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IPST 2021 AND GLOBAL PANDEMIC

Carrying on in difficult times

- Congratulations to the organizing committees on convening IPST 2021!
- Hopefully we will get back to in-person meetings soon!

PAPER PRESENTATIONS

PAPER #1

Title: Development of Phase Domain Frequency Dependent Transmission Line Model on FPGA for Real-Time Digital Simulator

Presented by: Jaidai Liu

Session: Real-Time Simulators

Time: June 7 at 10:00-12:00 GMT-3

PAPER #2

Title: A Multi-Star Synchronous Machine Model for Real-Time Digital Simulation and Its Application

Presented by: Ali Banitalebi Dehkordi

Session: Renewable Energy Sources

Time: June 8 at 16:00-17:40 GMT-3

NEW DEVELOPMENTS FOR THE RTDS SIMULATOR

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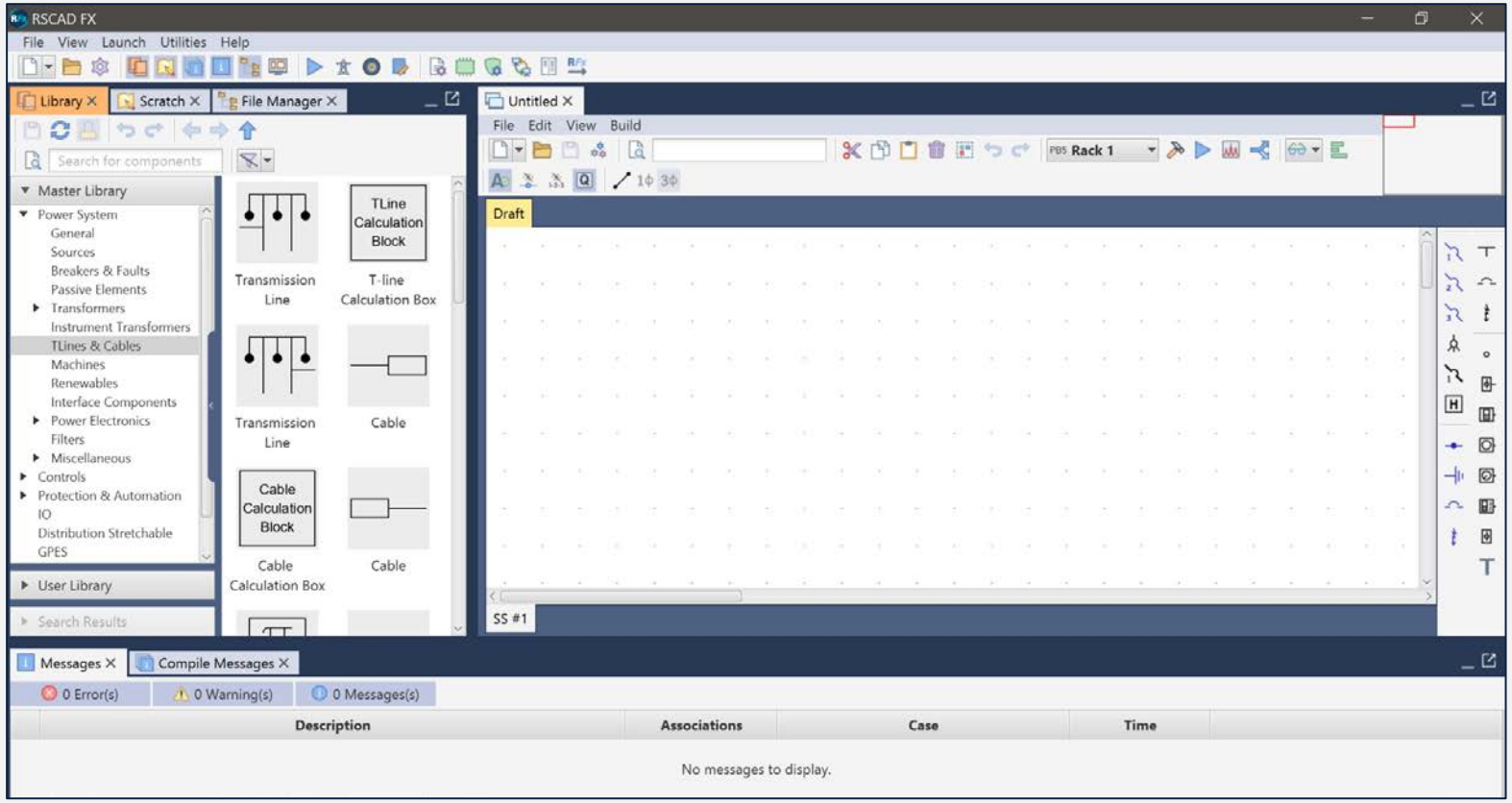
RSCAD FX

Enhancing productivity and ease of use

- Enabled by Java FX
- Launched April 2021
- Focused on updating the Draft (and FileManager) environments
- RunTime and other module updates to follow

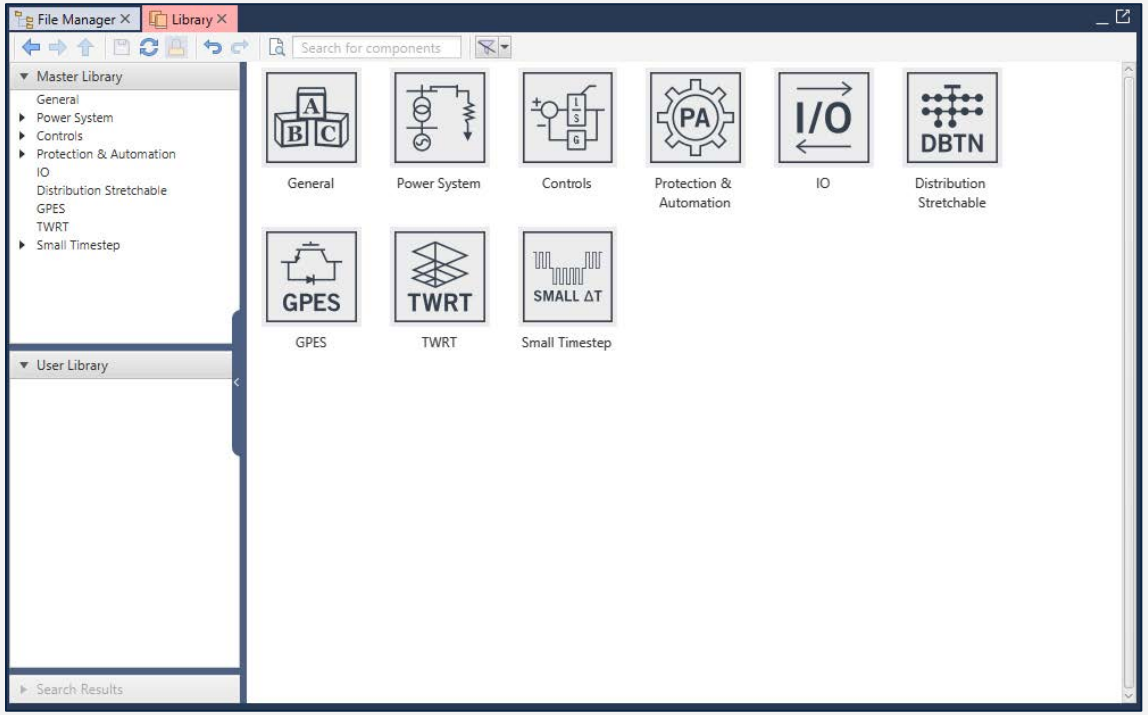
NEW AND IMPROVED GUI

- Standard windows shortcuts, drag and drop
- RSCAD FX is organized into tabs that can be resized and moved – user-configurable interface
- Easily look at multiple Draft cases at once
- Undock tabs into their own window for multiple monitors



LIBRARY LAYOUT

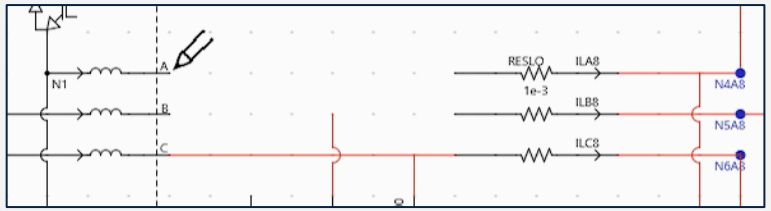
- The library layout in RSCAD FX has been substantially revised
- Components are displayed as convenient tiles — with the actual component diagram viewable by hovering over the tile — and can be dragged onto a case
- Easy navigation and search, filtration



NEW FEATURES

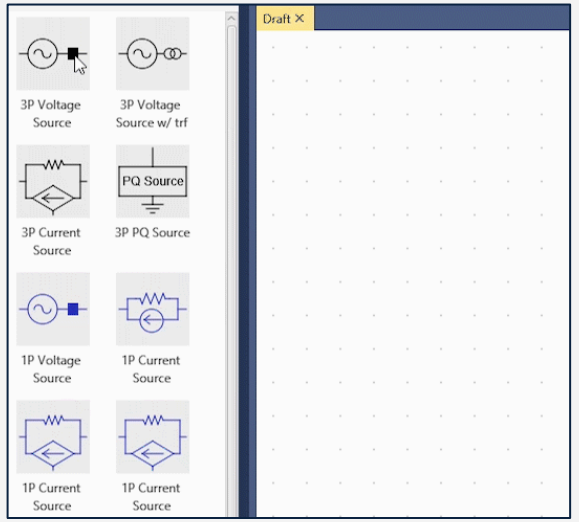
Wire Mode

- Wire mode allows a user to easily add wires and/or jumpers to a case using only the mouse.
- It significantly reduces the amount of time required to connect components together.



Auto-Naming

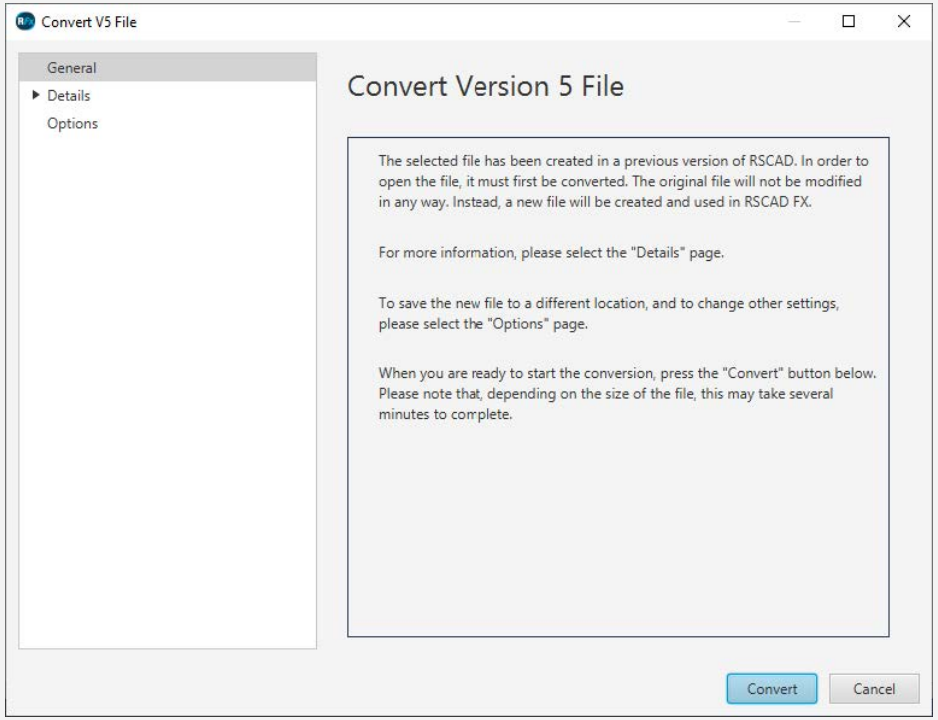
- Automatically increments component, signal, and bus names to avoid duplicates.



BACKWARDS COMPATIBLE

RSCAD FX Conversion Utility

- Draft files will now have the file extension .dfx instead of .dft
- When trying to open a .dft file in RSCAD FX, the RSCAD FX Conversion Utility is automatically launched



UCM - Universal Converter Model

Background

- Demand for converter modelling and simulations with higher switching frequencies (>30.0 kHz)
- Previous average model implementation is decoupled on the DC bus, which can cause instability
- Research found modelling techniques to achieve high resolution of firing

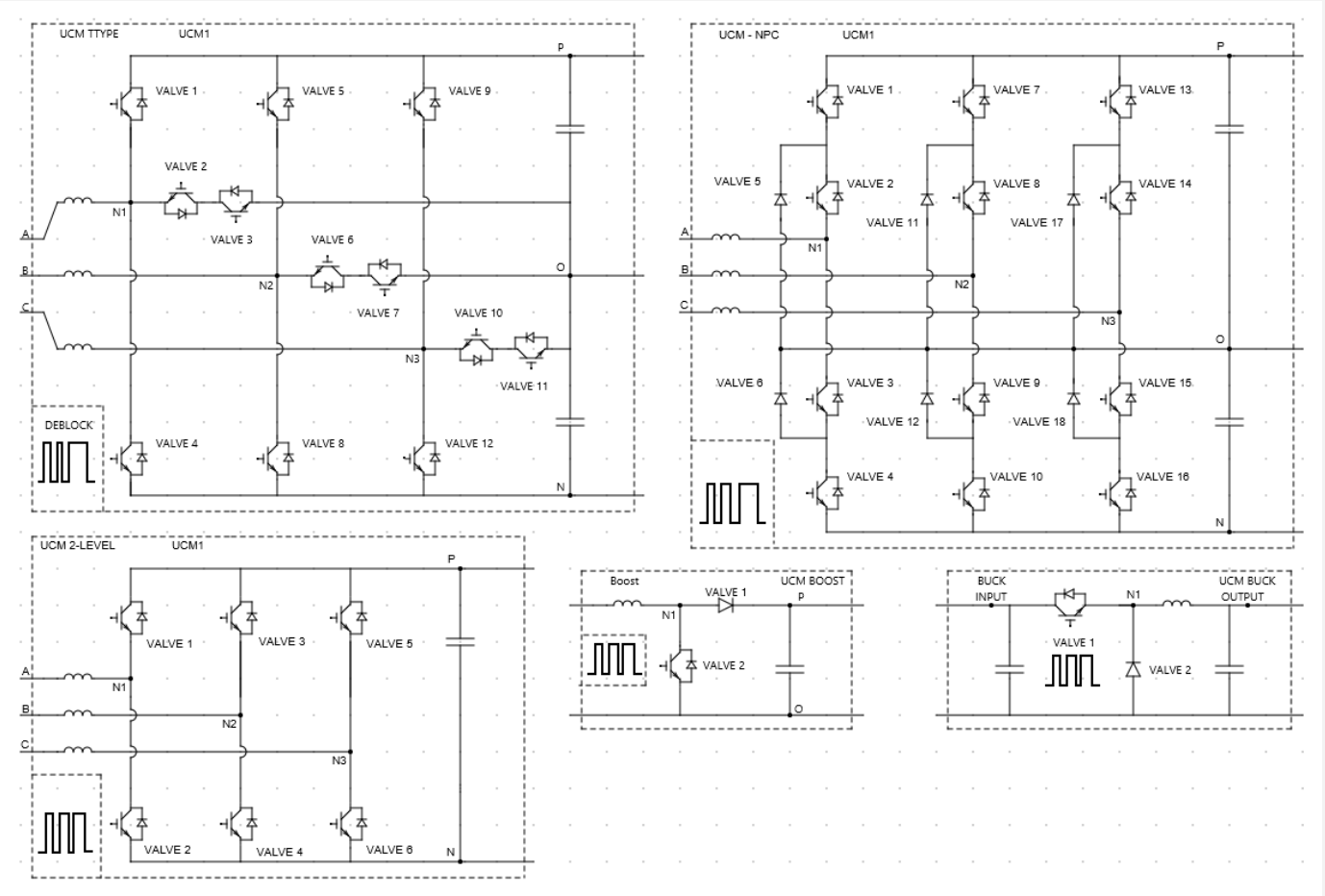
Solution: our new Universal Converter Model (UCM)

- **Universal** Converter Model covering
  - Multiple converter topologies
  - Three different input modes
  - Substep and Mainstep operation
  - Accurate modeling for +100 kHz switching frequencies

UCM - Universal Converter Model

Multiple Converter Topologies

- 2-level,
- NPC (ANPC)
- T-type
- Boost
- Buck
- Flying capacitor



UCM - Universal Converter Model

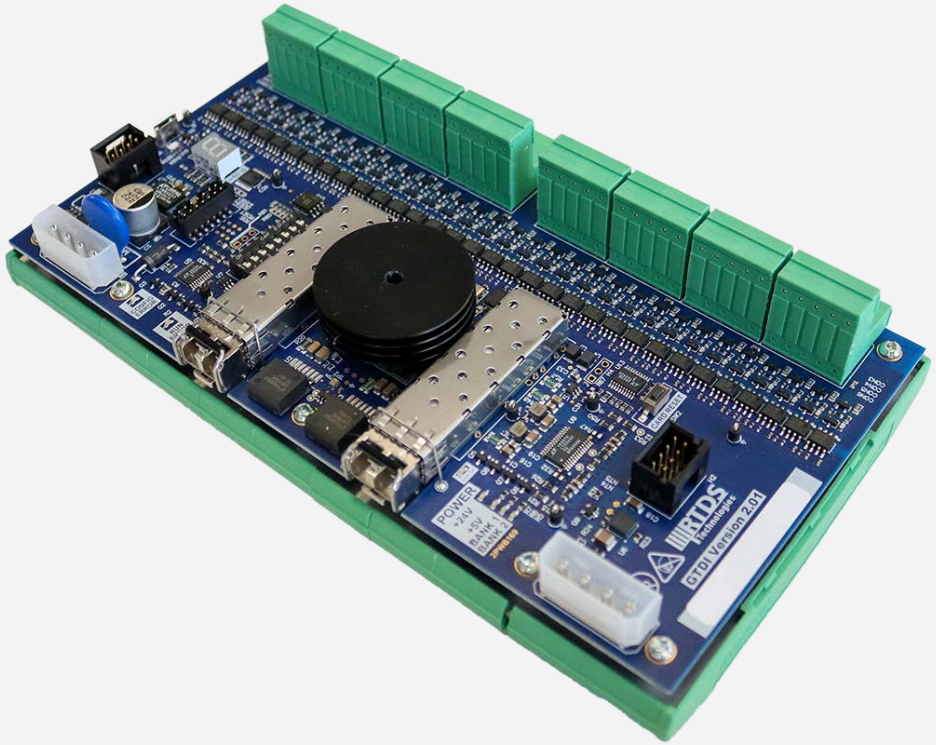
Different Input Modes

- Modulation Waveform (similar performance to existing average model – no harmonics)
- Full Firing Pulse (matches performance of existing Substep resistive-switching models)
- **Improved Firing** (with Mean Value High Precision)
    - Provides performance similar to interpolation, but without backing up in time
    - Captures firing pulses within a timestep at high resolution to calculate how much of the timestep the switch should be “on” (producing an effective duty cycle)
    - Multiple turn-on/turn-off transitions per timestep are allowed

UCM - Universal Converter Model

GTDI v2

- GTDI v2 provides Improved Firing input to the UCM model for CHIL testing
- Samples every 5 ns to capture the firing pulses with high accuracy



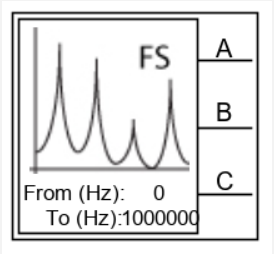
UCM - Universal Converter Model

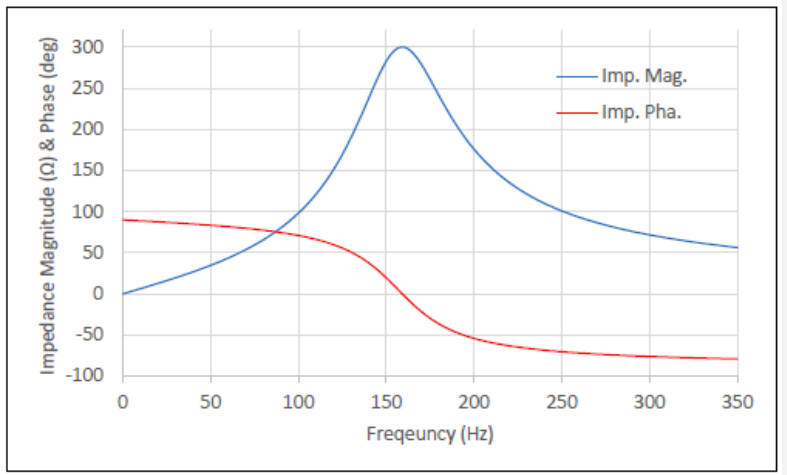
Benefits

- Very high switching frequencies possible with Improved Firing input (>100 kHz)
- No decoupling of the converter at the DC bus
  - Provides very stable simulation results
  - Good results even in Mainstep (no need to maintain very small timesteps for stability considerations)
- Proper transitioning from blocked to deblocked states – UCM incorporates predictive switching technique that was in previous Substep models.
- Harmonics for Improved Firing:
  - Represents very well the characteristic harmonics (multiples of switching frequency)
  - Has minimal non-characteristic harmonics (introduced from jitter)

Frequency scan component

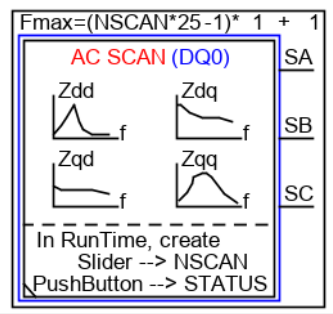
- Analytical, offline impedance scan of simulated network
- Done via Draft module prior to running simulation
- User specifies frequency range between DC and 1MHz
- Writes system impedance seen from scanning point to file
  - Lower triangular portion of phase impedance matrix
  - Pos., neg., zero sequence impedance
  - D-, q-, 0-axis impedance
  - Modified sequence quantities (PN0) good for high penetration of power electronics

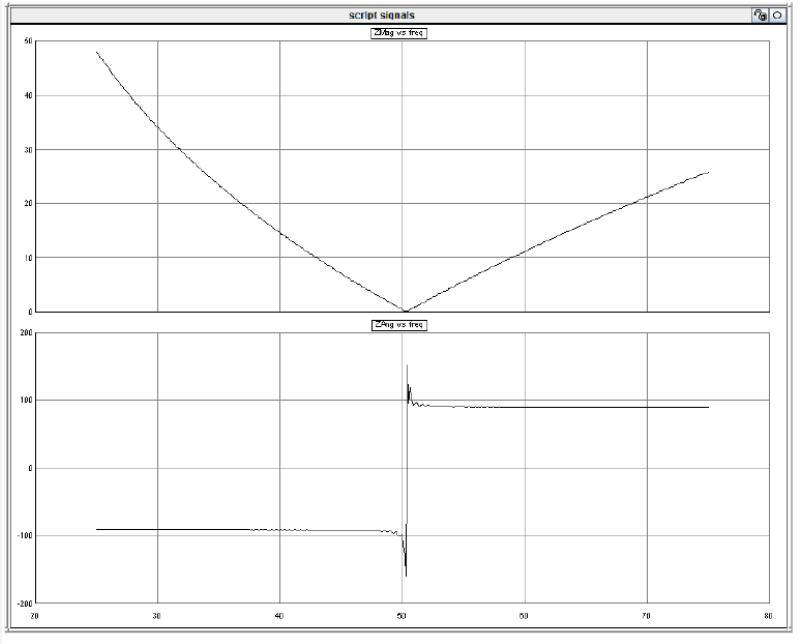




Harmonic scan capability

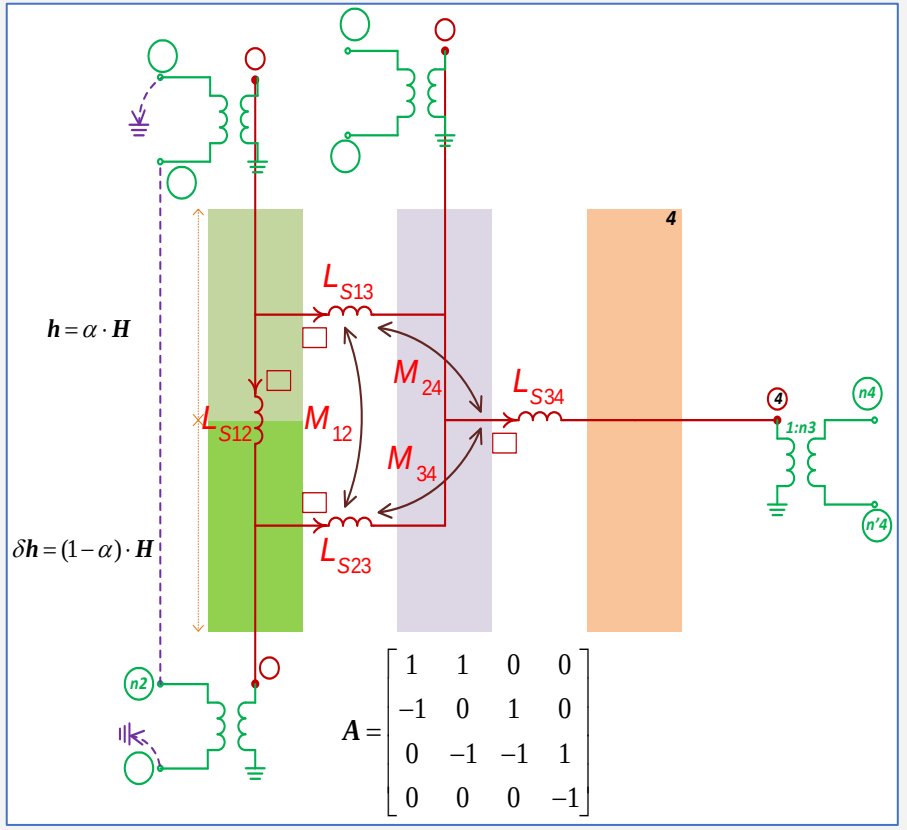
- Component injects small-magnitude white noise to the system
- Online calculation of impedance response in frequency domain
- User specifies frequency range and interval (up to 9 kHz)
- Controlled by script in RunTime
- Outputs DQ0 or PN0 domain impedance
- Procedure available to determine Nyquist stability criterion based on eigenvalues





New faulted transformer model using “terminal duality” approach

- More realistic representation than popular star equivalent circuit
- The electric equivalent circuit from this approach corresponds to the physics of the device; phenomena such as leakage inductance, etc. can be correctly interpreted
- Represents mutual coupling between branches of equivalent and takes transverse component of leakage flux into account



MMC Valve Model Enhancements

Experience gained from real projects

- Enhancements to FPGA-based MMC valve model made to support customer testing
  - Projects like Kun-Liu-Long multi-terminal UHVDC project provide valuable feedback
  - Mixed full- and half-bridge MMC valves
  - One terminal based on LCC technology
- Numerous internal fault options
  - Valve to valve mid-point fault or valve mid-point to ground fault
  - Change of submodule capacitance or short across capacitor
  - Submodule IGBT fault
  - Reactor fault

Protection & Automation Developments

- IEC 61850 Edition 2 and IEC 61869 Enhancements
  - New ICT tool in RSCAD FX with configurable support for all logical nodes
  - GTNET-GSE-v7 with 4 configurable IEDs supported with new ICT tool
  - Routable GOOSE and Sampled Values
  - 250 kHz Sampled Values for support of FACTS and HVDC projects
  - Sampled value data manipulation capabilities added to test implementation robustness
  - GOOSE Analyzer added
- PMU Test Utility enhancements
- DNP and Modbus enhancements
- Numerous new relay models added

TWRT

Traveling Wave Relay Testing

- GTFPGA-TWRT
  - o FPGA based model smaller network models
  - o Fixed timestep of 1.54 µs
  - o Phase domain frequency dependent traveling wave models supported for small timesteps

- NovaCor
  - o Uses Substep environment to model network at in range of 2-3 µs
  - o Larger scale network models possible
  - o Phase domain frequency dependent traveling wave models supported for small timesteps

- Commercial testing
  - o A number of customers are using RTDS to test traveling wave based relays
  - o Direct connection to the relays is required since amplifiers are not able to provide the necessary frequency response

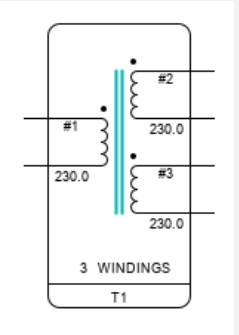
Hardware Developments

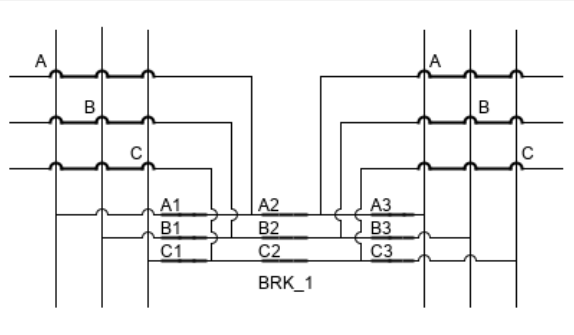
Purpose built for real time simulation

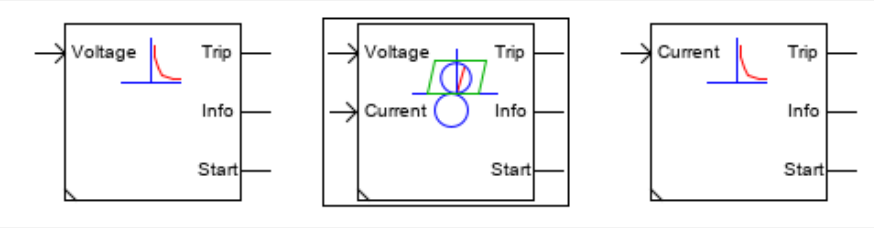
- NovaCor features
  - UDP port for direct real time data streaming
  - Controlled shut down for high power PHIL applications
  - Snapshot feature to allow the simulation to restart from the captured state
- New hardware components
  - GTAO v2 – improved performance plus increase to 16 channels per card
  - GTDO v2 – smaller form factor
  - GTDI v2 – smaller form factor and Improved Firing support for UCM
  - GTAI v2 – more versatile input filtering options
  - GBH v3 – support for 144 NovaCor chassis
  - IRC Switch v2 – smaller form factor and support for 144 NovaCor chassis
- Support for longer cable lengths
  - 100m for GBH and IRC cables using latest platform
  - >300m for I/O cables

OTHER DEVELOPMENTS

- Multi-winding terminal duality transformer
- Exciter Model AC7C
- 3/2 bus connection for breaker and a half
- Single-phase relaying components
- New version of MMC generic model with multiple internal faults
- Phase-shifted and multicarrier-based PWM generators
- Improved renewable and energy storage example cases







INFORMATION RESOURCES

- Webinar and informational videos on YouTube
  https://www.youtube.com/channel/UCCPD8f4jKs3sNzTfDi8uNVg
- RTDS Knowledge Base
  https://knowledge.rtds.com/hc/en-us
- RTDS Website
  https://www.rtds.com/
- Email us at
  marketing@rtds.com

QUESTIONS ?

Thank you!

For more details, please contact marketing@rtds.com.

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