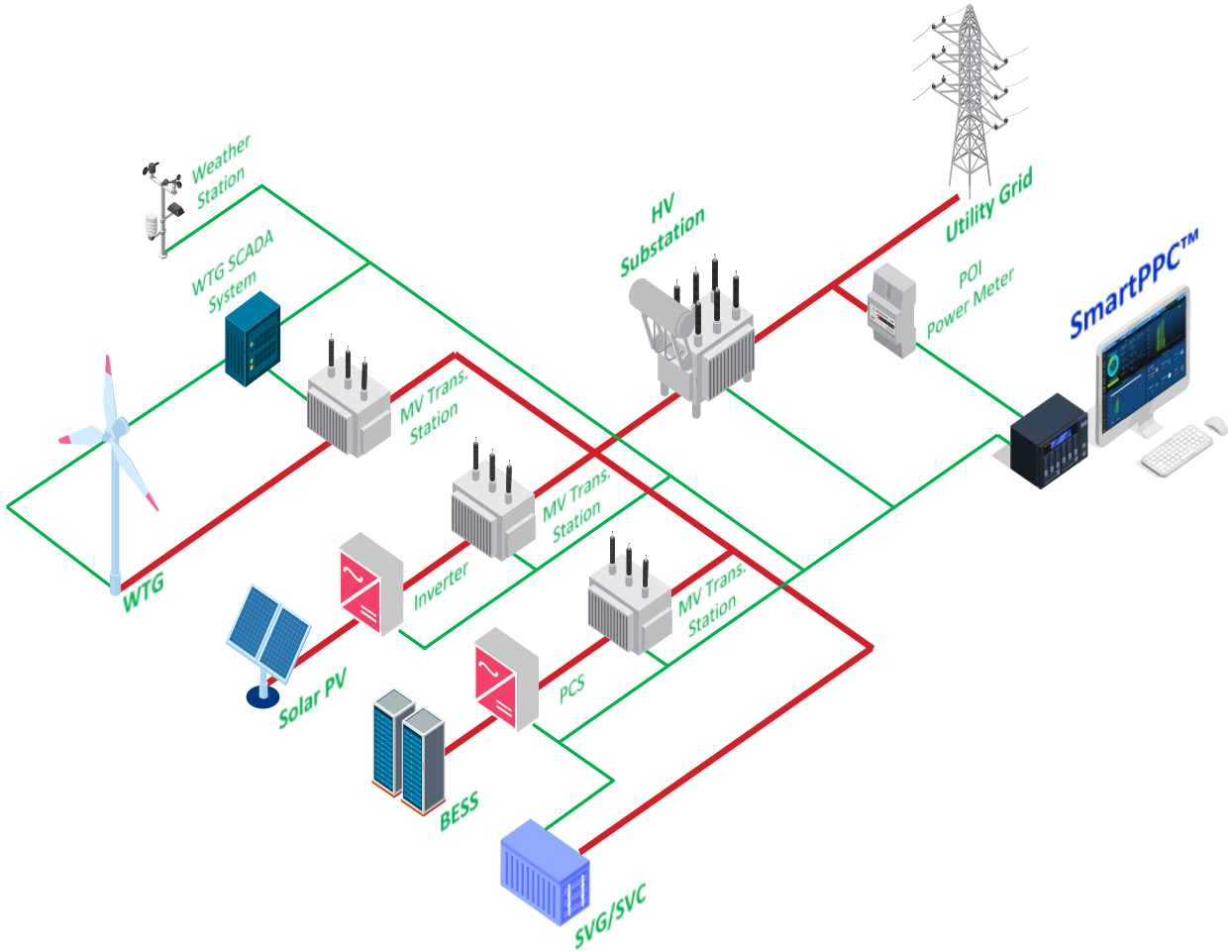
SmartPPC™: Power Plant Controller Solution

SmartPPC™: **A Software-based & Vendor-independent Power Plant Controller** developed by AusRE/ATS, designed for plant-level controls of solar, wind, BESS, and hybrid power plants, ensuring compliance with AEMO/NSP requirements.

Main features:

- ***Grid Codes Compliance***: Ensure compliance with international grid codes (Australia, Vietnam, Myanmar, Philippines, Malaysia, etc.).
- ***Multi-platform Simulation Model Support:*** EMT models (PowerFactory, PSCAD) and RMS models (PSSE) are created by our Digital Twin modeling technique, ensuring model accuracy and consistency.
- ***Vendor-independence:*** Support standard protocols (IEC61850, IEC60870-5-104, IEEE C37.118, DNP3, Modbus RTU/TCP, etc.) to be compatible with equipment from any manufacturers like ABB, SMA, Huawei, Sungrow, Vestas, GE, etc.
- ***Hardware-in-the-Loop Testing:*** Support HIL testing with physical PPC to verify grid compliance and performance at early stages.



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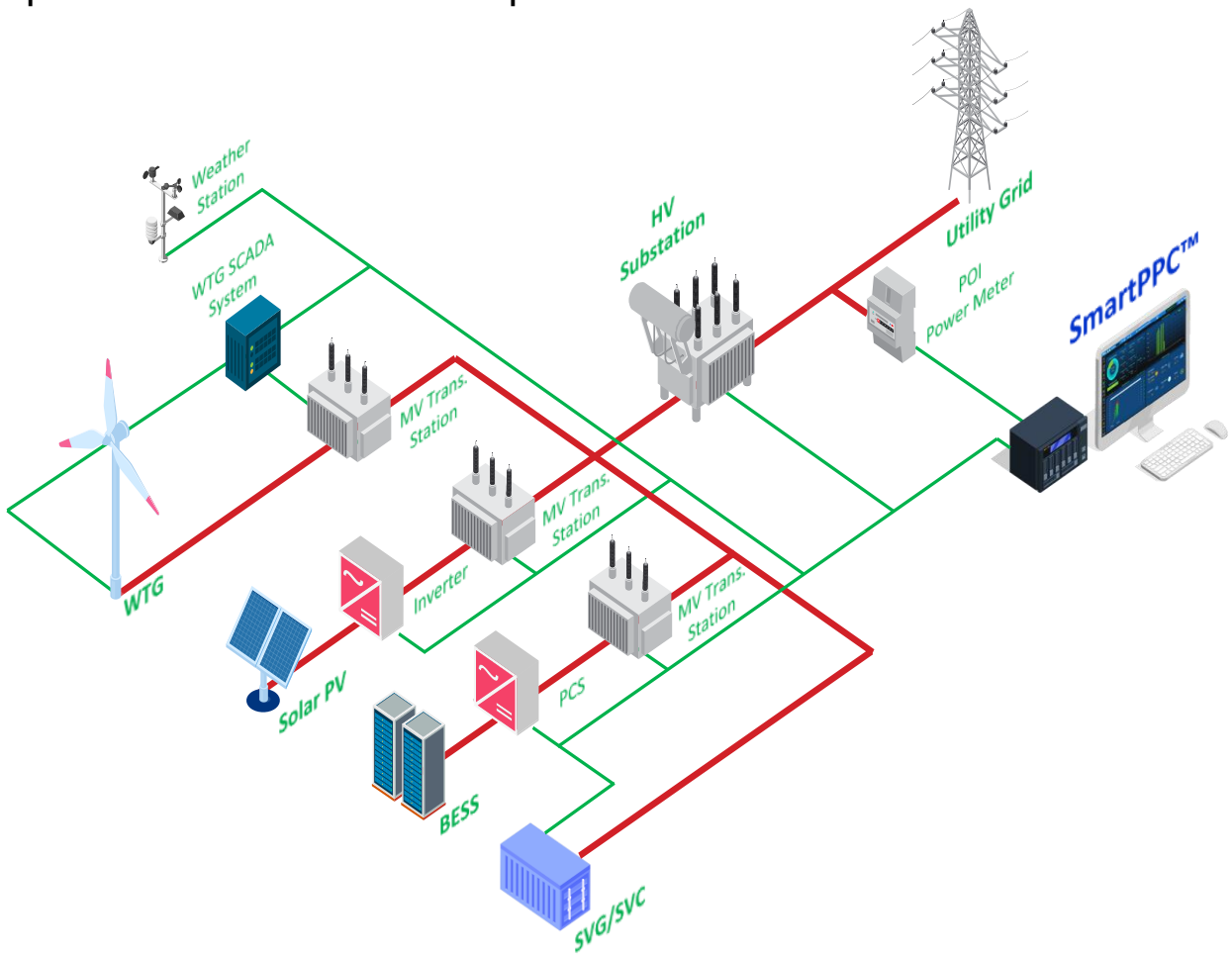
Main features:

- ***High-speed Controller:*** SmartPPC™ runs on **Real-time Operating System**, bringing high processing capability with a fast-sampling time of **20ms** for both P and Q loops, and **10ms** for power meters enabling advanced control schemes.
- ***Optimal Design***: SmartPPC™ can perform all control functions of Master and Slave PPCs.
- ***High Scalability:*** Up to **8 PPCs** can be configured in the same hardware device due to our modular design.
- ***Redundancy Operation*****:** Hot standby operation offers a high level of redundancy.



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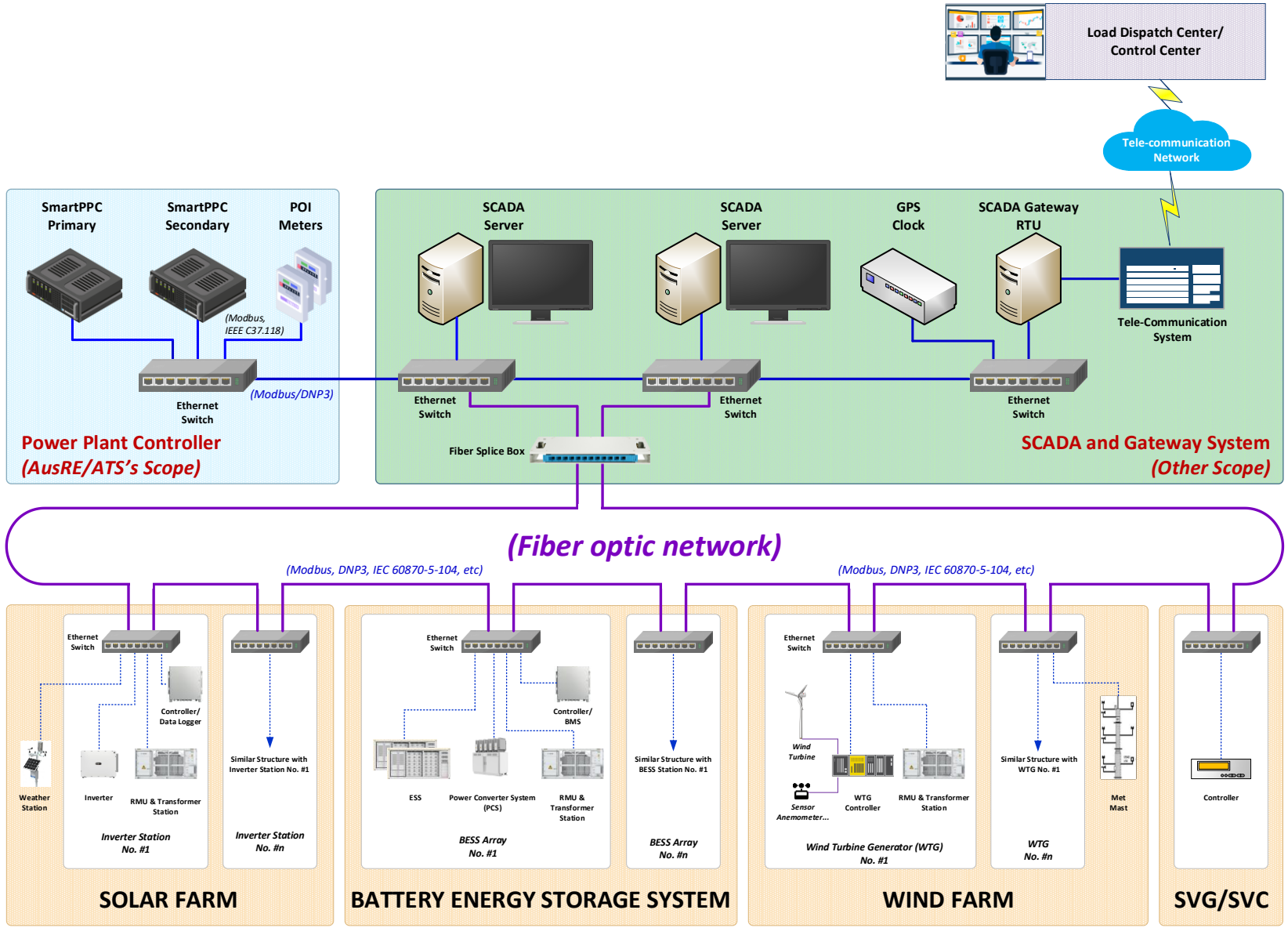
SmartPPC™: Power Plant Controller Solution



Typical hardware structure

- ***Redundant Power Plant Controllers:*** for control of the whole power plant. Monitoring and control signals of PPC can be connected and integrated into the plant SCADA and Gateway system to connect to the control centers of AEMO/NSP.
- ***POI Meters***: for measurement data acquisition (P/Q/U/Hz) at Point of Interconnection and providing data input for the PPC system.

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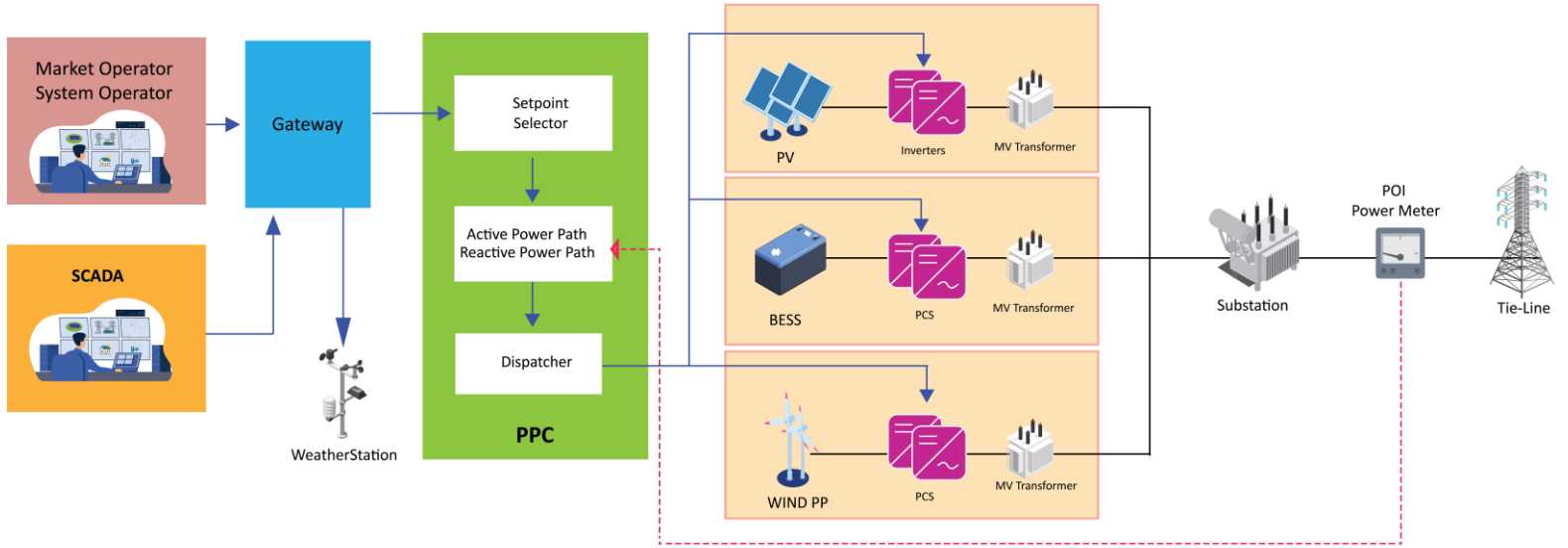
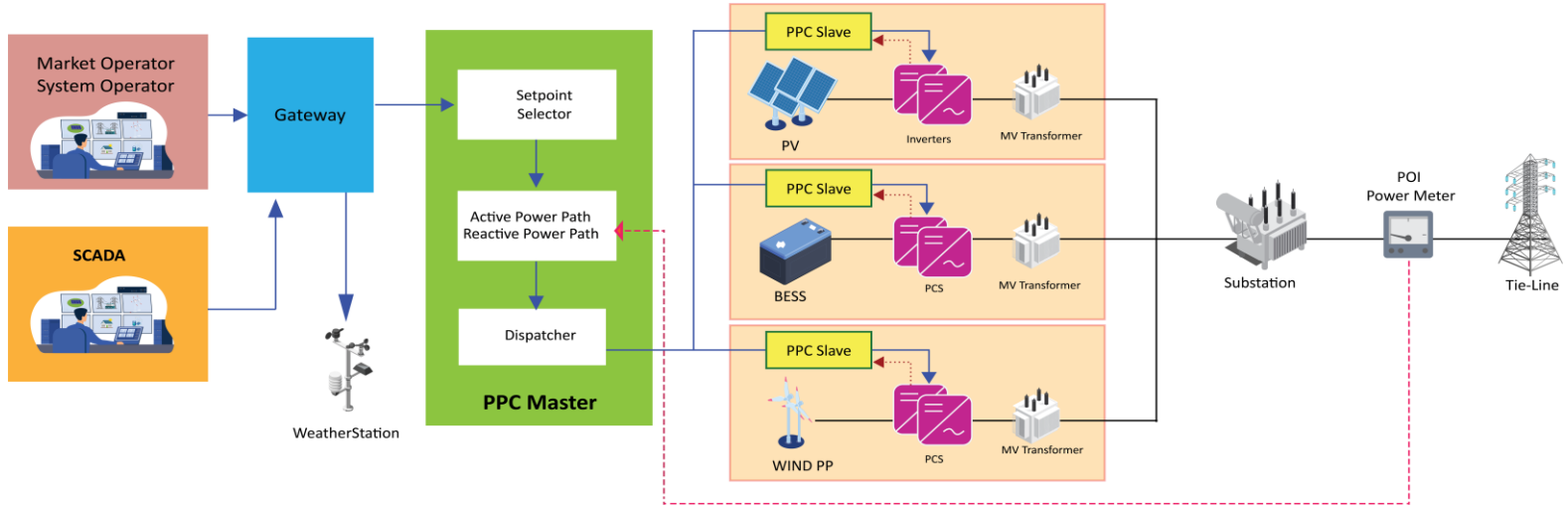
SmartPPC™: Power Plant Controller Solution

Configuration 1: SmartPPC™ functions as Master PPC without Slave PPCs



Configuration 2: SmartPPC™ functions as Master PPC with Slave PPCs



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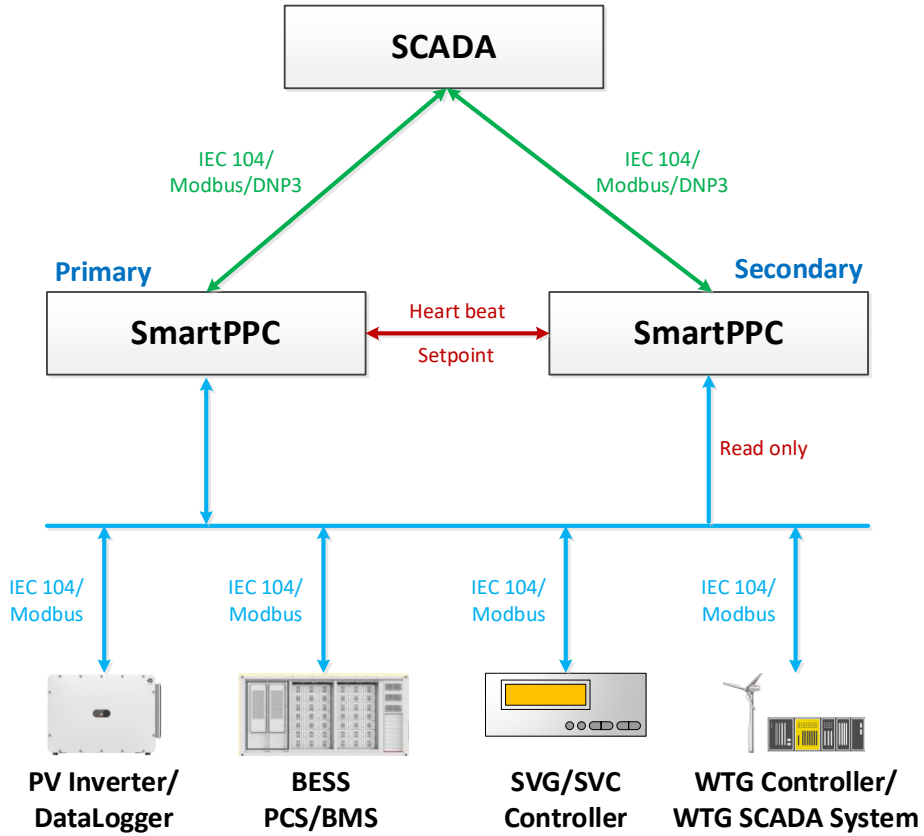
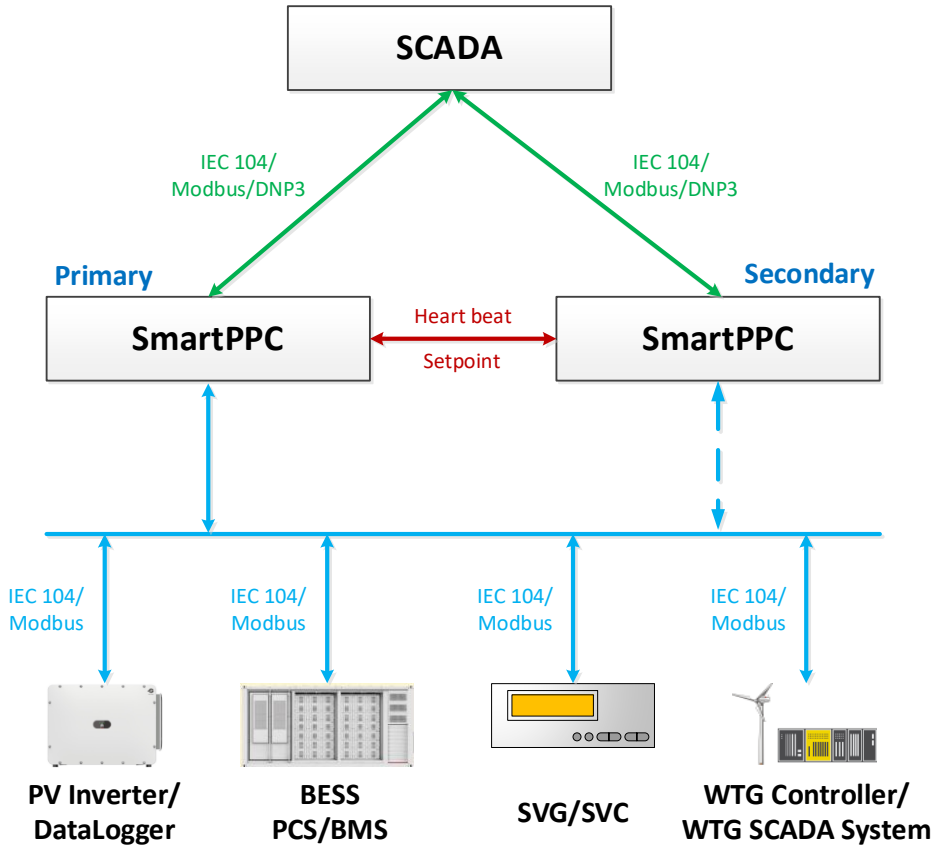
SmartPPC™: Power Plant Controller Solution



Hot-hot redundancy mode



Hot-standby redundancy mode

The design of SmartPPC™ allows hot-hot redundancy and hot-standby redundancy mode, improving the system reliability with single-fault-tolerant configuration.

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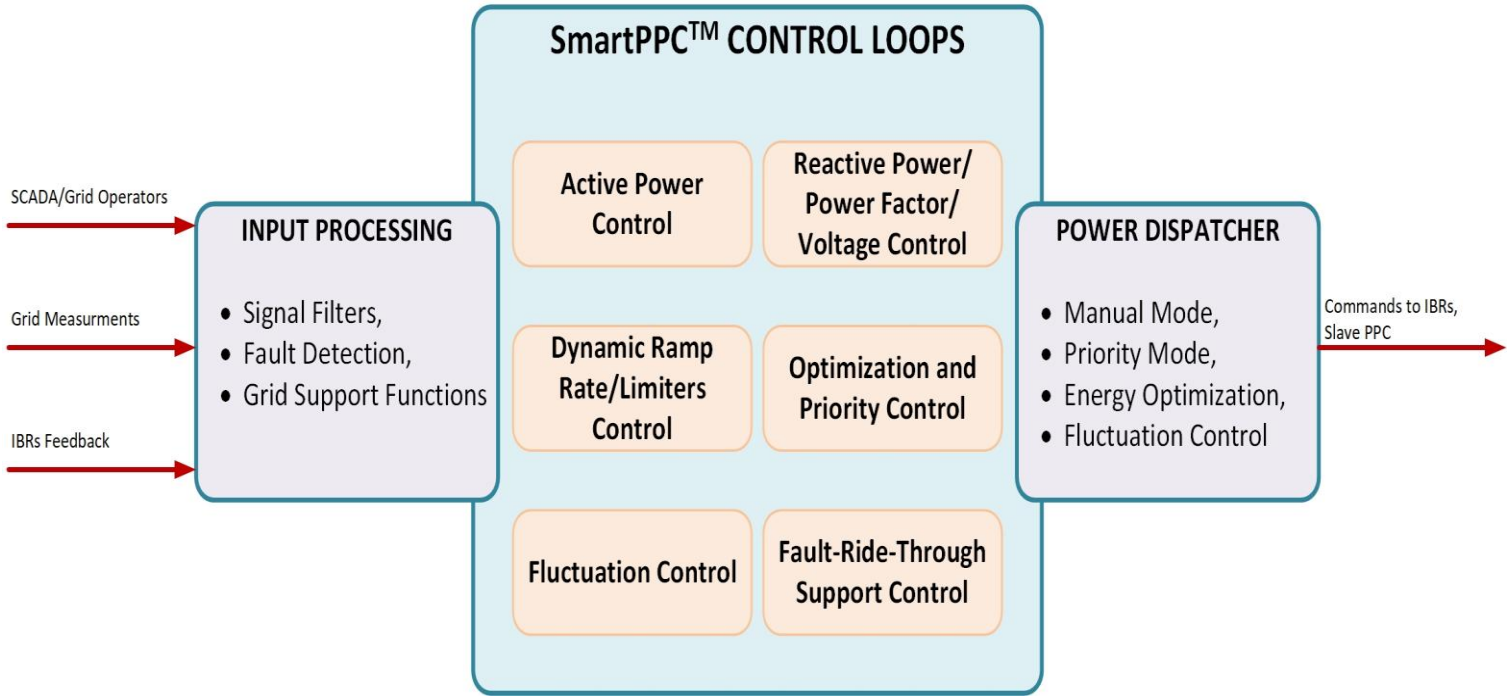
SmartPPC™: Power Plant Controller Solution

Main Control Functions of SmartPPC™:

- Active power control
- Ramp rate control
- Reactive power control
- Power factor control
- Voltage control
- Frequency support
- Frequency control ancillary service (FCAS)
- Fault Ride-through capability
- Energy Optimization and Power Generation Priority control
- Startup/Shutdown plant control
- Manual control



SmartPPC™ runs on **Real-time Operating System**, bringing high processing capability with a fast-sampling time of **20ms** for both P, and Q loops, and **10ms** for power meters enabling advanced control schemes.

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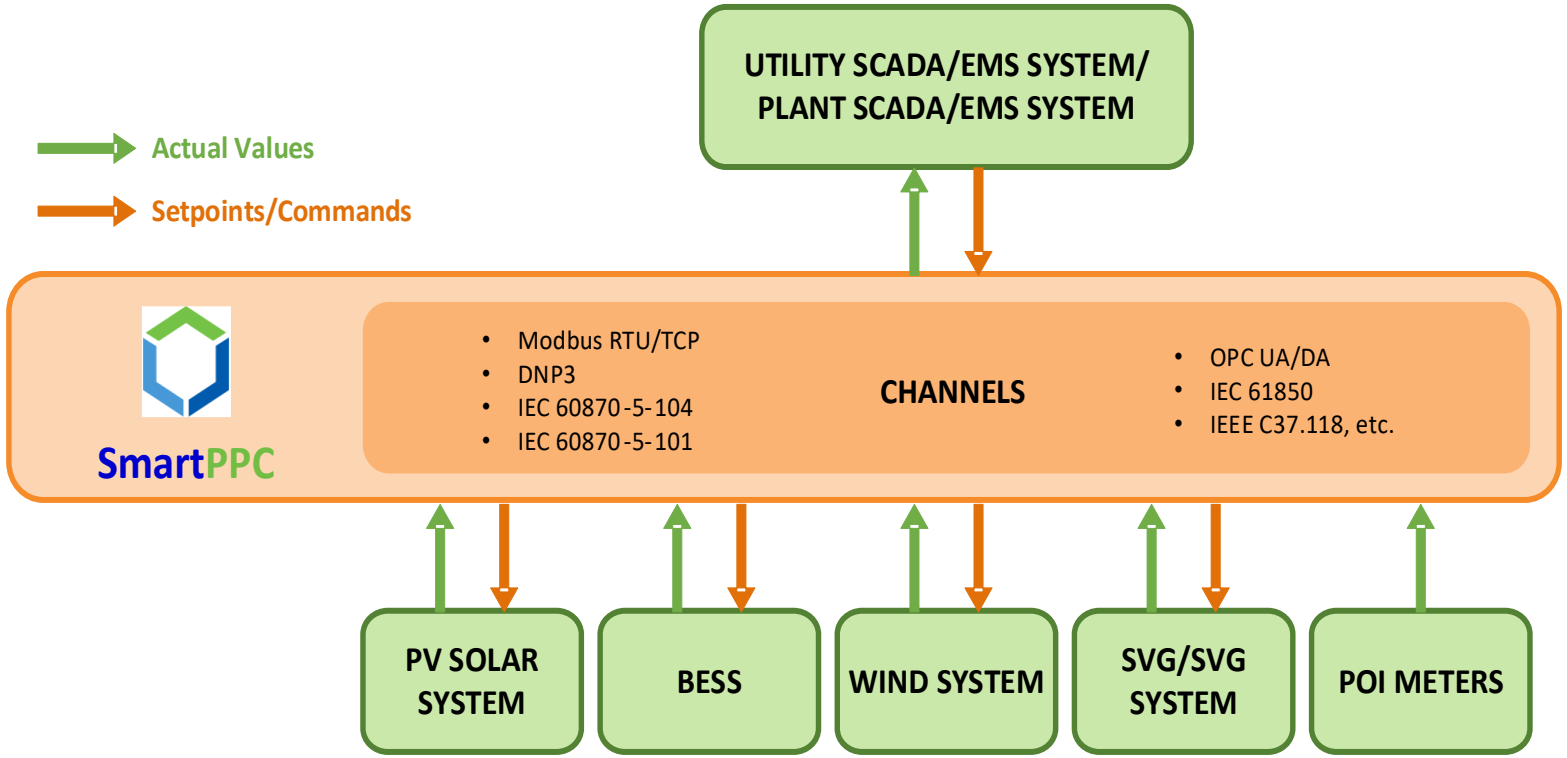
SmartPPC™: Power Plant Controller Solution

SmartPPC™ supports multiple protocols:

- Modbus RTU/TCP, DNP3, IEC61850, IEEE C37.118, IEC 60870-5-104, OPC DA/UA, etc.
- Managing multiple channels at the same time.
- Compliant with NERC-CIP standard recommendations and best practices.
- Certificates of compliance issued by DNV-GL (KEMA) for IEC61850, IEC60870-5-101, and IEC60870-5-104 protocols.



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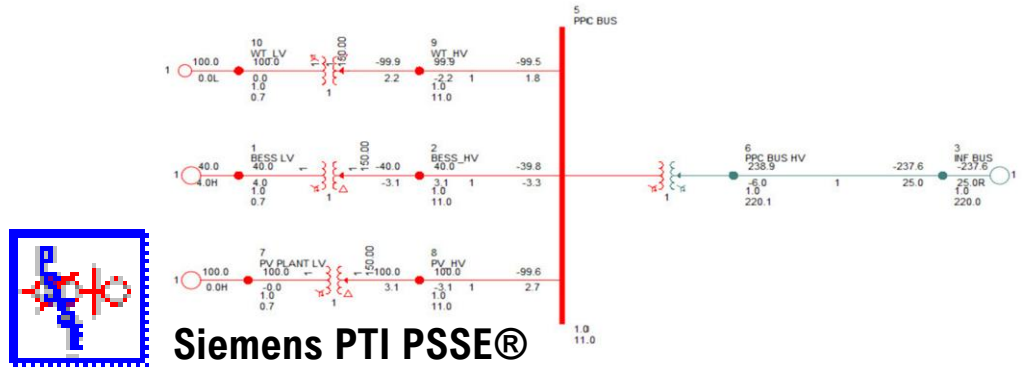
SmartPPC™: Power Plant Controller Solution

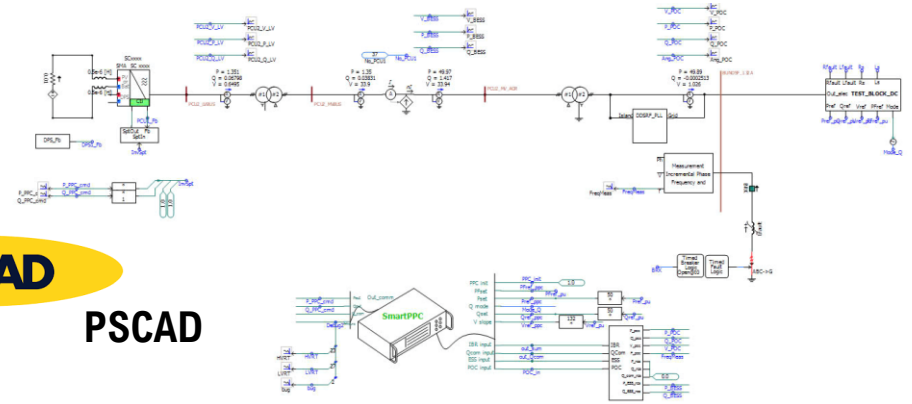
Multi-platform Simulation Models of SmartPPC™:

Our **Digital Twin Modeling Technique** make accurate and consistent RMS/EMT simulation models of SmartPPC™ across multiple platforms.

- RMS and EMT models in **DIgSILENT PowerFactory**, **PSS/E**, and **PSCAD**.
- Models fully **adhere to the technical requirements** set by grid operators for reliable grid connection studies.
- Enable in-depth evaluation of grid performance, encompassing **transient stability, fault ride-through**, **voltage and frequency response.**
- **Full DMAT reports** for all required simulation platforms are performed by in-house engineers.

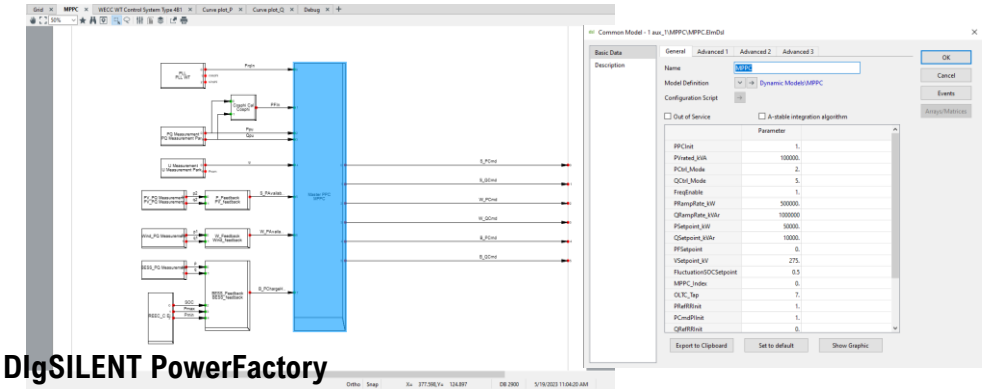


Siemens PTI PSSE®



PSCAD

PSCAD



DIgSILENT PowerFactory

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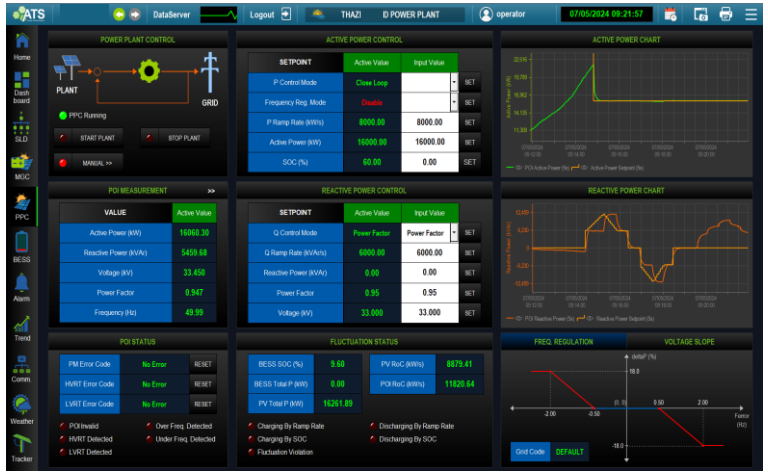
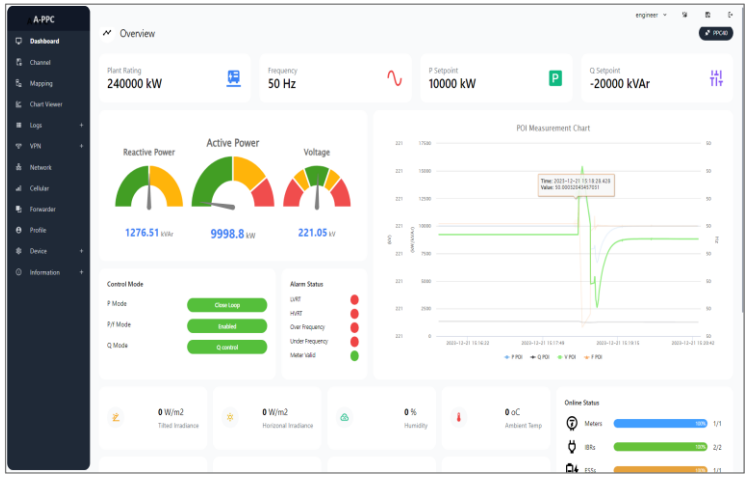
SmartPPC™: Power Plant Controller Solution

Intuitive User Interface of SmartPPC™:

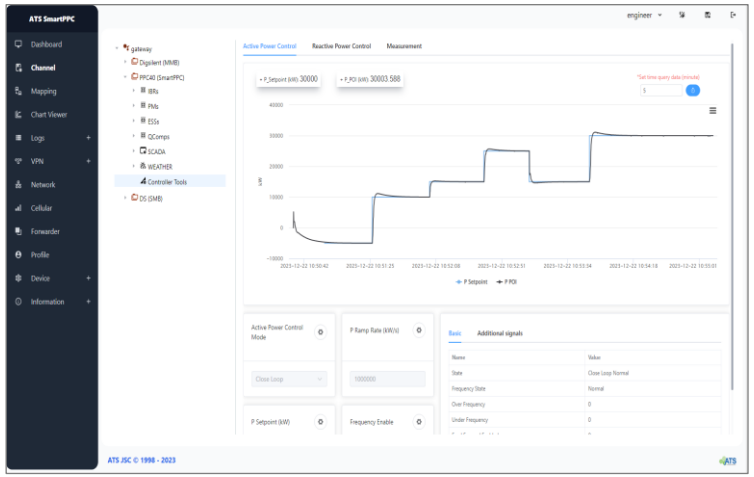
PPC HMI



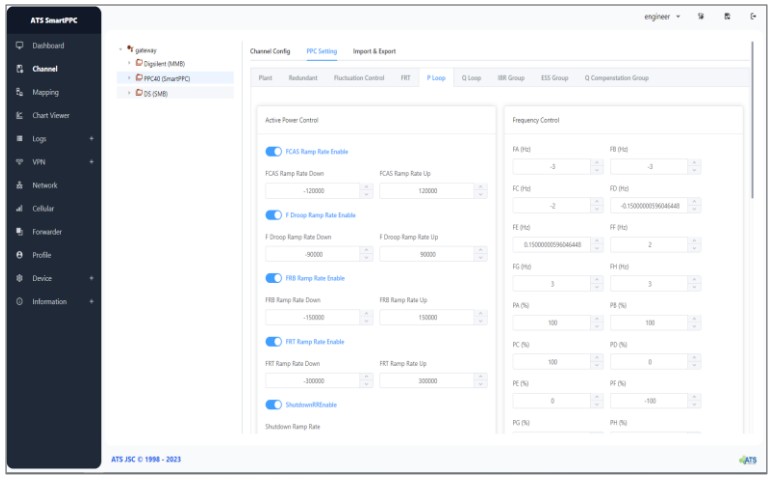
Web-based Dashboard



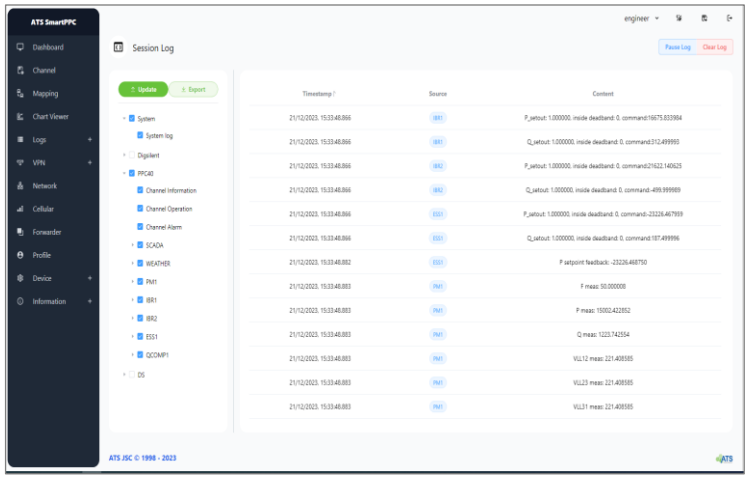
Active Power Control



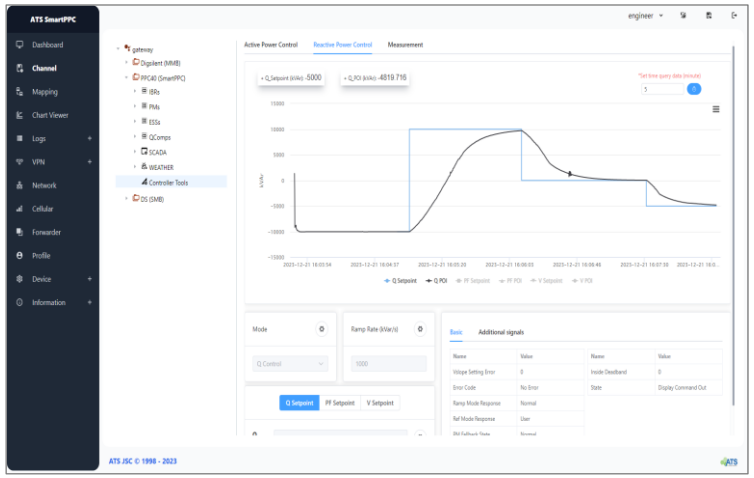
PPC Configuration



Data Logging



Reactive Power Control



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02 Hardware-in-the-Loop Testing of SmartPPC™

03 Sample DMAT Results of SmartPPC™

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Hardware-in-the-Loop Testing

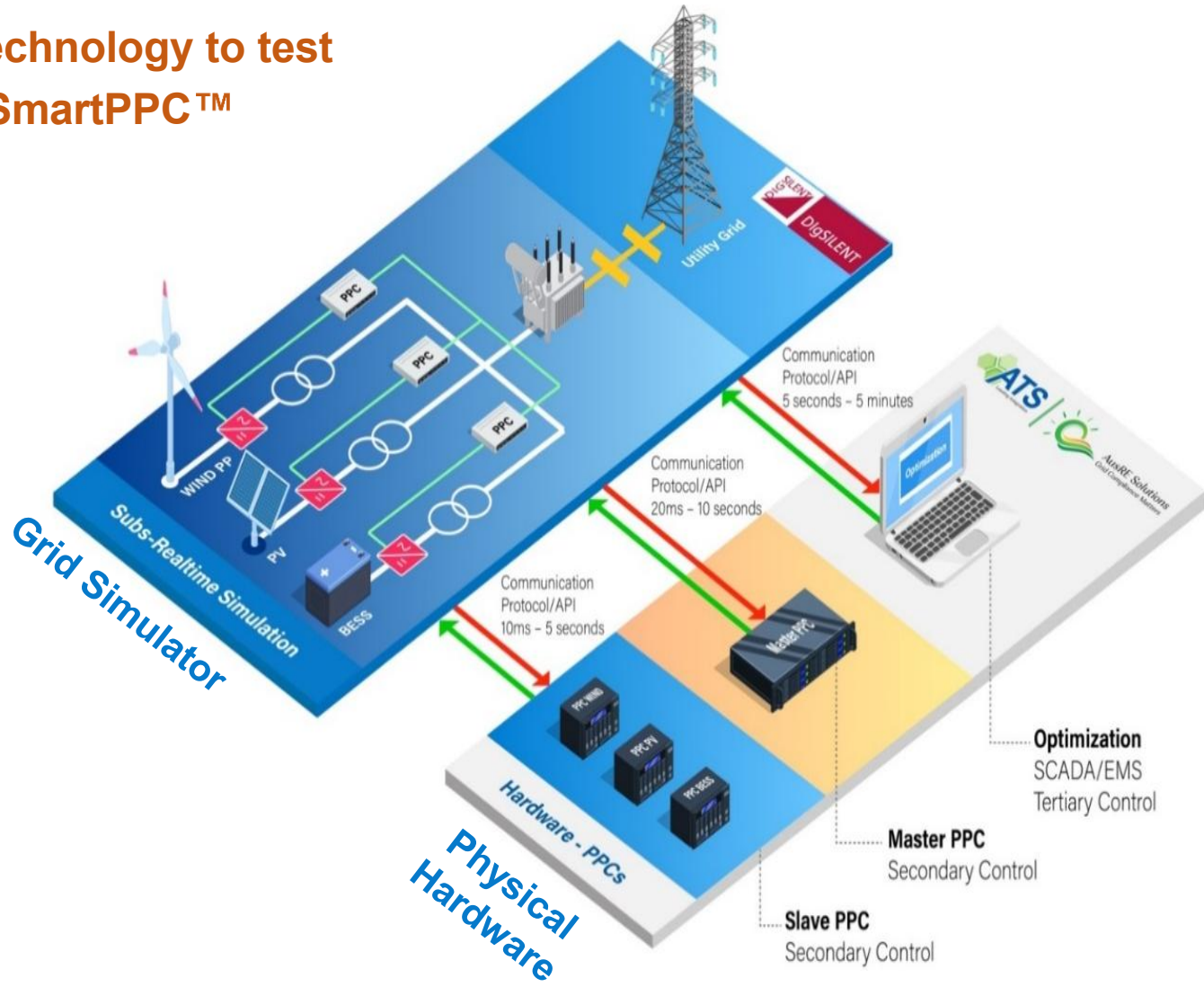
We have Hardware-in-the-Loop (HIL) simulation technology to test and validate the performance and compliance of SmartPPC™

<u>Grid Simulator:</u> Utility Grid and Renewable Power Plants are modelled in DIgSILENT PowerFactory

- Generic Dynamic Models from IEEE, IEC, WECC
- Manufacturer-specific Dynamic Models
- **Key advantage of performing HIL with NEM case**

<u>SCADA/Gateway/RTU and SmartPPC:</u> Integrated in Physical Hardware

- Support standard communication protocol for fast data exchange between hardware and PowerFactory
- Provide a portable and cost-effective HIL Testing Solution



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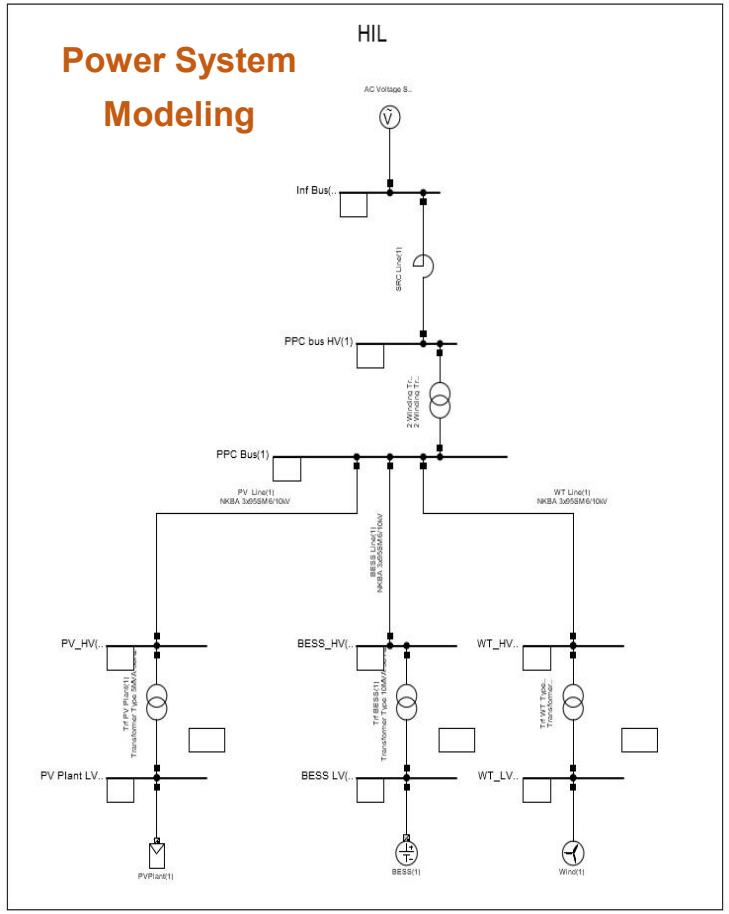
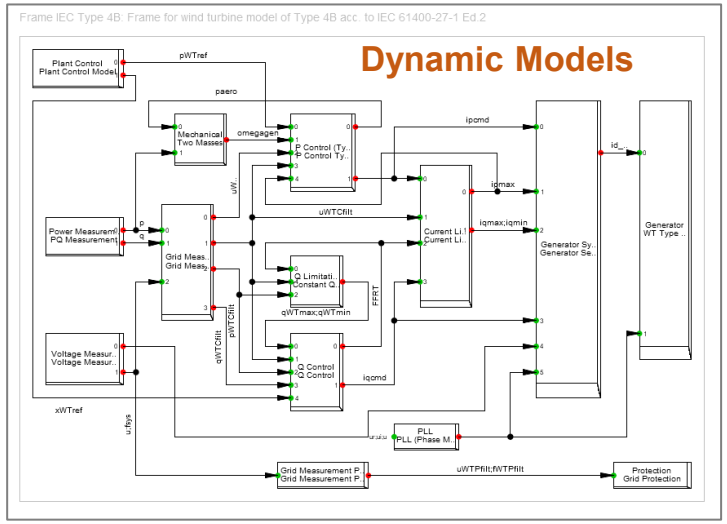
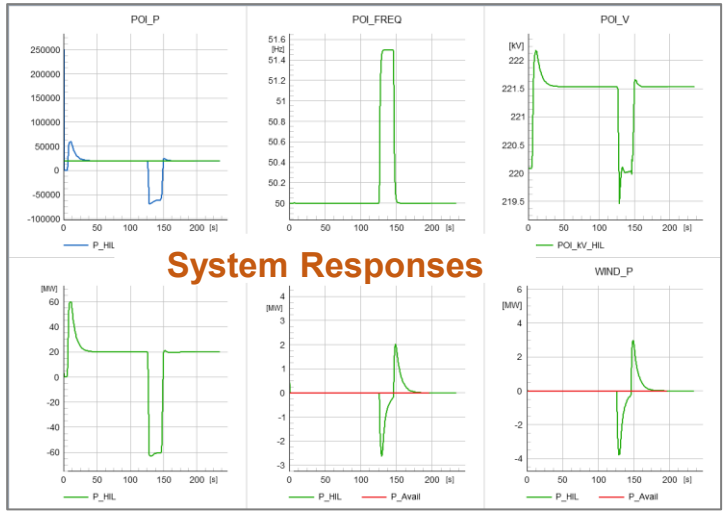
Hardware-in-the-Loop Testing

We select DIgSILENT PowerFactory for HIL simulation:

- The Grid & Power Plant Facility are modeled in PowerFactory.
- The Manufacturer-defined Dynamic Models of PV Inverters, WTGs, BESS PCS, SVG/STATCOM, etc. can be integrated.
- **Flexibility to create Grid Disturbances** to test control performance and compliance: Over/under-voltage, over/under-frequency, Short-circuit with impedance, etc.
- **Flexibility to model the Grid**: the SMIB grid model and NEM case grid model can be integrated for HIL testing.







Modeling of Renewable Power Plants in DIgSILENT/PowerFactory

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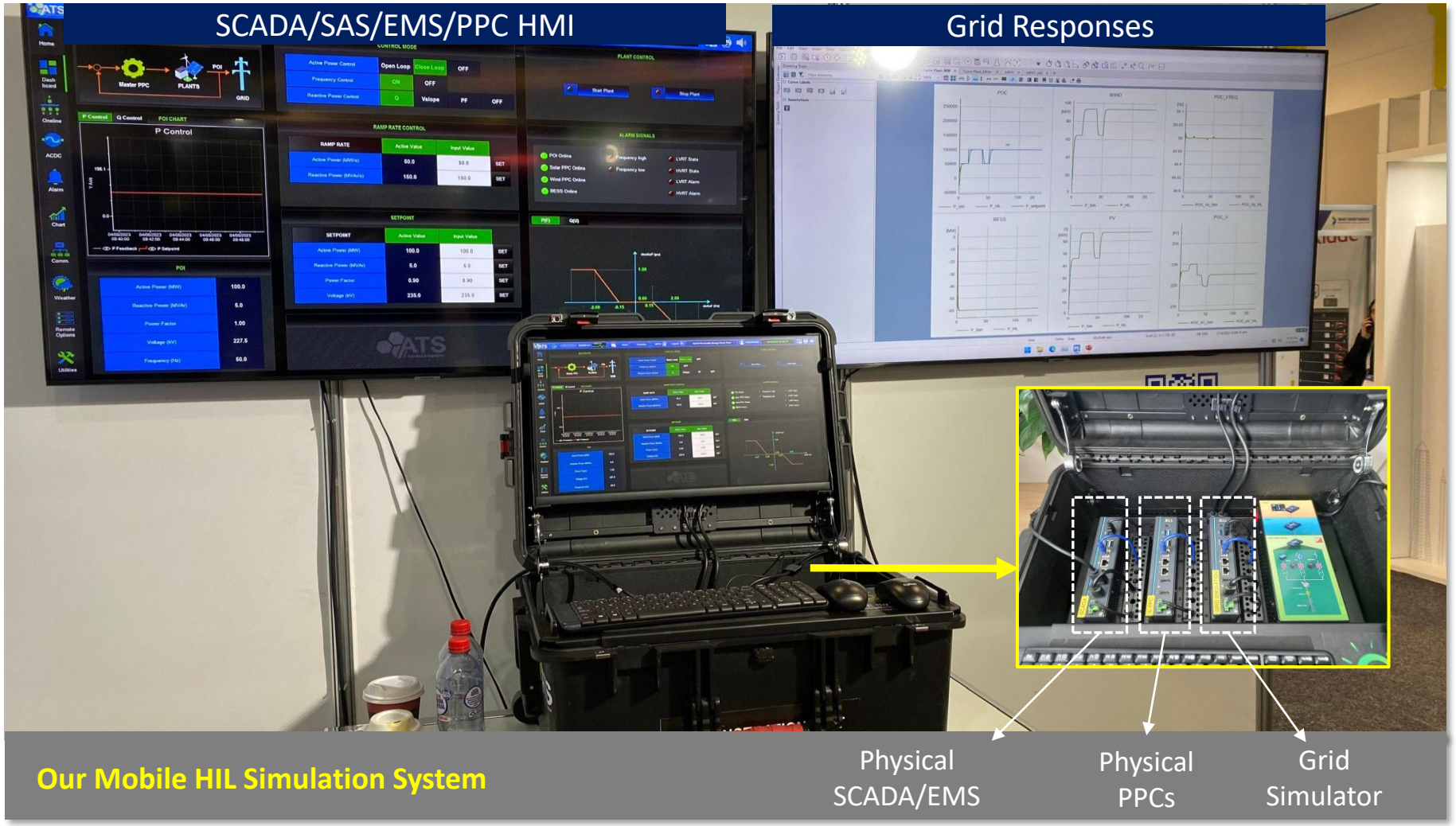
Hardware-in-the-Loop Testing



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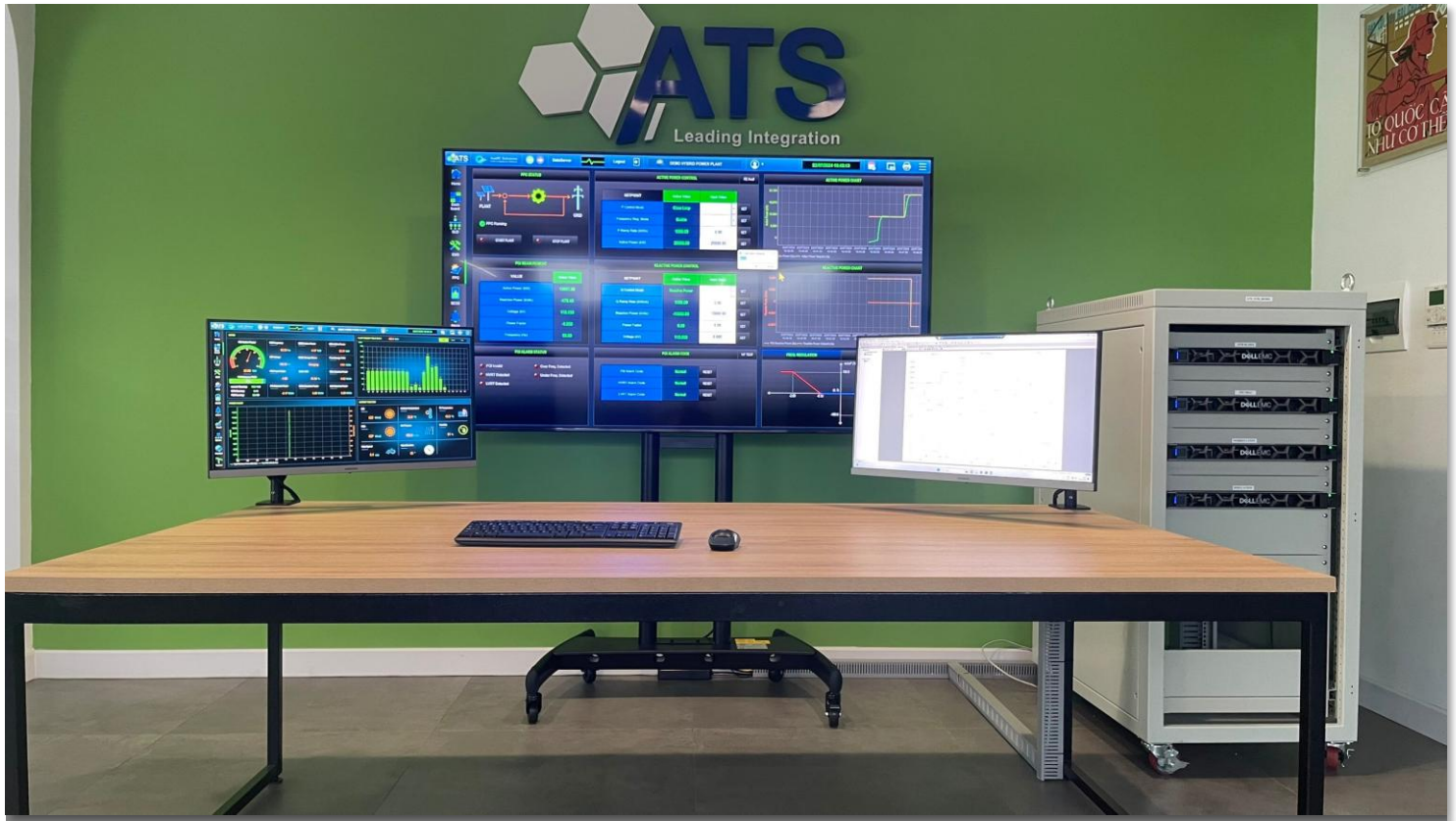
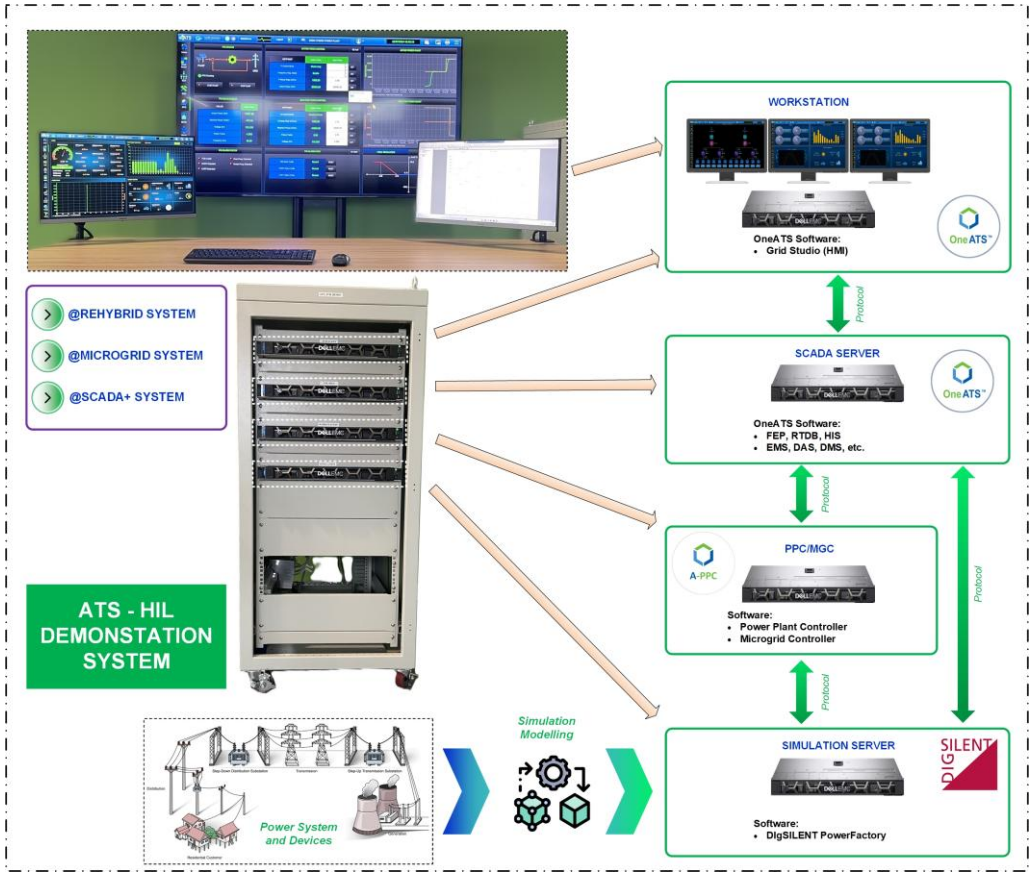


HIL Simulation System at Our Office



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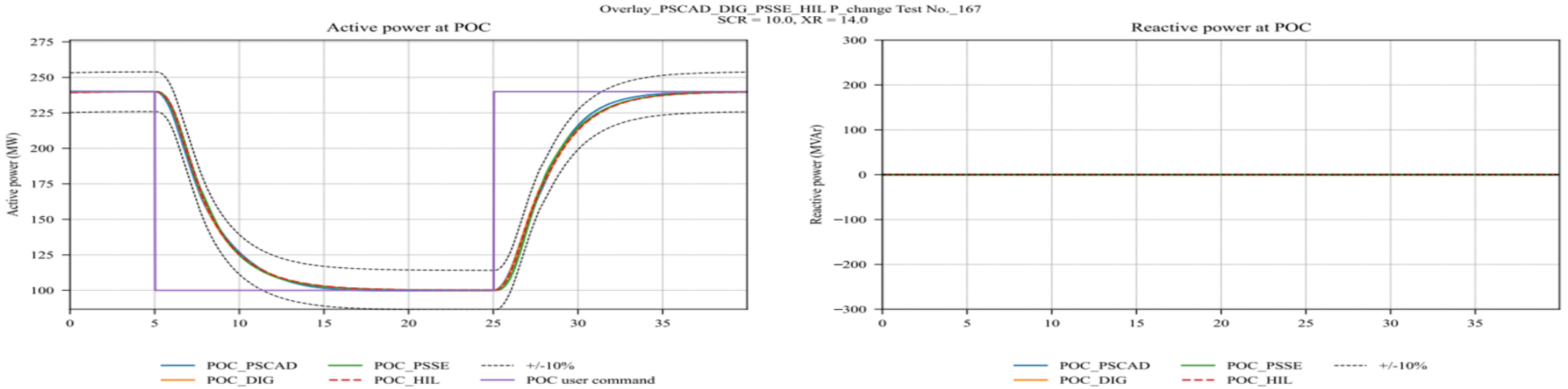
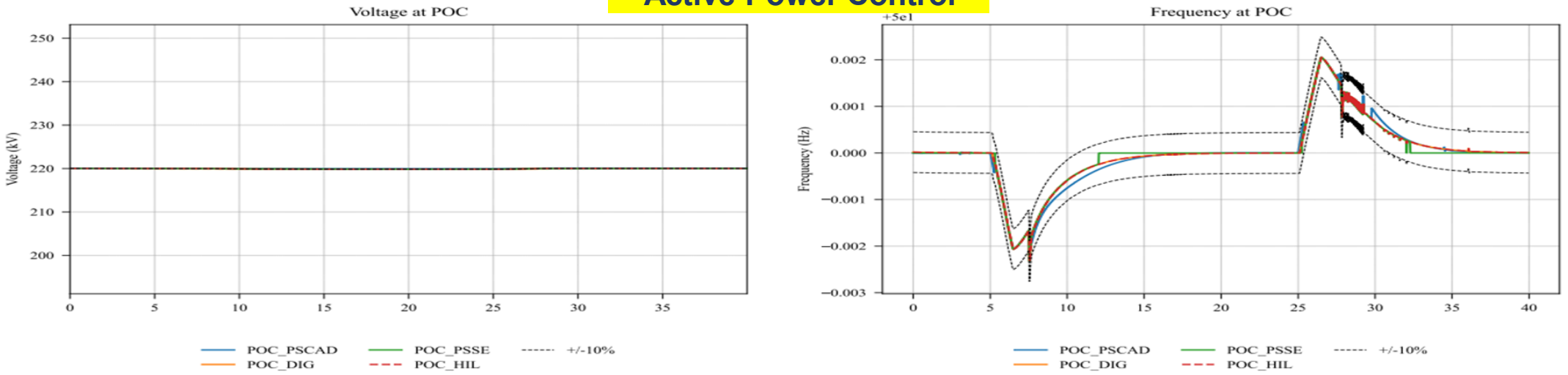
Hardware-in-the-Loop Testing

SmartPPC™ Benchmarking of PSCAD, DIgSILENT PowerFactory, PSSE, and HIL testing



Active Power Control



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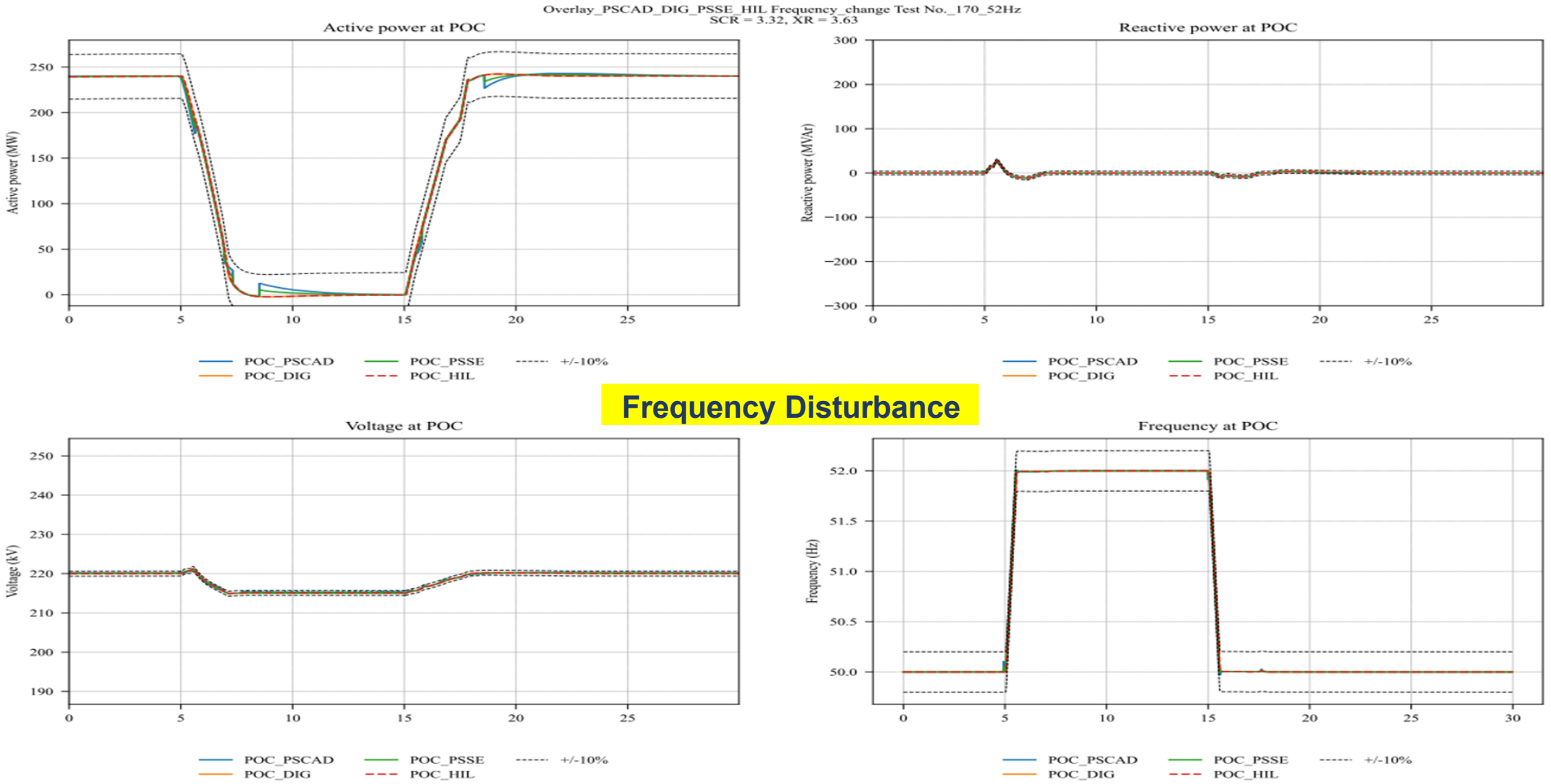

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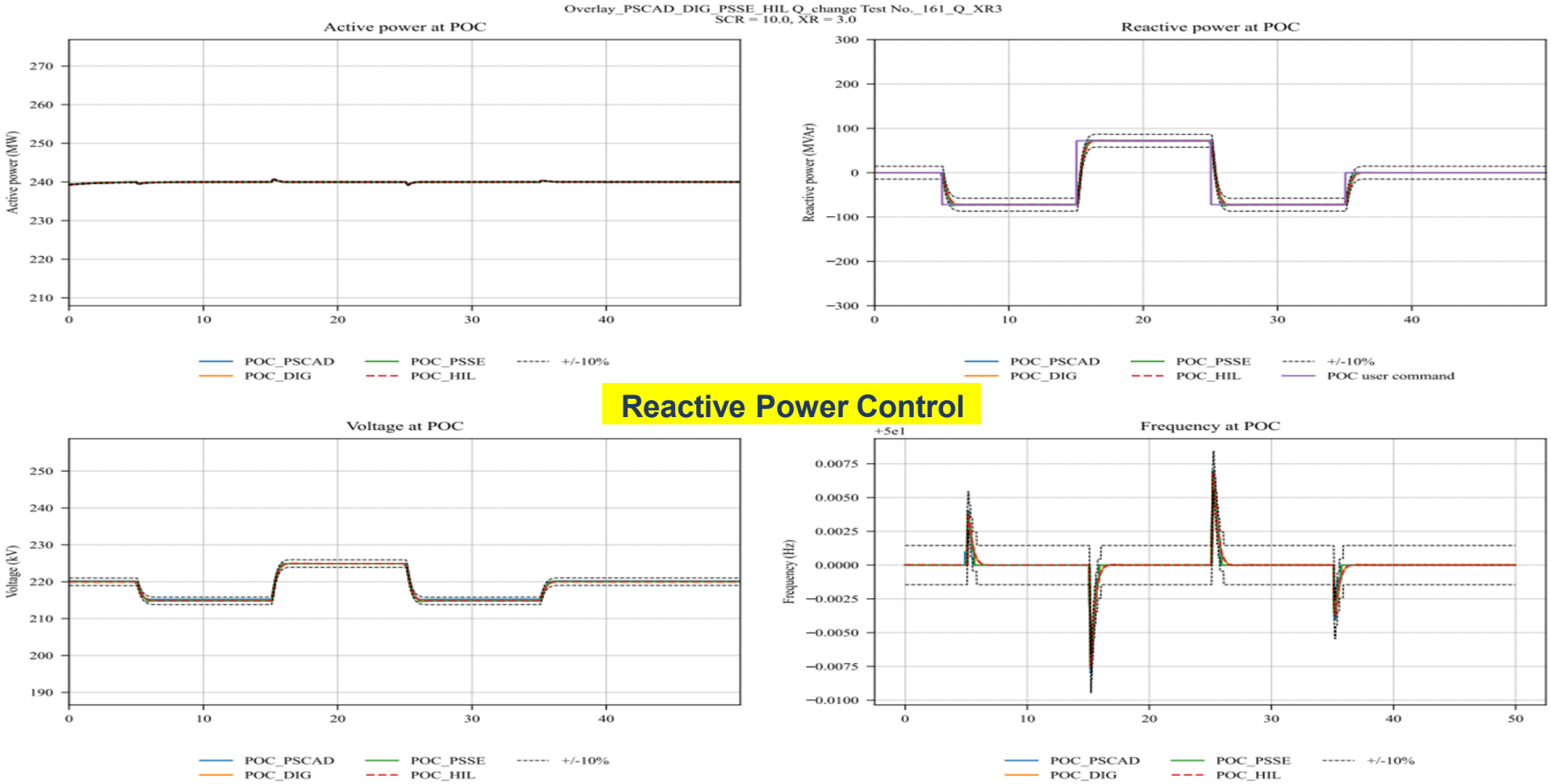

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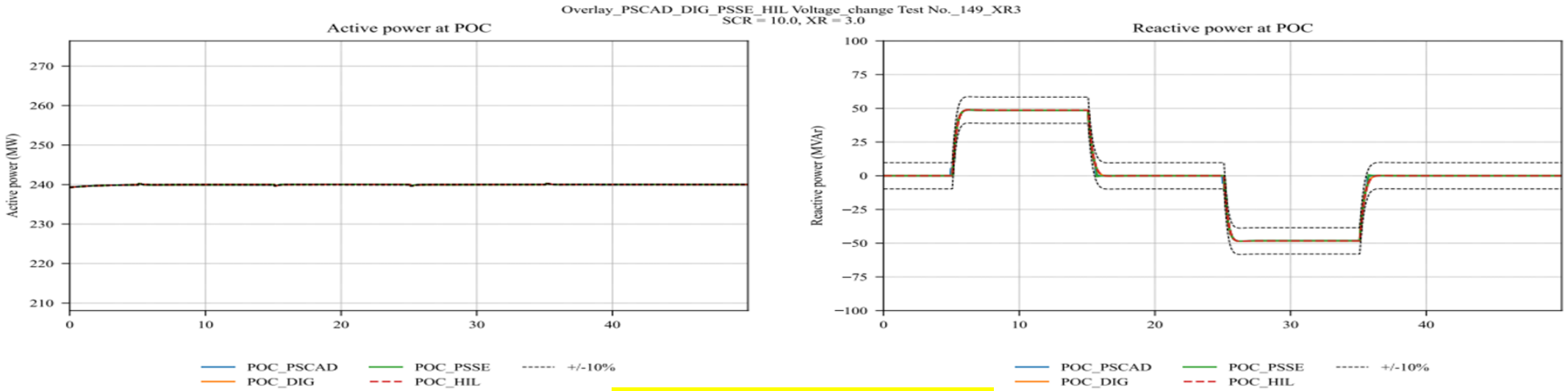
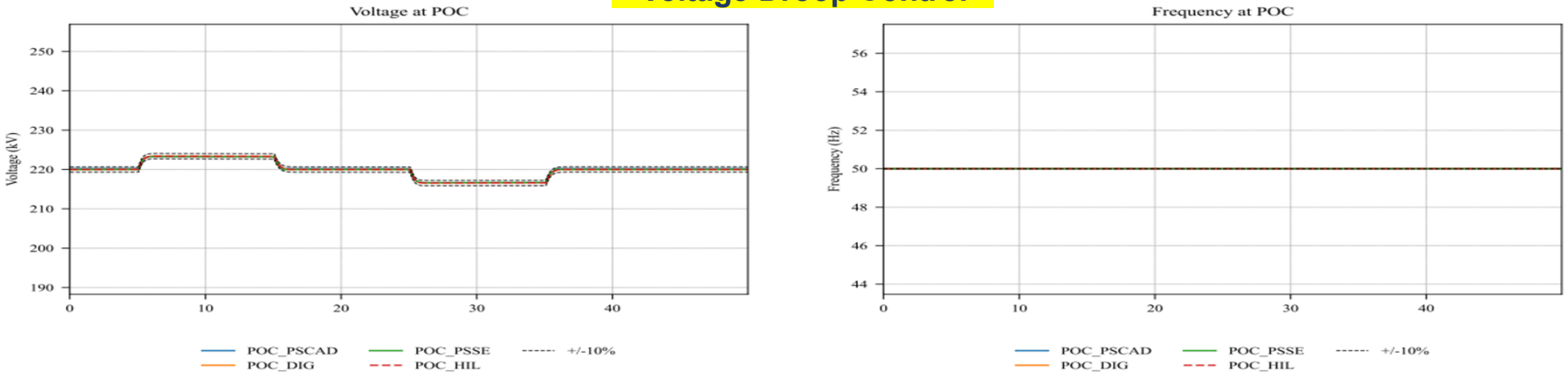


Voltage Droop Control



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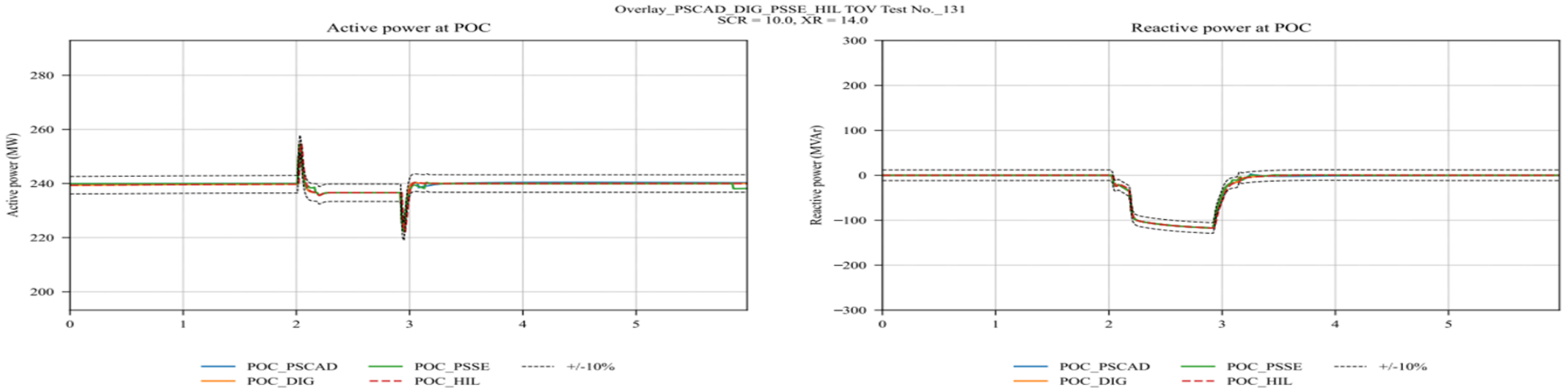
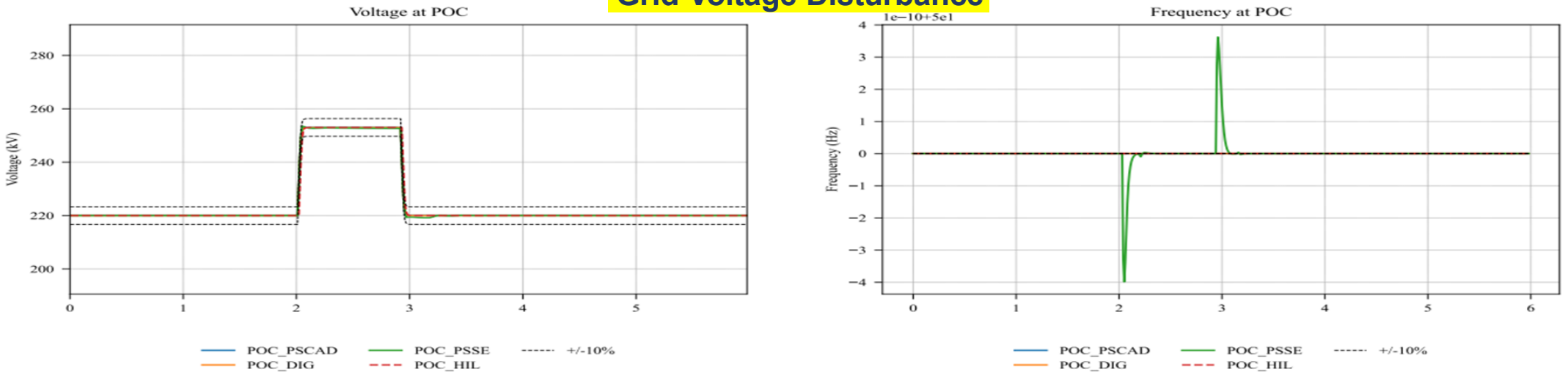


Grid Voltage Disturbance



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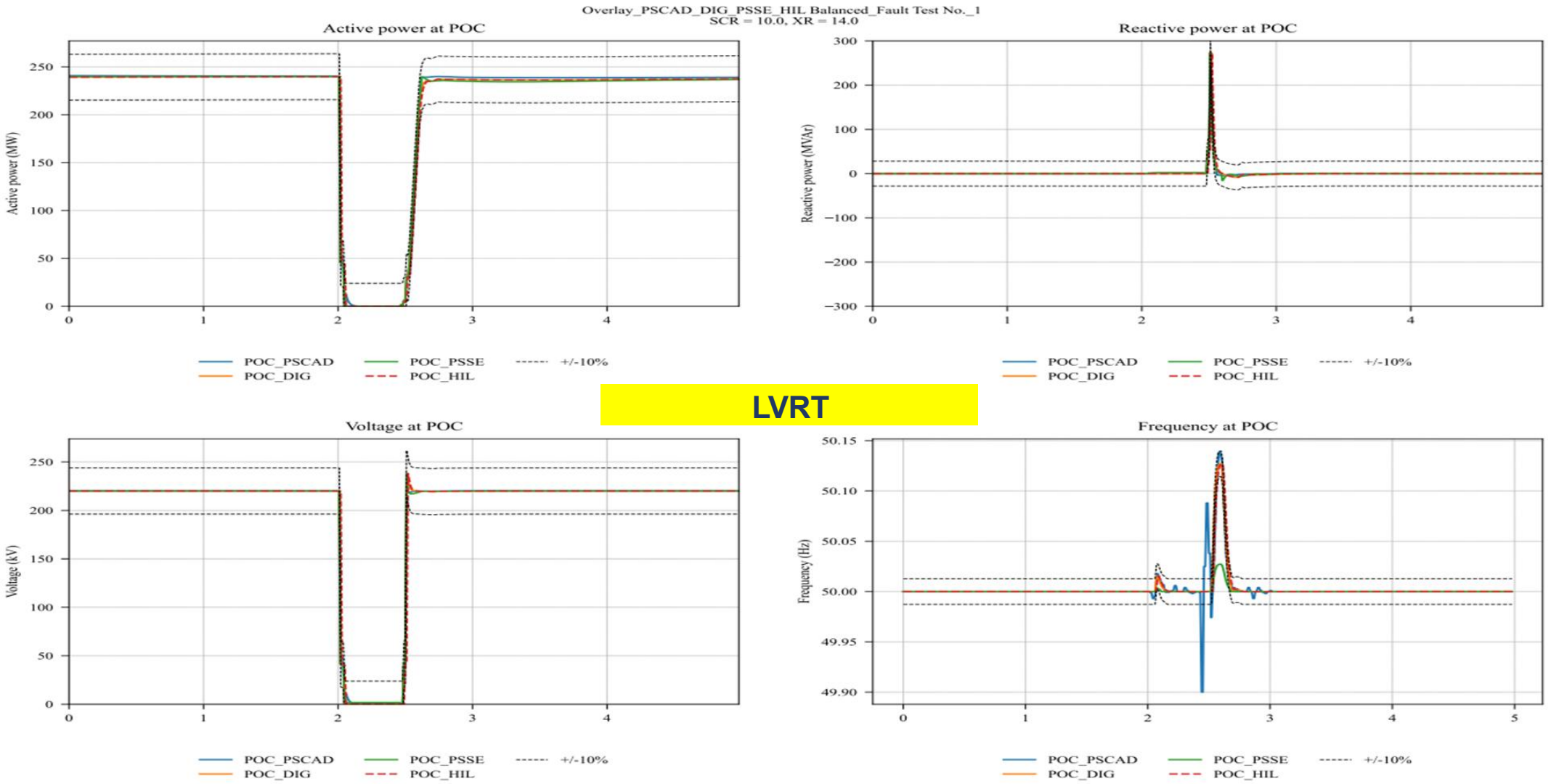

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Power Grid Engineering

AusRE Solutions
Grid Compliance Matters

ATS
Leading Integration

Thank you

Empower Your Systems with Our Smarter Solutions

Contacts

- **Applied Technical Systems JSC**
- 74 Ba Trieu Str., Hoan Kiem Dist., Hanoi, Vietnam
- **T.** +84-24-3825 1072
- **F.** +84-24-3825 8037
- **W.** www.ats.com.vn
- **E.** contact@ats.com.vn

Power Grid Engineering Pty Ltd
Suite 1.11, 3 Clunies Ross Ct, Eight Mile Plains
QLD 4113
T. (+61) 07 2103 4100
W. www.powergridengineering.com.au
E. info@powergridengineering.com.au

AusRE Solutions Pty Limited
Unit 5205-464 Collins street, Melbourne
VIC 3000
T. (+61) 4933 070 17
W. www.ausresolutions.com.au
E. support@ausresolutions.com.au