



GE VERNOVA

# Using Vendor specific Control and Protection real code for SIL testing with RTDS GTSOC

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DELFT, NETHERLANDS



# Introduction



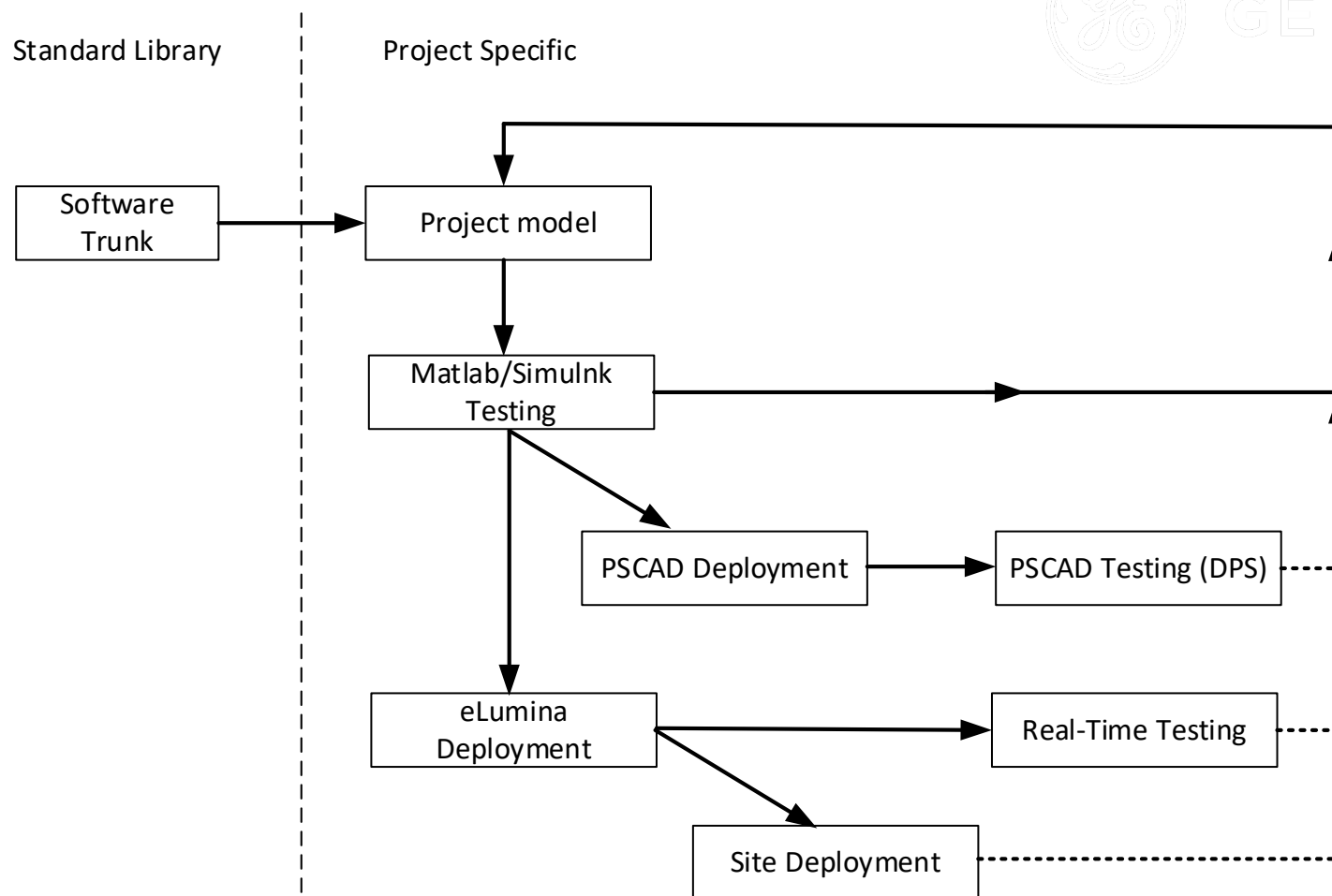
- Growing need for support in research and development projects aiming to develop and de-risk ‘power systems of the future’
- Some of these projects have particular interest in SIL modelling and testing facilitated by the market interest in multi-terminal DC systems
- The deployment of vendor specific real-code on a vendor agnostic platform (such as the GTSOC) could facilitate model sharing and testing of HVDC systems in R&D development or commercial project for real-time testing.

# Introduction



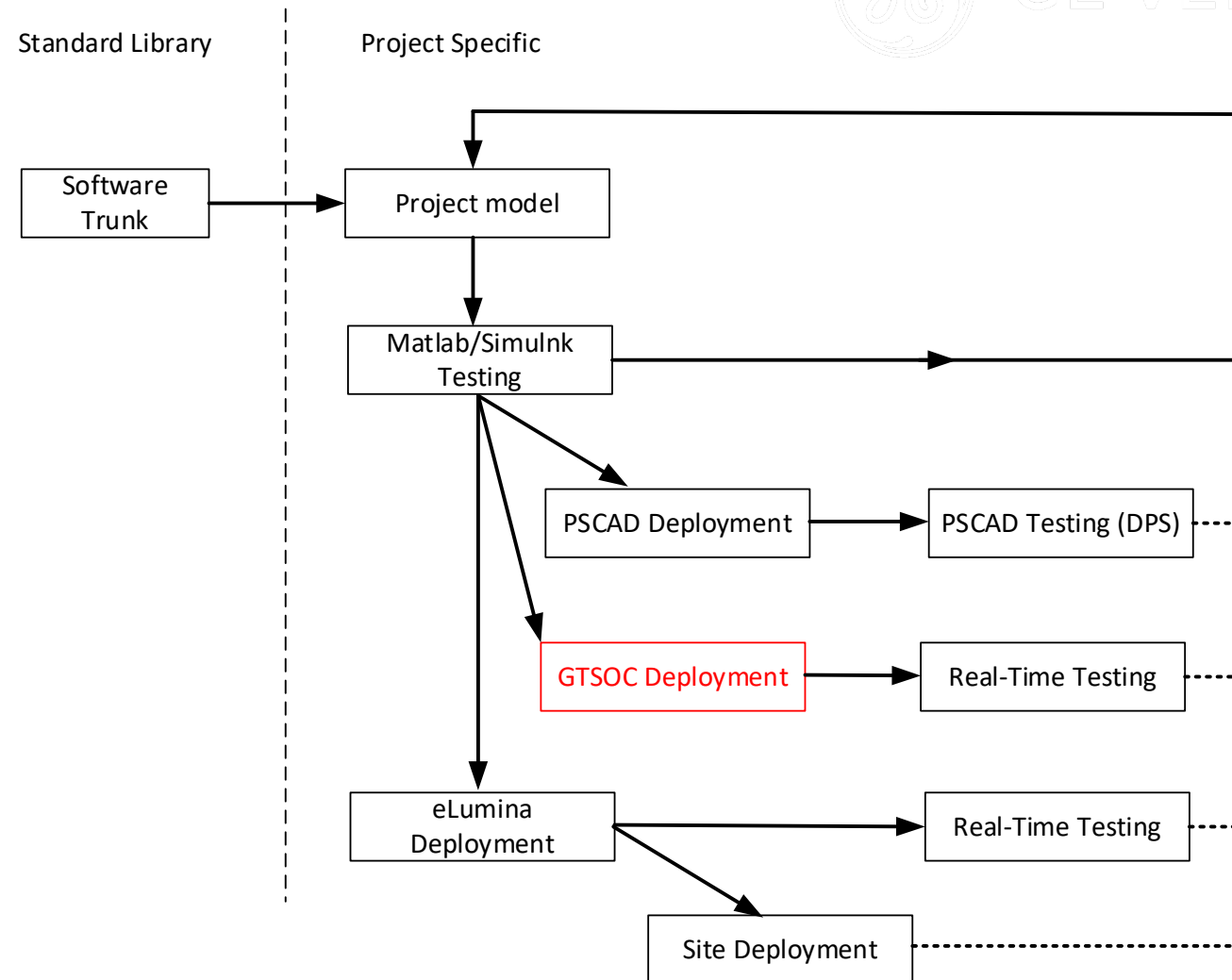
- Implementation on the RTDS-GTSOC system provides flexible laboratory approach to reuse equipment across multiple projects
- Flexibility to model “other” terminals in multi-terminal HVDC projects when performing HIL testing for a part of the HVDC grid
- Could have positive contribution to delivery, cost and space constraint on physical Control & Protection replica

# Development process: Accommodating software integration on the GTSOC



“Single source of truth” design and validation approach

# Development process: Accommodating software integration on the GTSOC

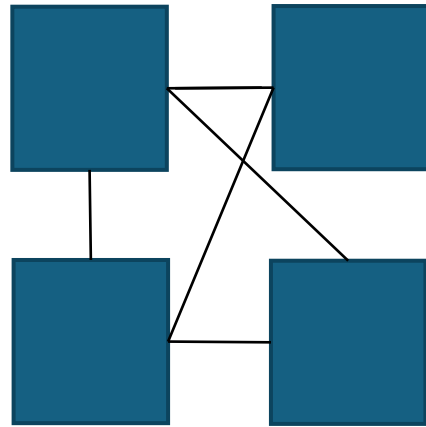


- “Single source of truth” design and validation approach

# Development process: Task Allocation

GTSOC

four core ARM processor



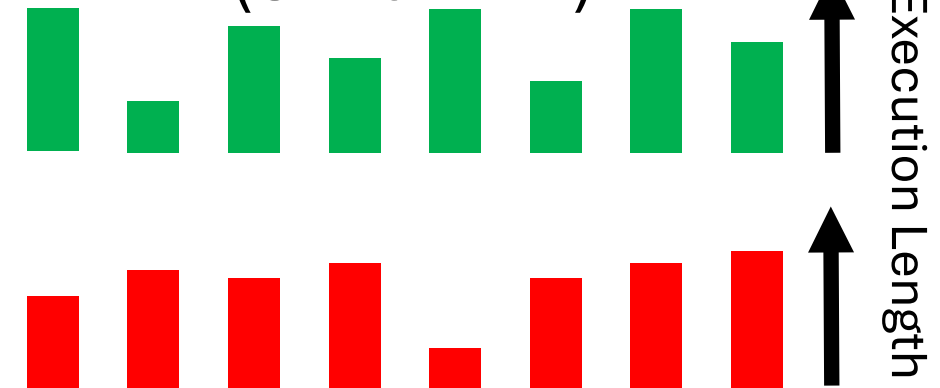
Control

Protection

GE eLumina™ C&P

Multiple “tasks”

(Simulink™)



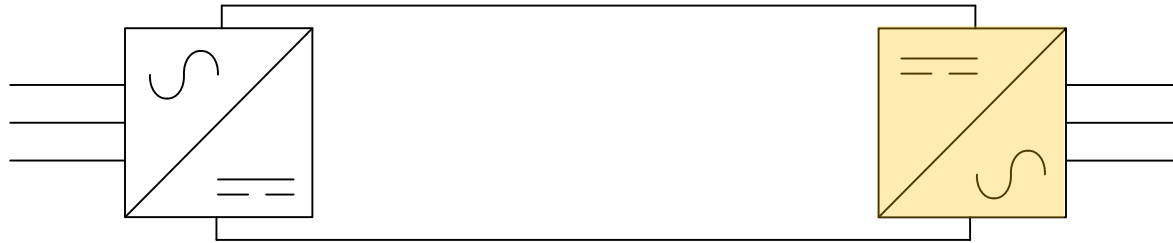
- Making it fit



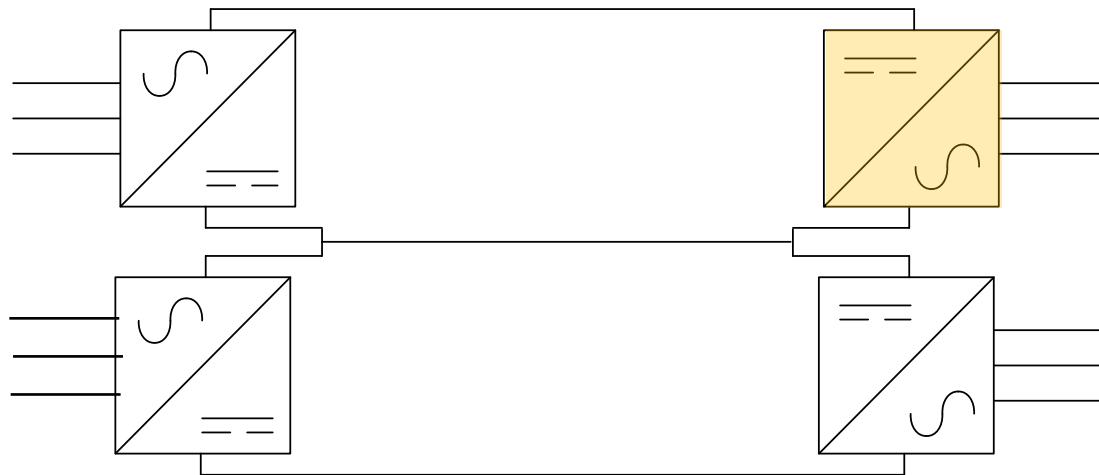
# Development process: eLumina Modelling



## Symmetrical Monopole



## Bipole



## One pole-end





# Development process: Converter Modelling

Full Implementation



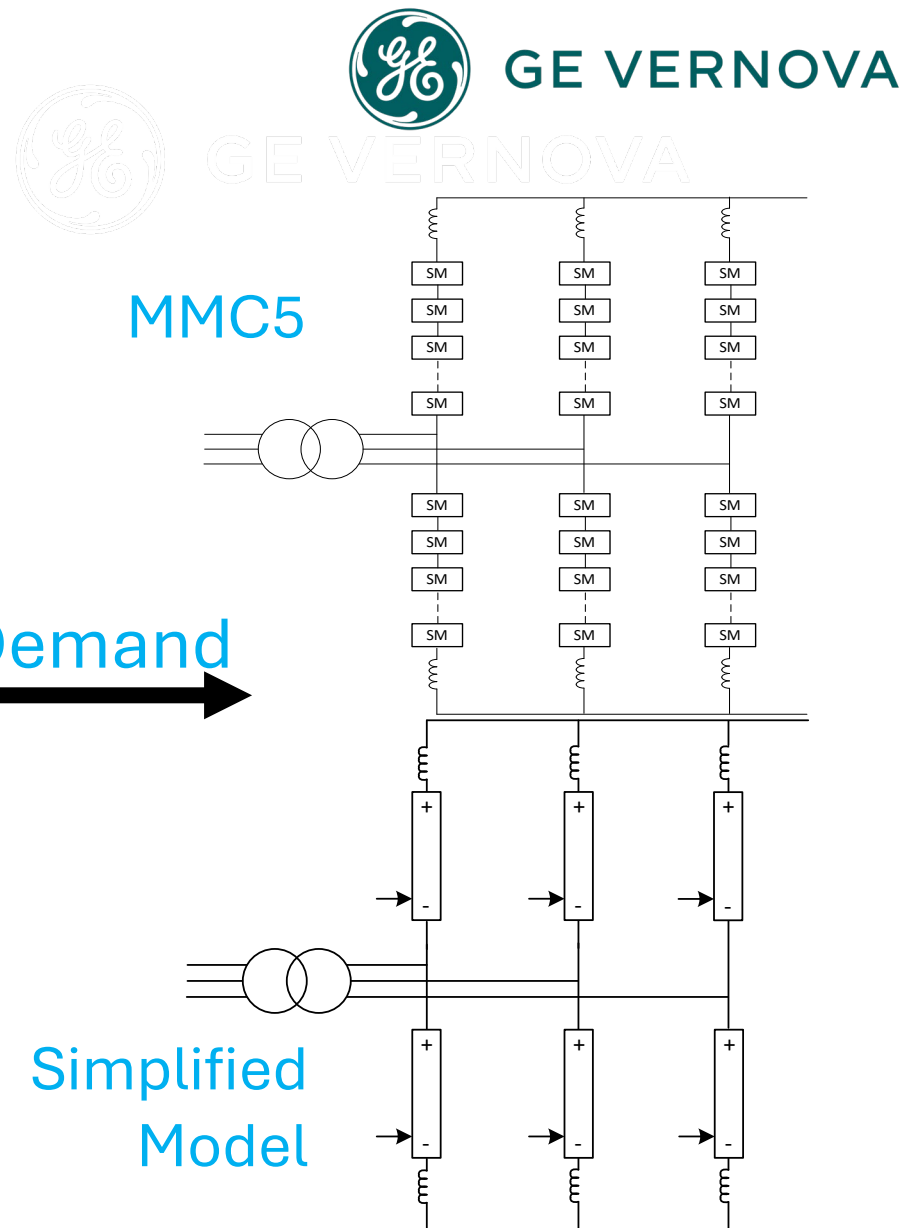
**Valve Base Electronics**

Simplified Implementation



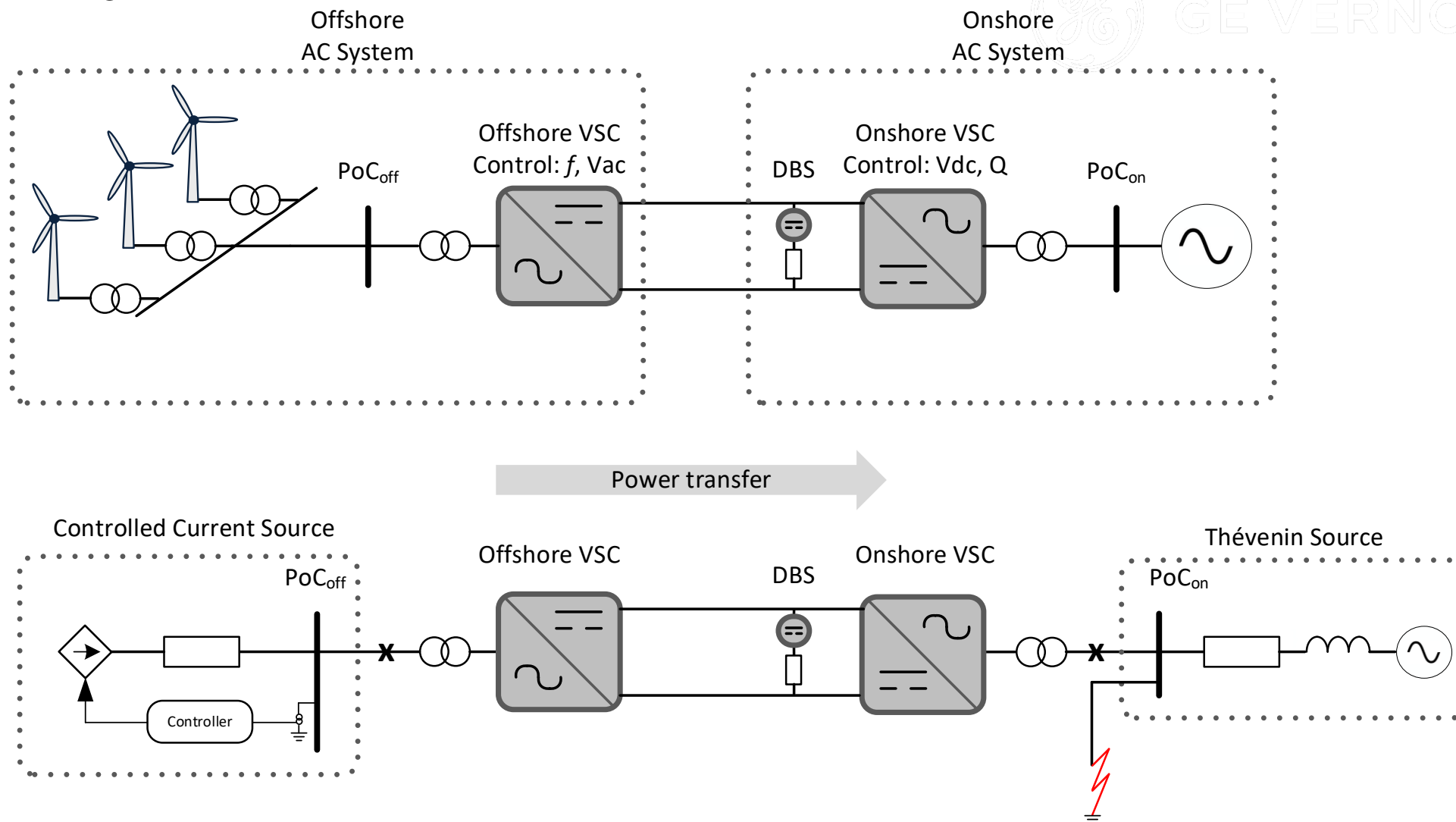
Full Implementation

Valve Demand





# Development process: Test System



# Development process: Test Setup: Vendor's lab setup



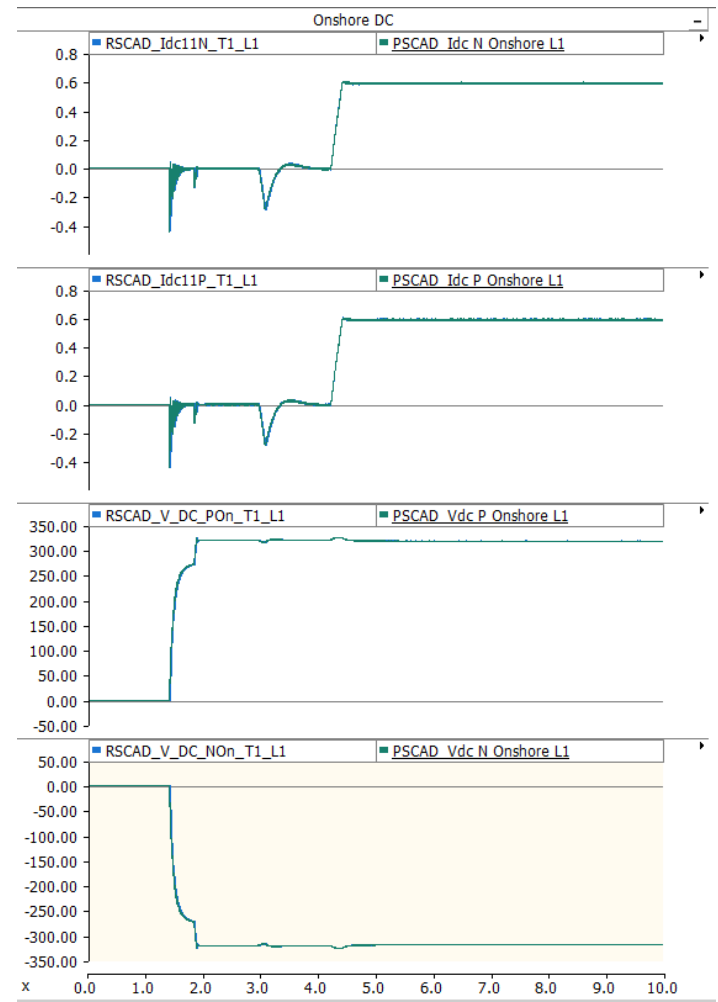
- ❖ GE Vernova's lab setup, consists of:
  - 4 GTSOC units and,
  - 1 Novacor 2 unit



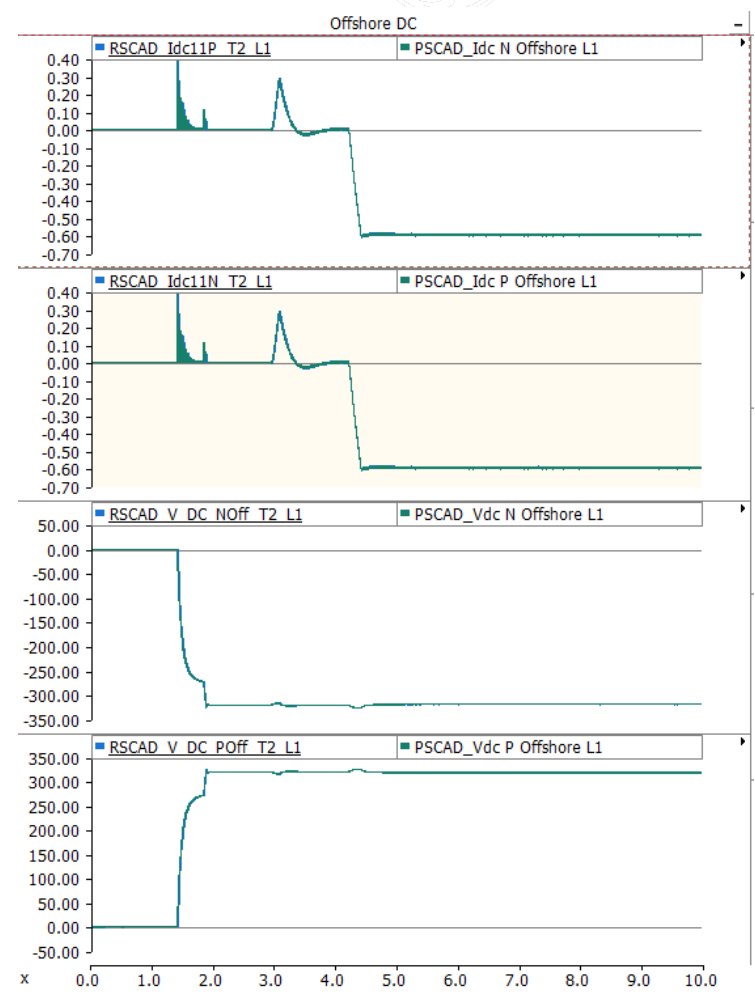
# Selected Test results: Energisation



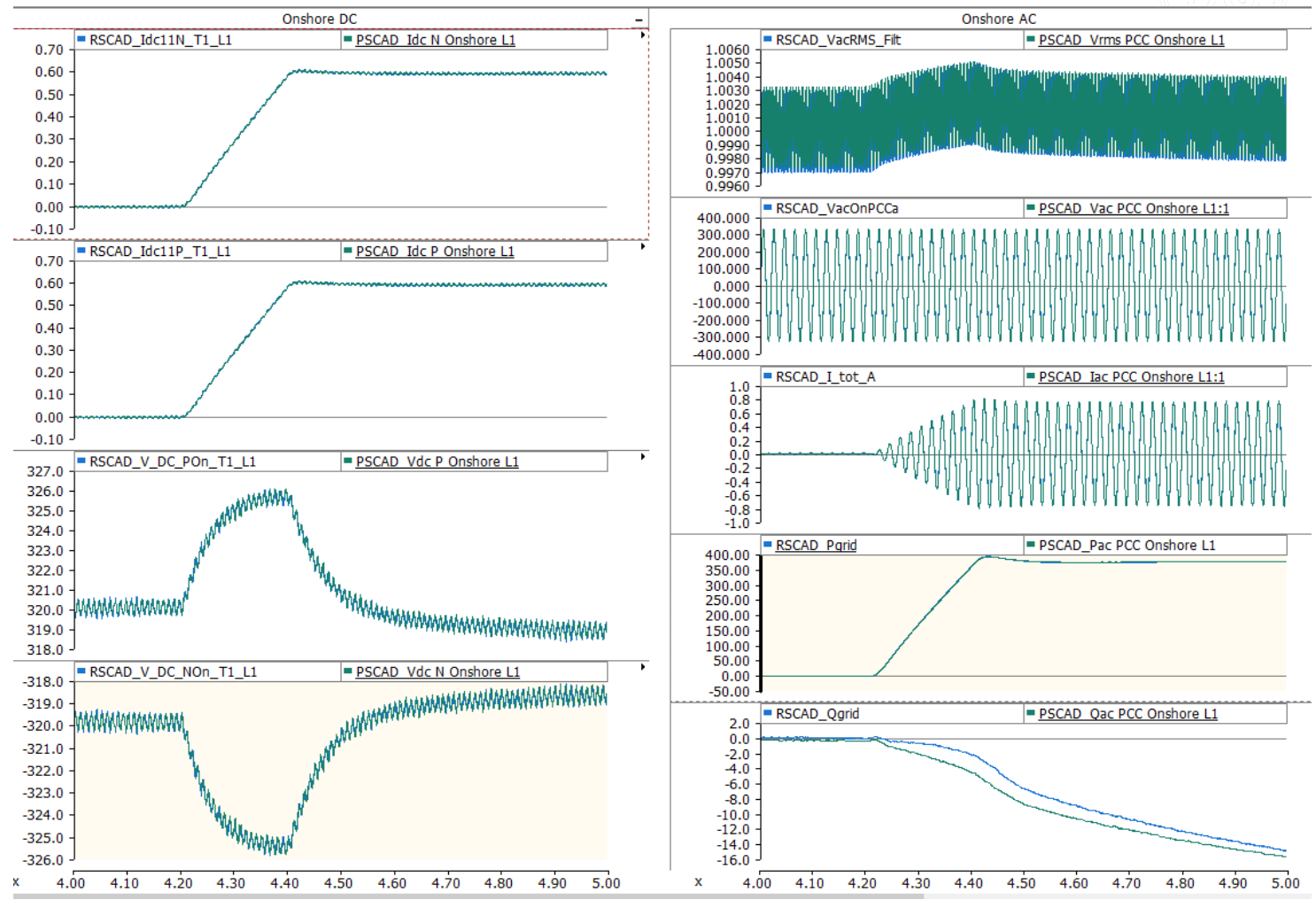
Onshore



Offshore



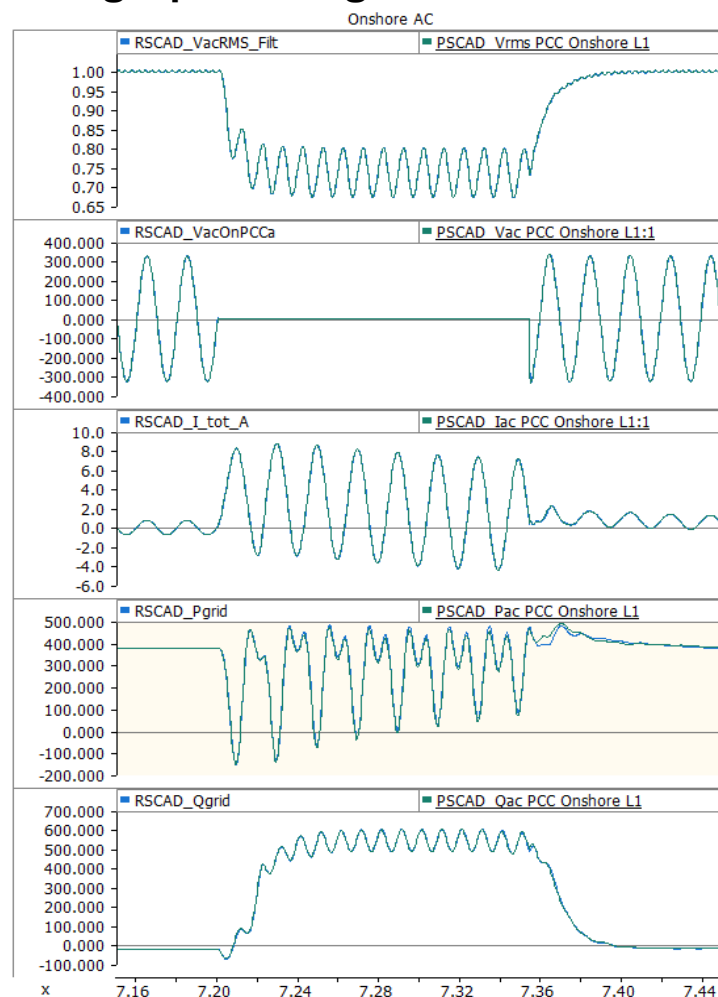
# Selected Test results: Power Ramp



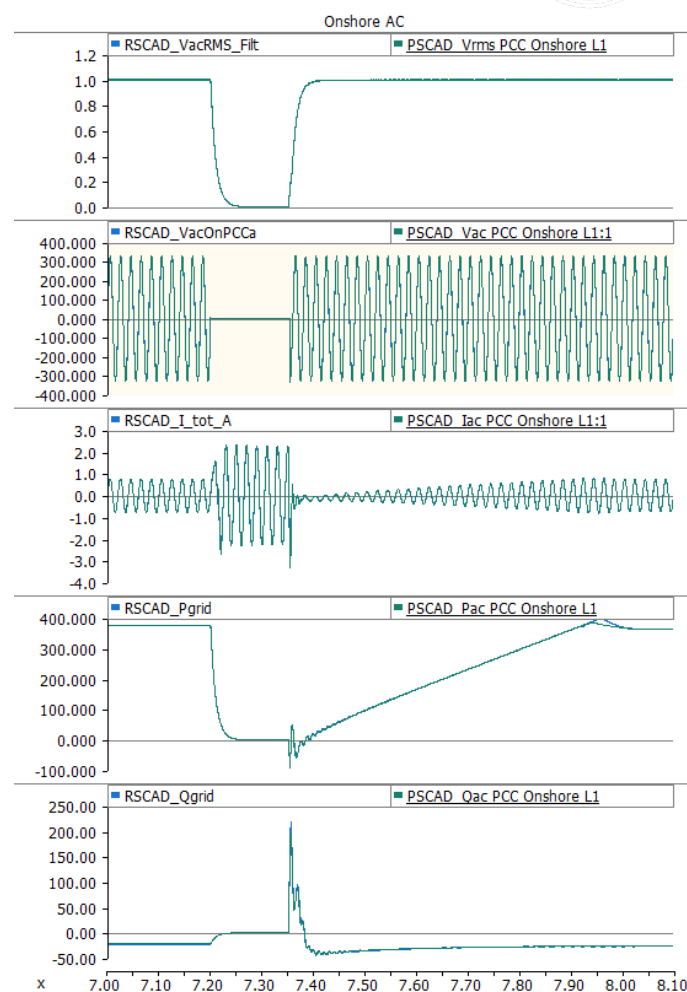
# Selected Test results: AC Side Fault -150ms duration



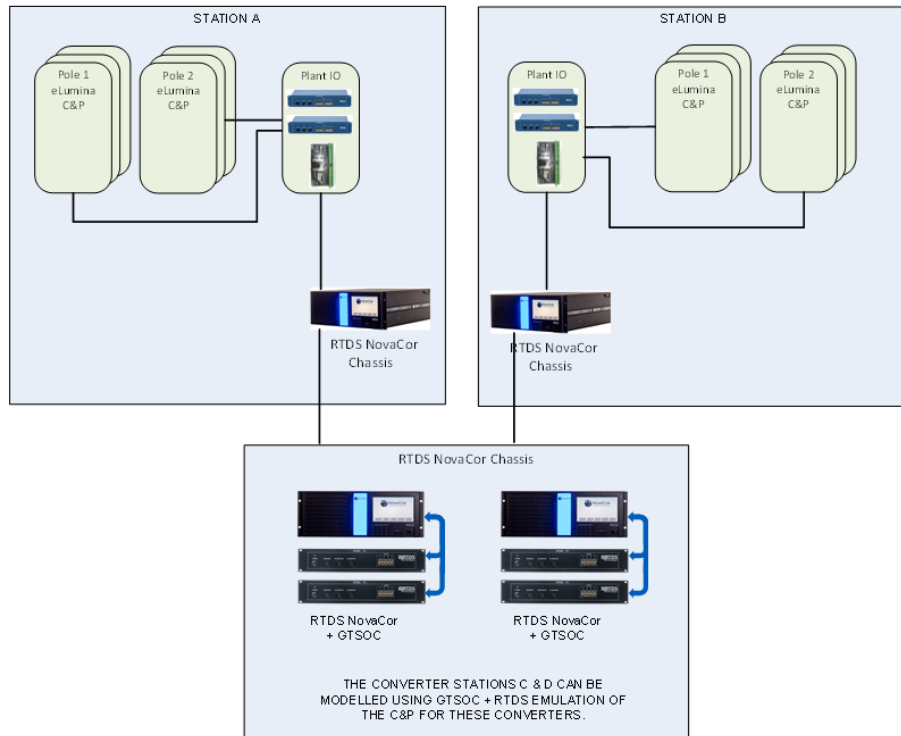
## Single phase to ground Fault



## 3-Phase to ground Fault



# A possible use case in multi-stage project testing



A possible arrangement for a Factory System Test considering physical control & protection equipment for Stations A and B along with black-boxed real-time emulation of a future station C and D

## ❖ An example hybrid test system

- ❖ Considering multi-terminal system
- ❖ Multi-staged development
- ❖ Possibly multi-vendor/single vendor

## ❖ The first stage development & testing

- ❖ Stations A and B – vendor specific HIL
- ❖ Future expansions (Stations C&D) on a vendor agnostic SIL platform

## ❖ 2nd Stage development & testing

- ❖ Existing system (stations A&B) on SIL
- ❖ New development (Stations C&D) – vendor specific HIL setup

# Conclusion

- Growing industry need for real-time testing
- Summary of a vendor's approach to host real C&P code on a vendor agnostic platform to facilitate SIL real-time testing
- Validation results show good performance
- It is possible to host a vendor's project specific C&P code on a GTSOC SIL system for real-time studies.