



Webinar and demo: Real-time simulation with NovaCor™ Light

*A lightweight alternative
for heavyweight innovation*



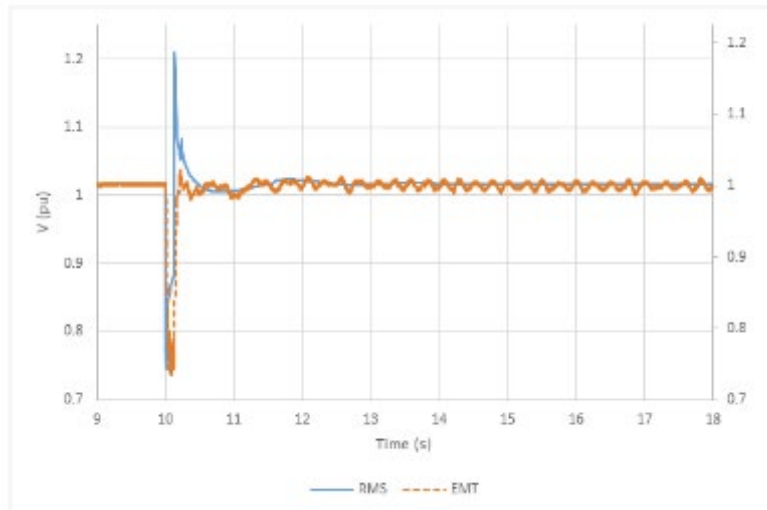
AGENDA

- Brief real-time simulation fundamentals
- What we do differently at RTDS Technologies
- NovaCor Light product tour
- Overview of simulation capabilities
- Simulation demo
- Q&A

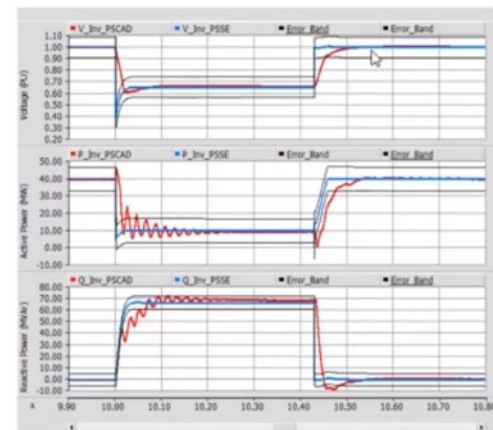


Advantages of EMT simulation

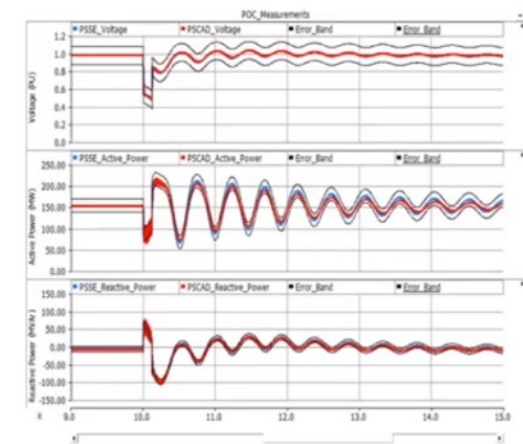
- Allows for a greater depth of analysis than phasor domain (RMS) representations
- RMS models lack the ability to capture fast network dynamics during transient conditions and may provide optimistic results
- Important for modern systems with many power electronic converters (more likely to predict control instability)



Wind farm fault ride through

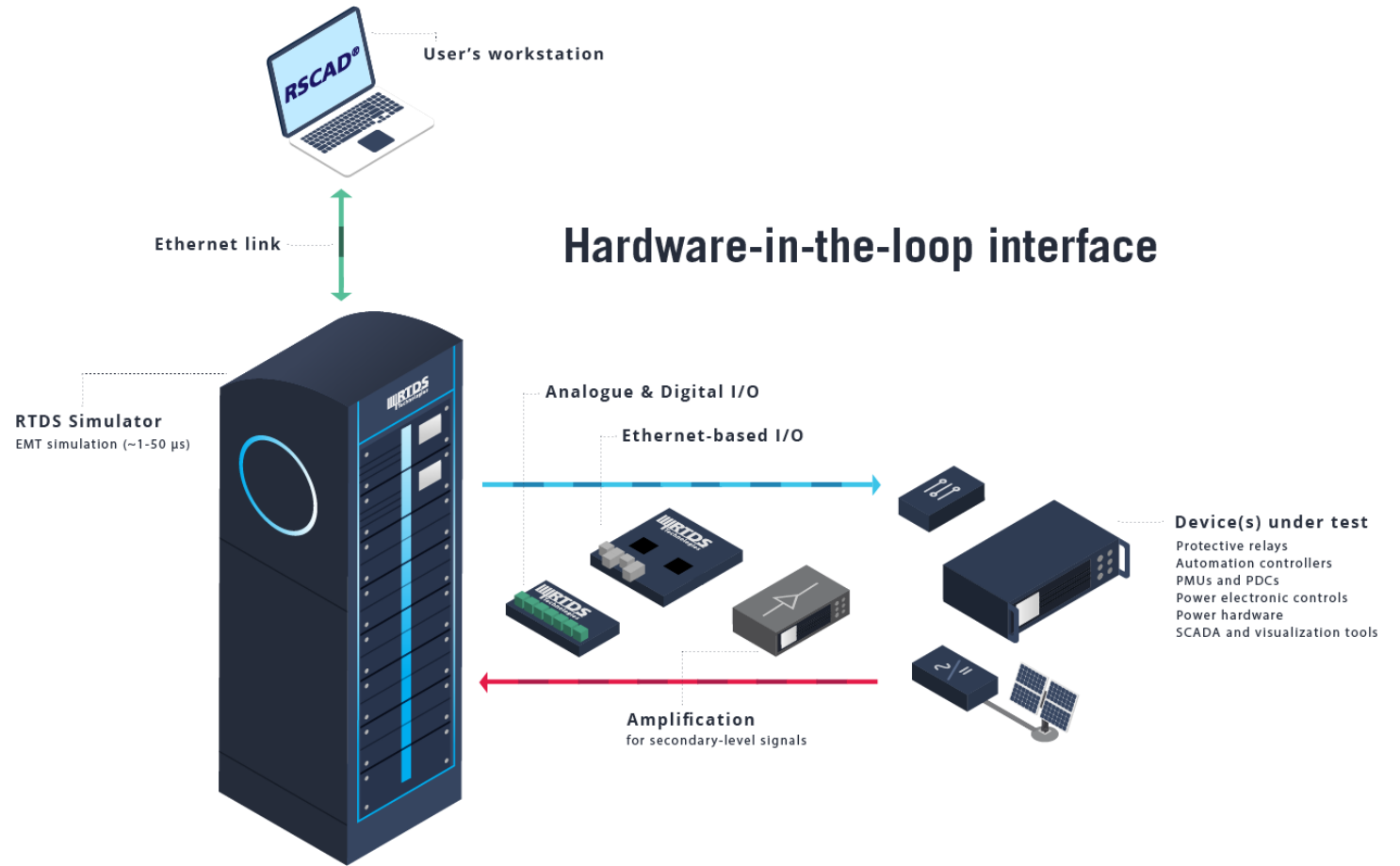


Synchronous generator fault ride through



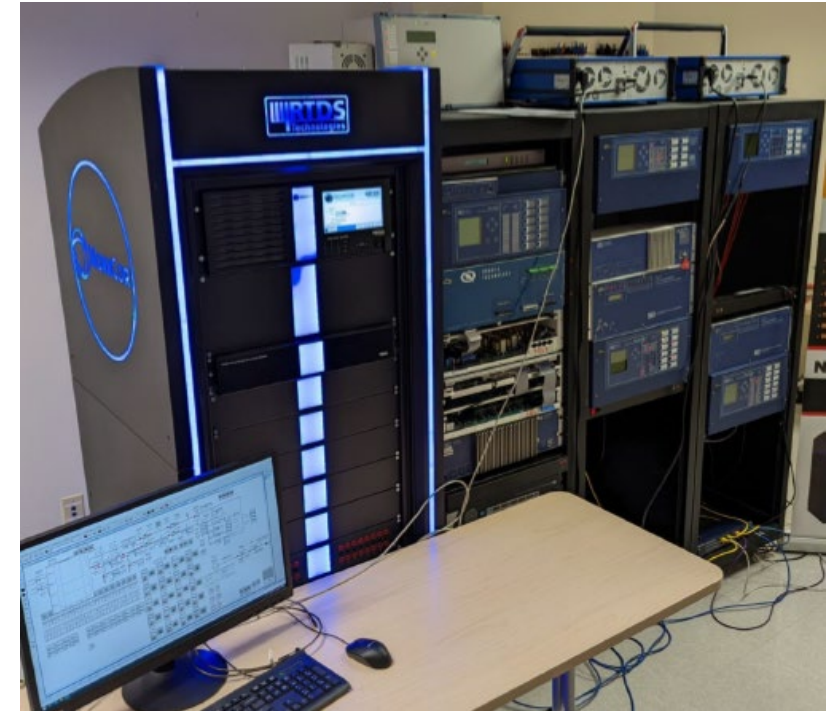
Hardware-in-the-loop testing

- **Real time operation** is what allows us to connect physical devices in a **closed loop** with the simulated environment (hardware-in-the-loop or HIL testing)
- **True closed-loop testing** is only possible with a real time simulator



Advantages of HIL testing

- Test continues after the action of the protection/control device, showing dynamic response of the system
- Test multiple devices (and entire schemes) at once – gain an understanding of interoperation of different devices and systems (e.g. multi-tiered control and protection in microgrids)
- Much more detailed system representation than open-loop test systems provide (e.g. modelling power electronics)



Source: Quanta Technology

About RTDS Technologies



- Pioneers of real-time digital simulation: world's first real-time digital HVDC simulation in 1989
- First commercial installation in 1993 – over 30 years in business
- Based in Winnipeg, Canada with customers in over 57 countries around the world
- World-class facility with R&D, hardware and software development, and product assembly under one roof

The in-house, custom advantage

- Our hardware and software is developed specifically for our application (e.g. no OS running under our code on the hardware)
- No off-the-shelf hardware or third-party software products
- No issues for users when it comes to compatibility / third-party software versions
- Full control over our product means we can offer the comprehensive simulation support that we're known for



The industry standard in real-time simulation

- The RTDS Simulator and RSCAD FX software is used by all the leading protection and control manufacturers and many major utilities
- Frequently specified as part of major HVDC projects (to be connected to replica controls for testing)
- Opportunity for students to get transferable experience and/or work alongside industrial partners with their tool of choice



NovaCor Light

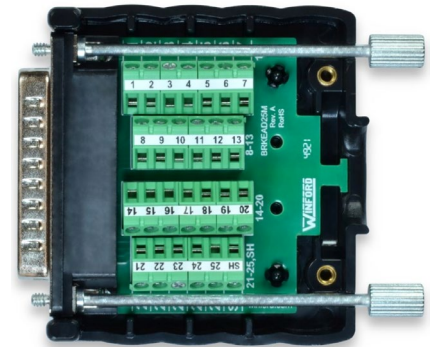
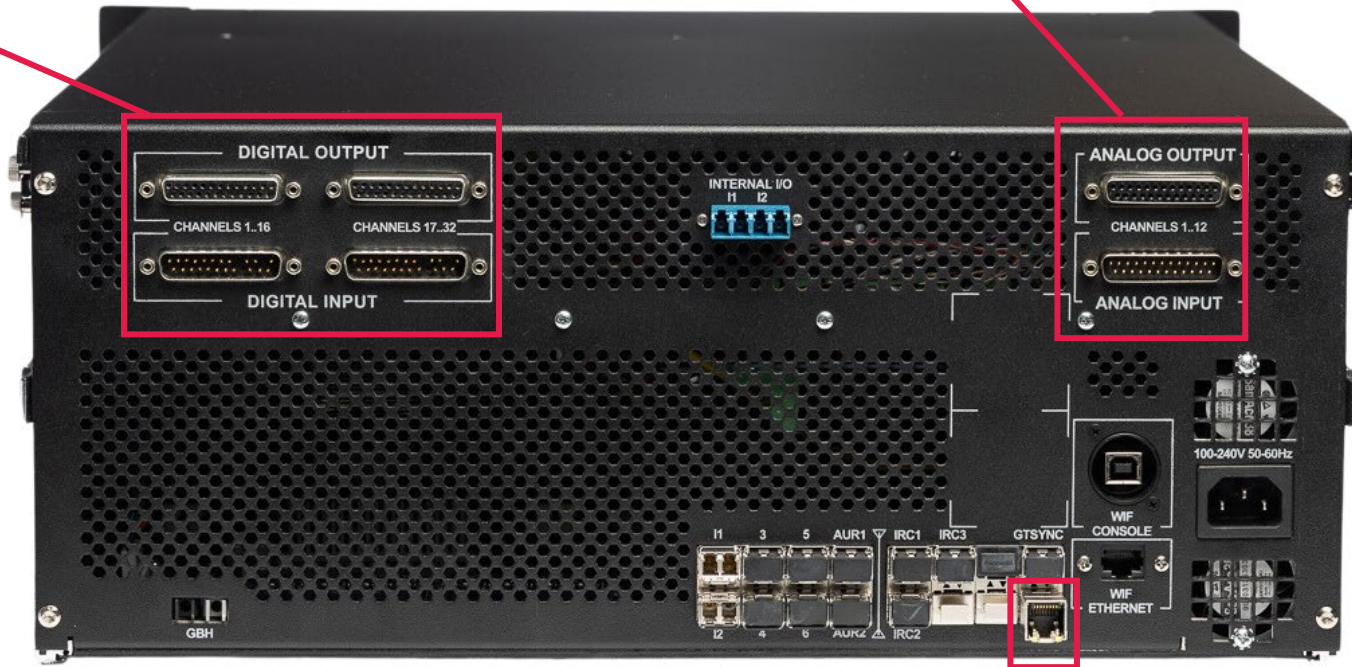
- Lightweight alternative to our flagship product (NovaCor 2.0)
- 4U tall, 19" wide unit (rack-mountable, optional cubicle available)
- Based on a multi-core processor with 4 available cores
- Central processing capabilities + built-in I/O for hardware-in-the-loop testing



NovaCor Light's Built-in I/O

- 32 x digital input channels (0-50 Vdc)
- 32 x digital output channels (5-30 Vdc)

- 12 x analogue input channels (16 bit, +/- 10V)
- 12 x analogue output channels (16 bit, +/- 10V)

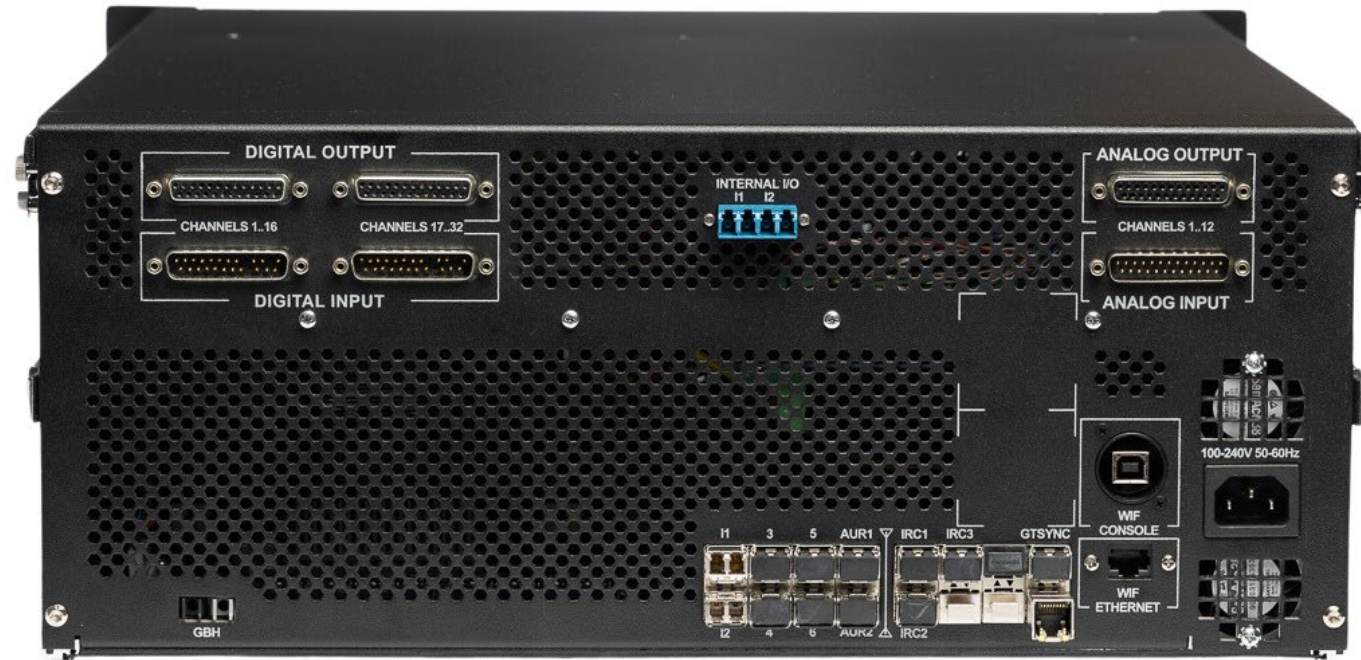


Terminal blocks provided for easy connection to external equipment

- 1 x RJ45 UDP port for data logging or co-simulation

NovaCor Light – Additional I/O options

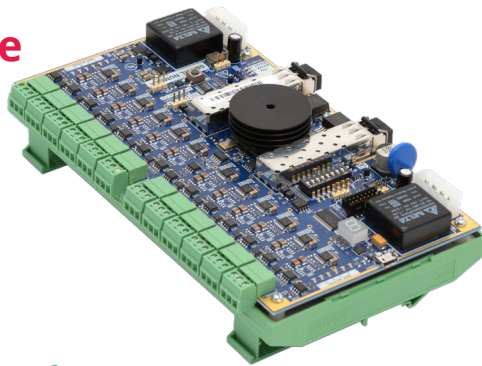
- 2 reserved fibre ports can optionally be licensed for Aurora communication protocol
- 4 fibre ports available for connecting additional I/O cards
- Multiple I/O cards can be daisy chained from a single fibre port, so many I/O cards can be connected to a single unit



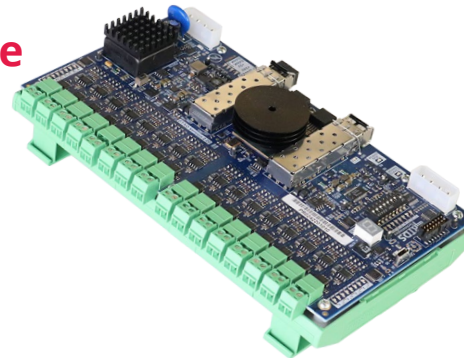
NovaCor Light – Additional I/O options

- Compatible with all current-generation I/O, including conventional I/O, communication-based I/O, and FPGA-based auxiliary hardware

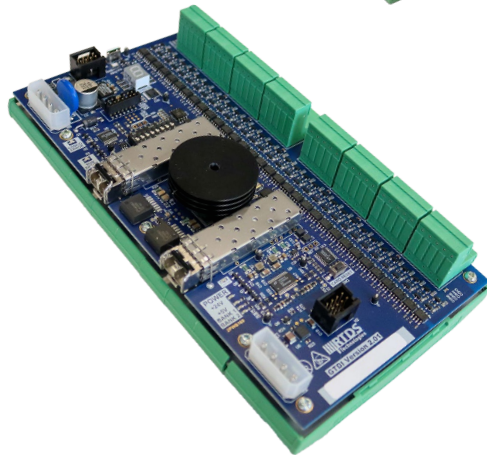
Analogue
input



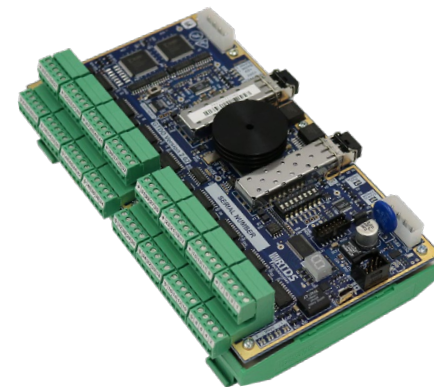
Analogue
output



Digital
input

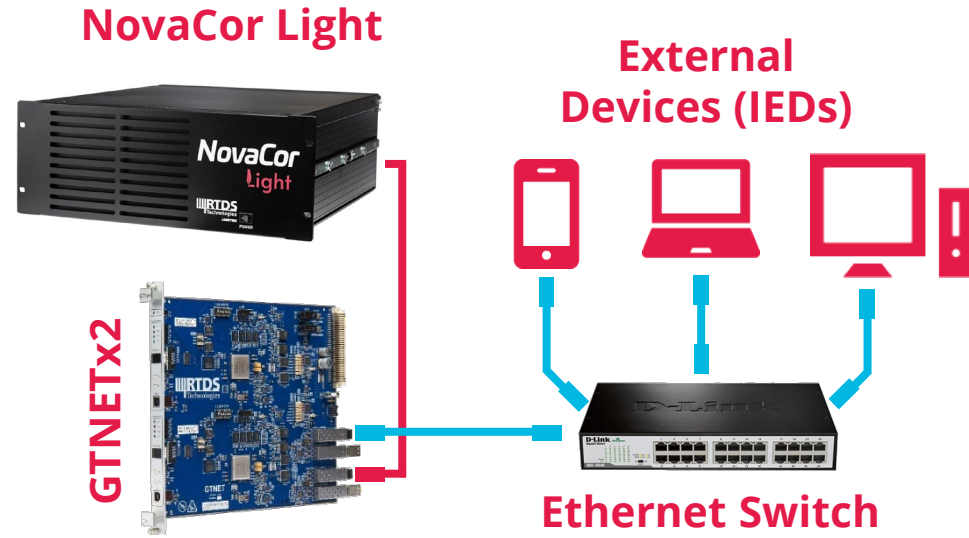


Digital
output



NovaCor Light – Additional I/O options

- Compatible with all current-generation I/O, including conventional I/O, communication-based I/O, and FPGA-based auxiliary hardware



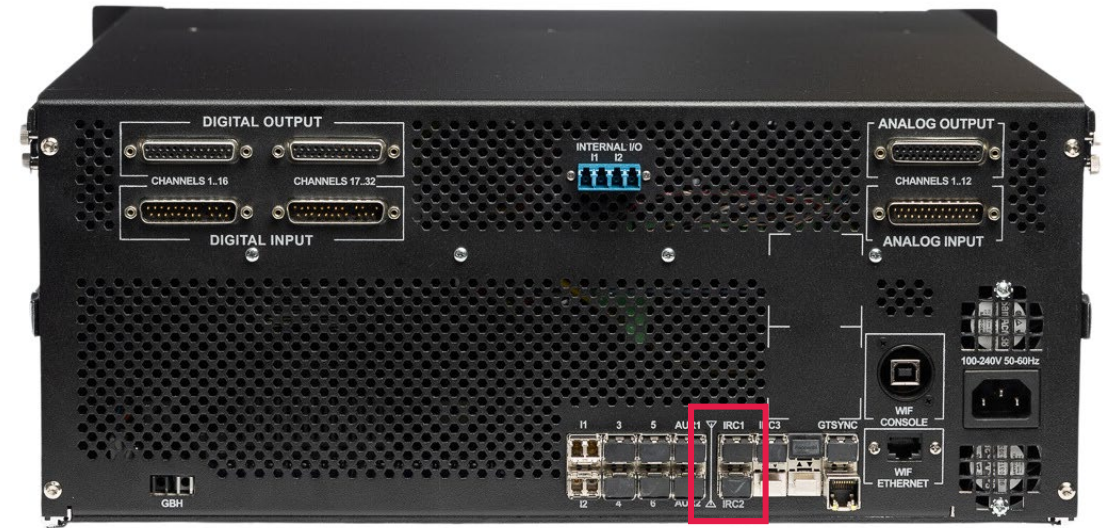
Communication protocols including IEC 61850, DNP3, MODBUS, TCP/UDP, and more



Special applications including black box control MMC-HVDC simulation, and more

NovaCor Light – Expanding the system

- Beyond core licensing, can also expand the system by connecting multiple units together
- Each NovaCor Light chassis has 3 fibre ports for direct interconnection with other NovaCor Light, NovaCor 2.0, or NovaCor 1.0 chassis (maximum of 4 units can be directly interconnected)
- Use of our Global Bus Hub / Inter-Rack Connection Switch allows many more units to be connected
- Simulation will be decoupled with travelling wave interface between units



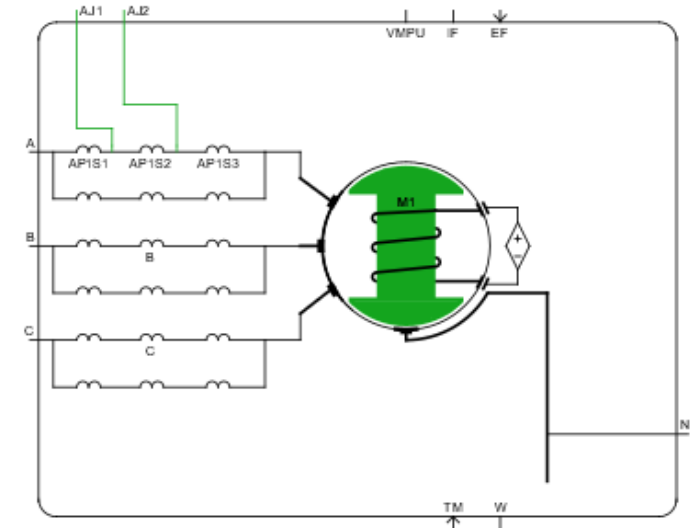
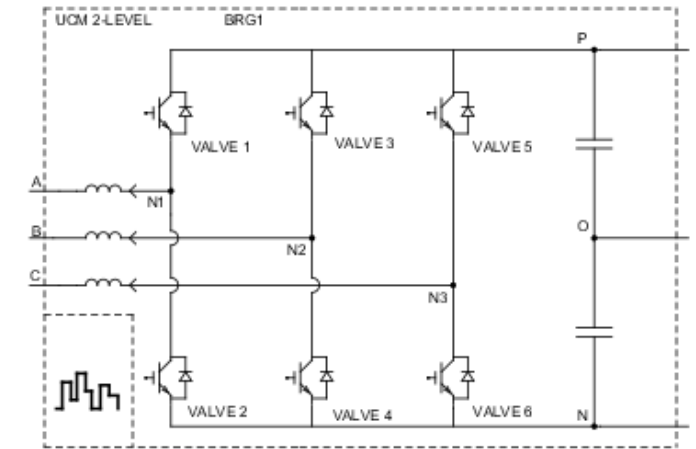
Software: RSCAD[®] FX

- NovaCor Light integrates with the same software that is used with our flagship product
- Includes all existing modules and features – no limits to libraries or features
- **Site license – can be installed on an unlimited number of PCs**
- **No third party modules – we develop, maintain, and support the entire package in-house**



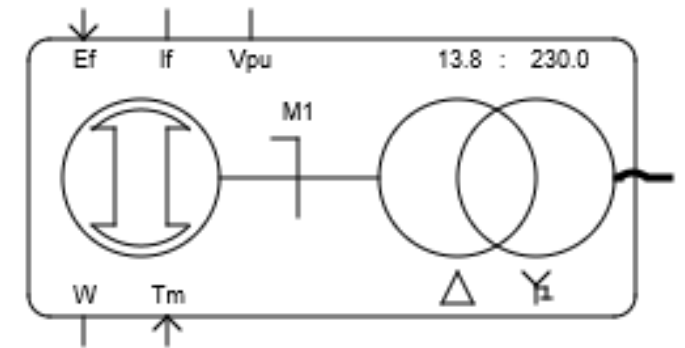
Our models differentiate us

- RSCAD FX has the most robust and detailed library of real-time models
- **Universal Converter Model** allows for lightweight, detailed power electronics simulation and control testing in the main timestep environment (up to 10 kHz)
 - For PWM up to ~200 kHz, model can be placed on a dedicated core running at a smaller timestep
- **Faulted PDSM model** allows for testing 100% stator ground fault protection
- **Detailed MMC valve model** allows for internal submodule faults, addition of a damping module or battery, over 1,000 submodules represented, and more



A note on real-time simulation capabilities

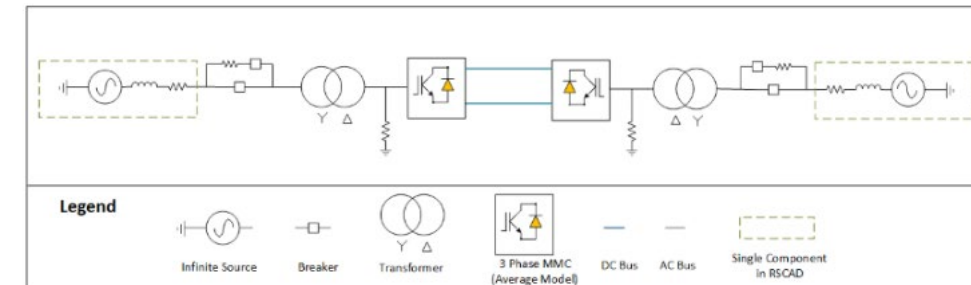
- Our sample circuits show how we define network size (i.e. nodes), but also power system complexity – important to have more than just passive components involved to represent realistic networks
- For node limits listed in this presentation, the network solution is always tightly coupled (no decoupling transmission lines that can impact the simulation)
- Embedded nodes effectively increase the potential network size (some nodes are offloaded from the network solution)



Machine model includes embedded transformer and breaker nodes (not solved by network solution)

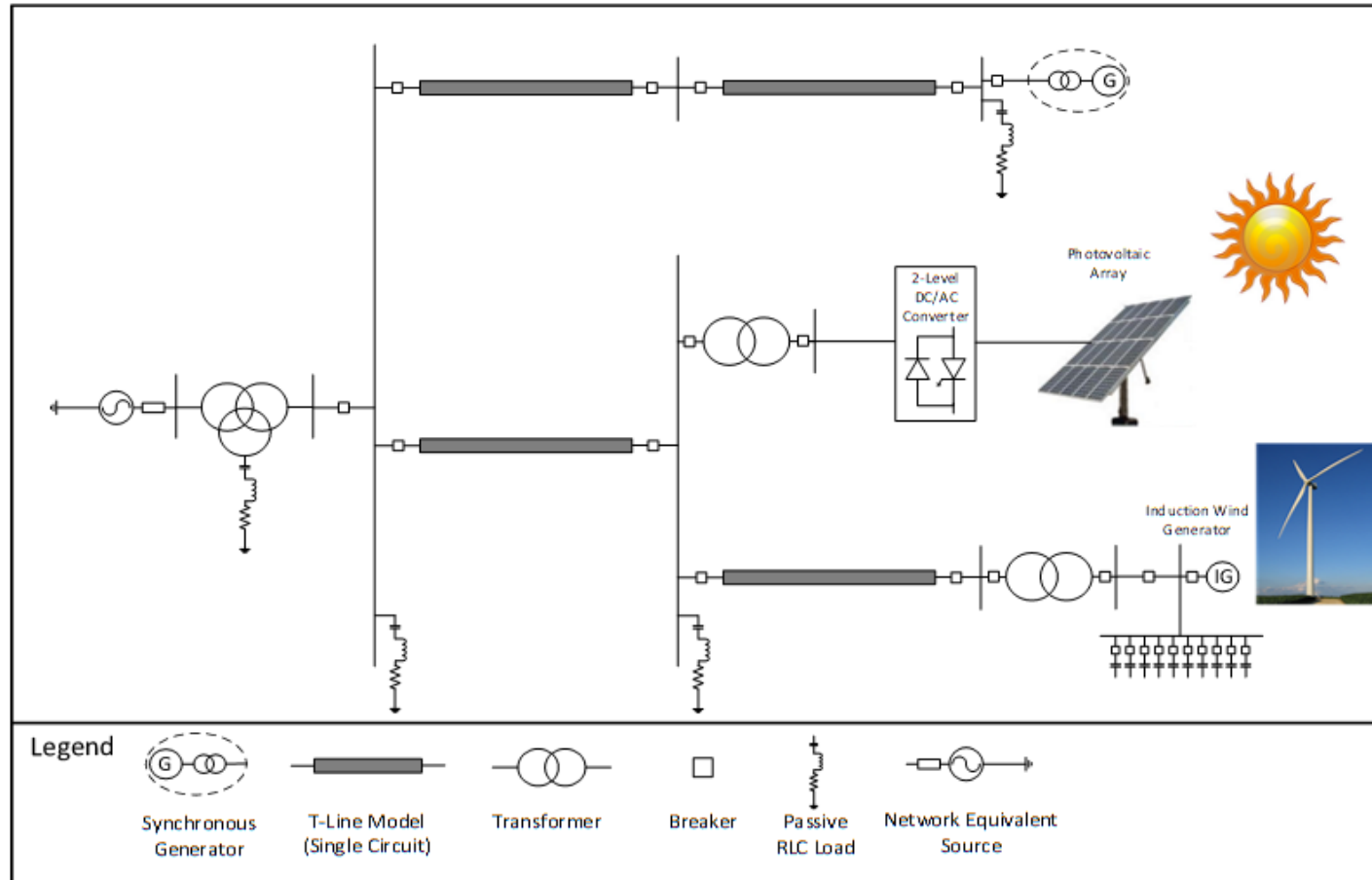
NovaCor Light – Simulation Capabilities

- Entry-level system has 1 licensed core; additional cores can be licensed to expand capabilities (to a maximum of 4 cores)
- **With a single core:** A portion of the core handles the network solution (**54 single phase nodes**) while the rest handles power system, power electronics, and control components.
- **With multiple cores:** One whole core is dedicated to the network solution (**180 single phase nodes**) while other core(s) handle power system, power electronics, and control components
- Detailed hardware allocation examples are available, showing sample circuits and number of cores required



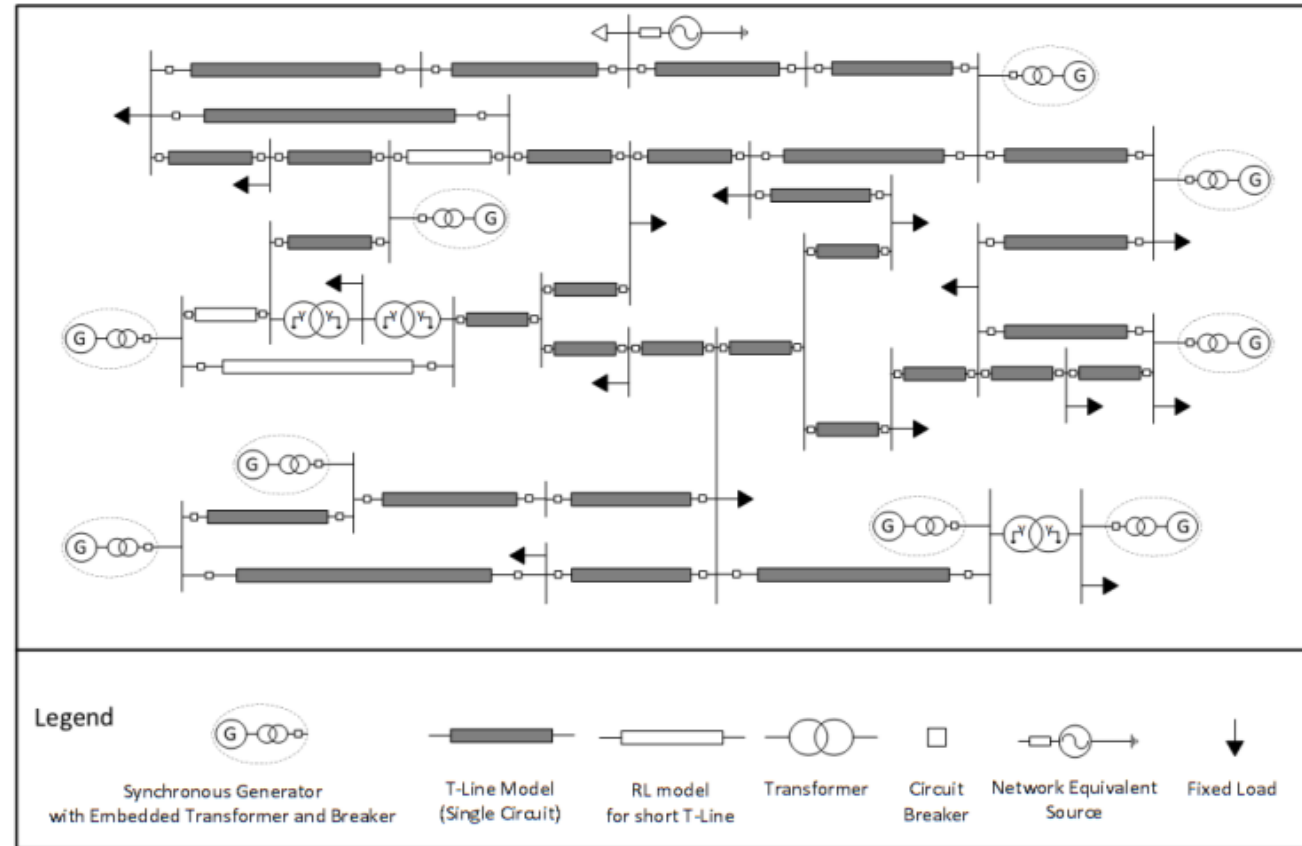
This MMC-HVDC point to point system (with average models) runs on 1 core

NovaCor Light – Simulation Capabilities



Runs on a NovaCor Light chassis with 2 licensed cores

NovaCor Light – Simulation Capabilities

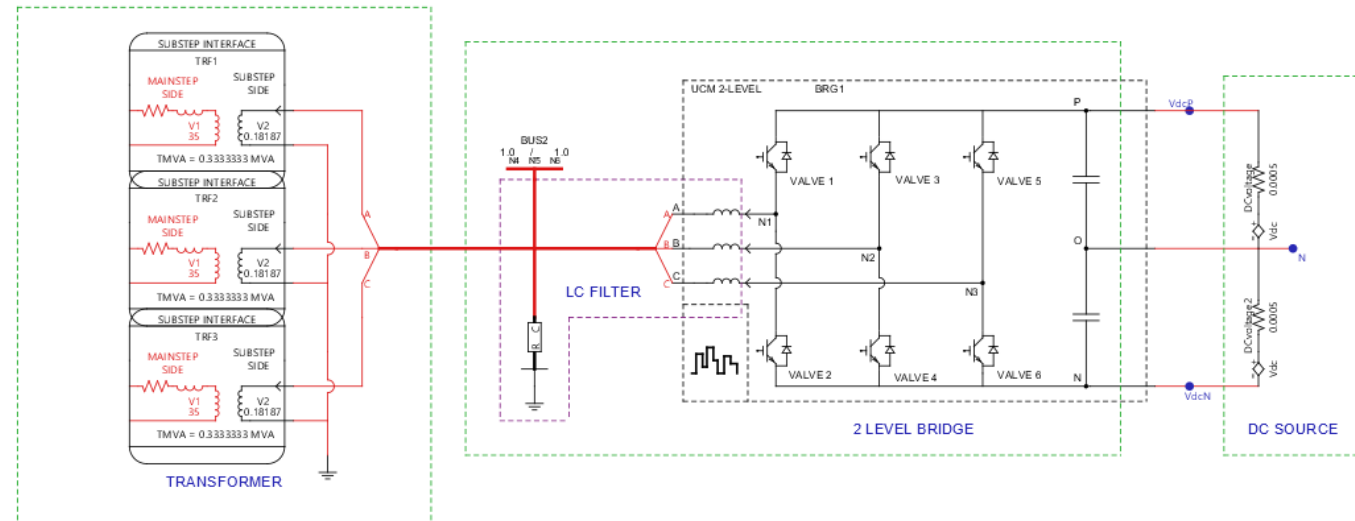


IEEE 39 bus system – Runs on a NovaCor Light chassis with 4 licensed cores

NovaCor Light – Simulation Capabilities

Other simulation environments - Substep

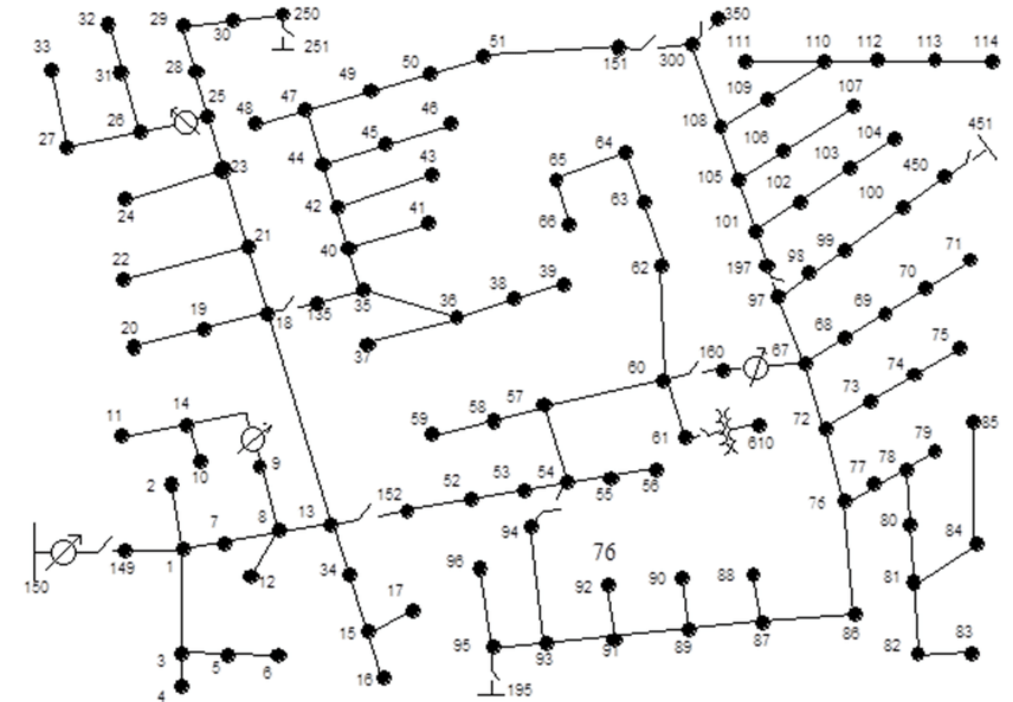
- Substep subnetworks with $\sim 1\text{-}10\ \mu\text{s}$ timestep can be used for power electronics simulation
- Typically, PWM applications within the $\sim 10\ \text{kHz}$ range can run in the Mainstep environment and Substep is only required for higher frequencies
- Each subnetwork requires a dedicated core and can handle **36 single-phase nodes**



NovaCor Light – Simulation Capabilities

Other simulation environments – Distribution Mode

- Distribution Mode assumes a radial feeder structure and therefore sparse admittance matrix, so it can accommodate more nodes in the network solution
- Minimum timestep of 100 μ s
- Can solve **375 single-phase nodes** with one core participating, or **750 single-phase nodes** with multiple cores



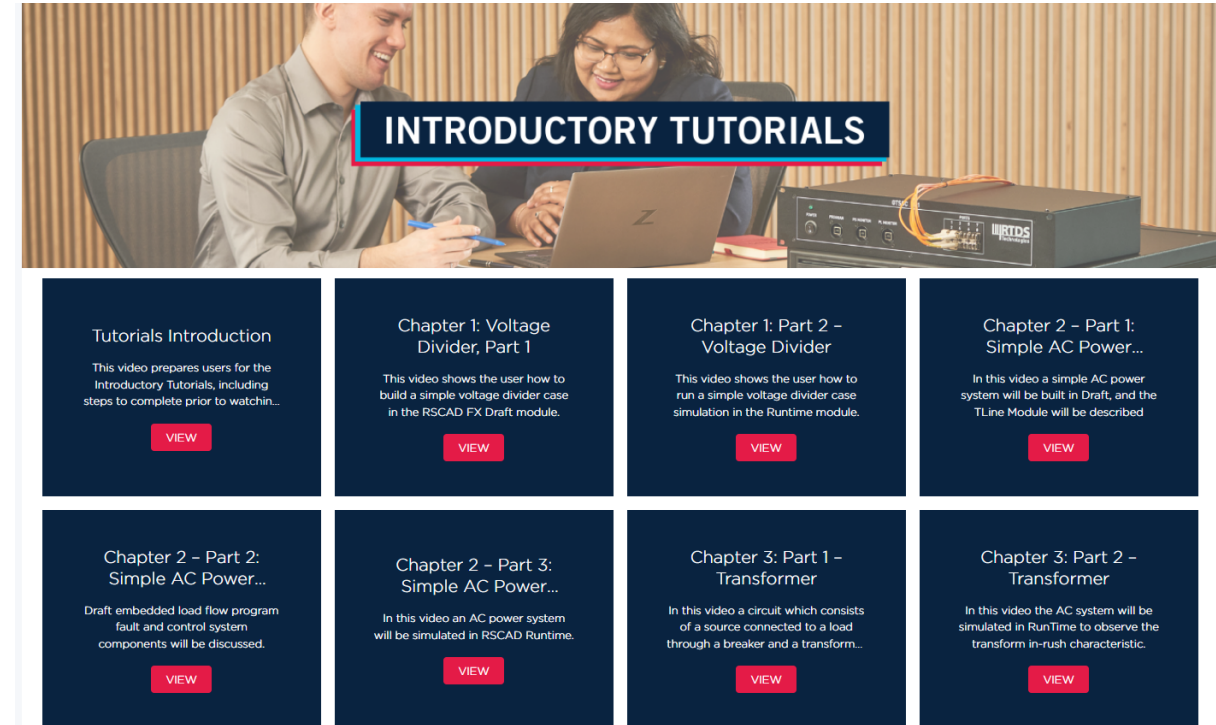
Pricing Model

- Core licenses are purchased outright – no ongoing core licensing fees
- Optional (recommended) annual hardware warranty fee for repair/replacement with no deductible
- **Educational institutions receive perpetual software maintenance free of charge for non-commercial use – always have the most up-to-date software and access to our simulation support team to ensure success, with zero fees**
- Please reach out to rtids.sales@ametek.com for further information / quotes



Training and Learning

- Video Resource Library available free of charge for all users – includes many hardware, software, and applications tutorials
- Large library of sample cases for a wide variety of applications (grid-forming control, microgrids, power hardware in the loop, protection testing, and more)
- Connect with our active community of users through our regular UGMs and webinars
- Our online Knowledge Base contains a wealth of information including UGM/webinar presentation material





Thank you!

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NovaCor Light Webinar Demonstration

Christian Jegues, P.Eng



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Demo Cases

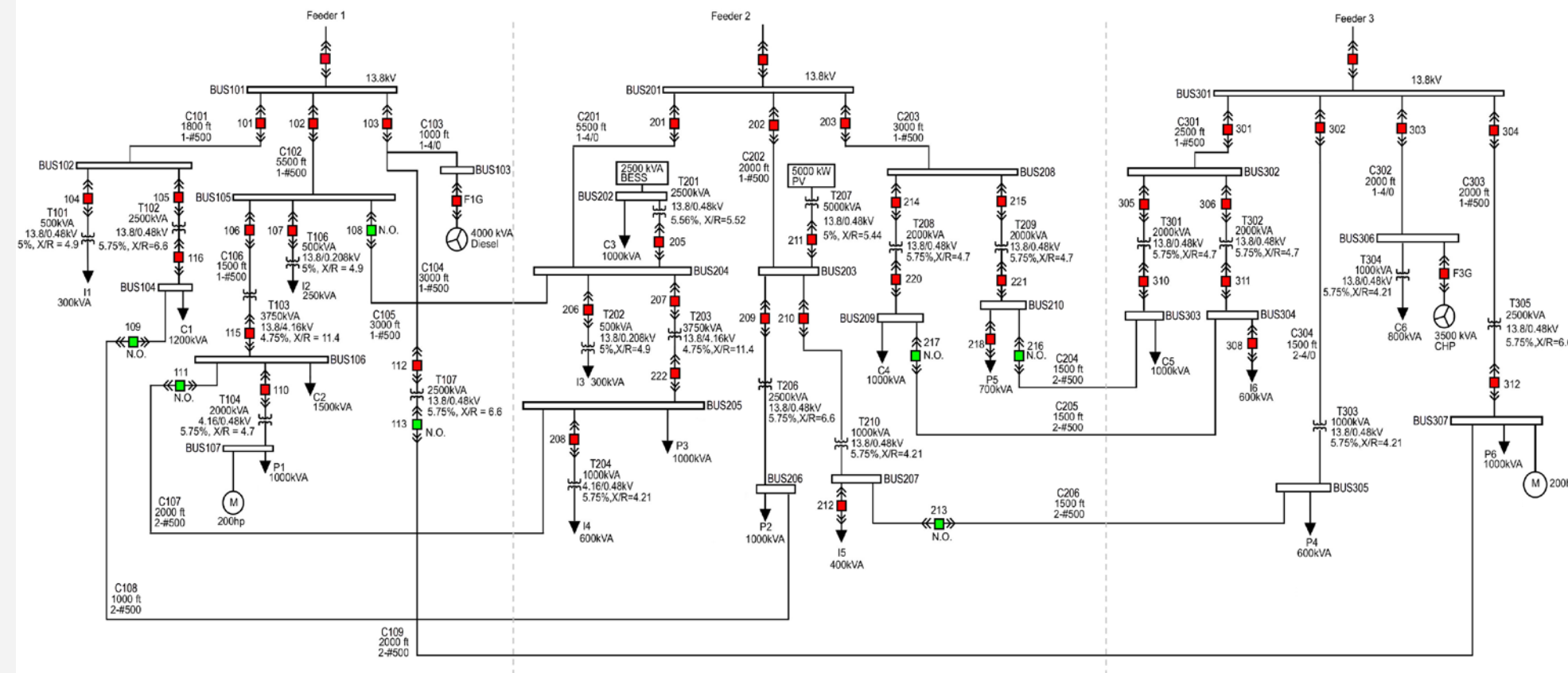
Multicore & Single Core Demo Cases

- NovaCor Light Multicore Demo Case
 - Uses all 4 cores of the NovaCor Light
 - Industrial Microgrid System
- NovaCor Light Single Core Demo Case
 - Uses a single core of the NovaCor Light
 - Type 4 Wind Farm with Ride Through Controls



NovaCor Light Multicore Demo Case

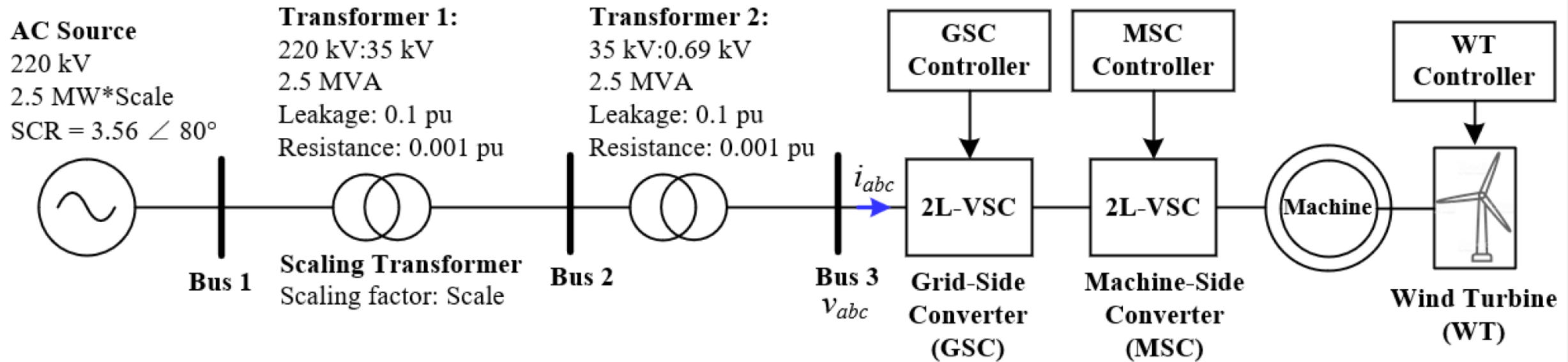
Banshee Microgrid Model



- Industrial facility with 3 radial feeders
- Load range 5-14 MW
- 18 Aggregated loads
- 4 MVA Diesel Gen.
- 3.5 MVA CHP
- 5 MW PV
- 2.5 MW BESS
- Detailed Switching Models used for IBRs (UCM with Improved Firing)

NovaCor Light Single Core Demo Case

Type 4 Wind Farm with Ride Through Controls





Thank you!



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