PowerFactory 15

PowerFactory User’s Conference and Future Networks Technical Seminar

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Overview

- PowerFactory’s history

- Highlights PowerFactory Version 15
  - Graphical User Interface & Network Diagrams
  - Data model enhancements
  - Database & License Server
  - New/enhanced analysis functions
  - New/enhanced models

- Outlook PowerFactory Version 15.1

- At last but not least....
PowerFactory History

1985: First commercial power system analysis software (Unix, M.Schmieg)
1995: Final release DIgSILENT 10.31
1998: DIgSILENT PowerFactory 11.0
2000: DIgSILENT PowerFactory 12.0
2003: DIgSILENT PowerFactory 13.0
2005: DIgSILENT PowerFactory 13.2
2008: DIgSILENT PowerFactory 14.0
2010: DIgSILENT PowerFactory 14.1
2013: DIgSILENT PowerFactory 15

Installations in more than 110 countries; > 10000 licenses
Graphical User Interface

- New Project Overview Window
  - Display state of the project at a glance: study cases, operational scenarios, variations, grids, and triggers

- Redesign of Main Menu
  - Main menu in close accordance with the toolbars
  - Additional Main Menu items:
    - View (functions from the Graphic Board)
    - Insert (new project objects such as study case, variation, etc.)
Graphical User Interface

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  - Display state of the project at a glance: study cases, operational scenarios, variations, grids, and triggers
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Graphical User Interface

- Redesign of Dialogue Tabs
  - Original tabs now presented as a menu and the original second page now presented as a tab
Graphical User Interface

- User Profiles to customize the GUI, including the ability to customize:
  - Main, Graphic Board and Drawing Toolbars
  - Element dialog pages
  - Main Menu and context-sensitive menu commands
  - Add user-defined icons for custom DPL commands and templates

- Pre-configured Standard and Basic Package user profiles
Network Graphics

- Support of *Geographical Diagrams*
  - Automatic generation
  - Based on GPS coordinates (latitude and longitude)
  - Support background maps of various common projection types
  - Customize from which scale level text and result boxes become visible

- Additional layer *Load/Generation Distribution* to illustrate the magnitude of network load and generation
Handling & Data Management

- Better support of distinct calculation models (such as Contingency analysis, sensitivity analysis, optimal power flow, etc.)
  - Improved predefined results in single line diagrams and flexible data pages
- Completely new look of Variable Set dialogue
Handling & Data Management

- Variation and Expansion Stages: **Error Correction Mode**

Variation A
Stage 1: 01.01.2015

Variation B
Stage 1: 01.01.2020 (recording stage)
Handling & Data Management

- Pack external references
- Invalidation of calculation results (User Settings)
- Hot Keys
  - F10 Load Flow calculation
  - Ctrl+F10 Edit load flow options
  - F11 Short-circuit calculation
  - Ctrl+F11 Edit short-circuit options
  - F12 Reset calculation
Database and License Server

- Offline Mode
Database and License Server

- User authentication on license server
  - License server can be configured to grant licenses only to a list of named PowerFactory users

- Housekeeping & Archiving for multi-user databases
  - Automatic execution of scheduled housekeeping tasks such as project purging, emptying of users recycle bins, archiving and/or deletion of old projects
  - Housekeeping moves heavy data processing to off-peak periods
  - Benefit: quicker activation of projects, quitting PowerFactory.

- Selective DB migration for multi-user databases (Oracle, SQL-Server)
Analysis Functions
Tie Open Point Optimization

- Enhanced, fast TOPO algorithm
- Power restoration in distribution networks incorporates *Tie Open Point Optimization* methods to achieve an utmost level of resupply.
Reliability Analysis

- Support of both balanced and unbalanced network representations (reliability & tie open point optimization)

- Feeder constraints
  - Maximum allowed voltage drop/rise (global or feeder-wise)
  - Particularly important in network with high portions of distributed generation, where bidirectional power flows may occur

- Load states and load distribution states

- Incorporates optimal power restoration based on an automatic Tie Open Point Optimization (reduction of network losses)
Optimal Power Restoration

- Optimal power restoration
  - Conduct optimal restoration analysis for a single element, even in case that no failure data is available
  - Report recovery scheme
Backbone calculation

- Backbone: electrical path between two meshed feeders
Optimal Remote Control Switch (RCS) Placement

- Optimizes RCS locations within feeders to minimize Energy Not Served (ENS), Expected Interruption Costs (EIC) or balance ENS
Voltage Profile Optimization

- Optimization of distribution transformer tap positions with consideration to the range of expected load and generation conditions (bidirectional power flow)

- Allows for a combined study of MV and LV networks
Protection

- **Short-Circuit trace**
  - Based on complete short-circuit method
  - Accounts for the effect of switching actions on the fault current

- **Tabular relay settings reports**

  ![Image of relay settings report]

  - Reach settings for distance relays in Primary or Secondary ohms
Arc-Flash Hazard Analysis

- Globally or individually specified circuit-breaker tripping times or fault clearing times based on actual protection settings
- Automated preparation of Arc-Flash labels

![ARC FLASH HAZARD WARNING]

**ARC FLASH HAZARD**

APPROPRIATE PPE REQUIRED

<table>
<thead>
<tr>
<th>Equipment Name</th>
<th>Motor Switchboard/ Bus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working Distance</td>
<td>910,00 mm</td>
</tr>
</tbody>
</table>

| Hazard Risk Category | 1                      |
| Incident Energy (working distance) | 13,19 J/cm² |
| Flash Protection Boundary | 2458,13 mm |
Cable Sizing

- **Cable Reinforcement**
  - Support of unbalanced networks
  - Constraints: loading, voltage per terminal and along feeder
  - When applied to a network without types, PF will automatically assign types from the library, with consideration of loading/voltage drops
  - Report on short-circuit loading of lines/cables

- **Automatic Cable Sizing**
  - Cable sizing optimization based on international standard:
    - IEC 60364-5-52
    - BS 7671
    - NF C15-100, C13-200
Techno-Economical Analysis

- Economic assessment of network reinforcement strategies (expansion stages) under consideration of:
  - Cost of electrical losses
  - Economic impact on the failure rates (reliability)
  - Costs for the expansion:
    - Investment costs, additional costs per year
    - Commercial equipment value: original value, scrap value, expected life span
    - User-defined costs

- Output: Net Present Value (NPV) of the expansion strategy over the selected period
### Additional Tools: Motor Starting

- **Motor starting**
  - Static motor starting (besides dynamic)
  - Assess voltages before, during and after starting
  - Assess whether starting is successful or not

<table>
<thead>
<tr>
<th>Motor Name</th>
<th>Terminal Name</th>
<th>Terminal Voltage</th>
<th>Motor Voltage</th>
<th>Minimum on</th>
<th>After Starting</th>
<th>Starting Current</th>
<th>Starting P.F.</th>
<th>Successful Start?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor 1</td>
<td>Motor</td>
<td>0,000</td>
<td>0,761</td>
<td>0,948</td>
<td>1,978</td>
<td>4,568</td>
<td>0,814</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Simulation Scan

- Monitor network results and parameters during time-domain simulations
  - Frequency minimum and maximum limits
  - Loss of synchronism
  - Voltage max/min limits and limit violation time
  - Voltage recovery and voltage recovery time
  - User-selected parameters

- Action:
  - Display output message
  - Stop simulation
Models
(Selected)
New Models

- Secondary substation
  - Broad variety of predefined secondary substation configurations

- MV load
  - Representation of distribution transformer together with a reduced load/generation model

- Single-phase and single phase-neutral static generator

- Single-phase and single phase-neutral PLL

- Detailed CVT model
Models Enhancements

- Series capacitor:
  - Built-in tripping criteria for spark gap acc. to:
    - Current or voltage,
    - MOV energy/power

- Cable parameter calculation
  - Better support of cross-bonding and reduction options
  - Support of segmental conductors
  - Material selection in accordance with IEC60287
Models Enhancements

- Station controller: support of following control options
  - Support of PWM converters
  - Support of following control options:
    - \( \cos \phi (P) \)
    - \( Q(V) \)-characteristics
    - Reactive power distribution acc. to voltage setpoint

- Background harmonics (phase correct, IEC61000)
  - External Grid
  - AC voltage source
Outlook

PowerFactory v15.1
Short Circuit Calculation in DC Networks

• DC short-circuit calculation acc. to IEC61660 and ANSI/IEEE 946
• Contribution to the short-circuit from:
  – AC/DC converters (recifier/inverter) in bridge connection
  – Batteries (new)
  – Smoothing capacitors (only IEC)
  – DC motor/generator (new)
• Pre-fault voltage calculation based on standard LDF calculation
• Calculation results
  – Peak short-circuit current
  – Quasi-steady-state short circuit current
  – Time to peak
  – Rise- & decay times, rate of rise
  – Equivalent system resistance and inductance, network time constant
Load Flow Sweep

• New „Time Characteristic“ in the operation library
  – Built-in time scale for easier handling
  – Recurrence (daily, weekly, monthly, yearly, none)
  – Resolution / Step size (minutes, hours)

• New „Characteristics Viewer“
  – All characteristics at a glance
  – Characteristic diagrams
  – Out of service flag per characteristic

• Load flow time sweep
Protection Functions

- Protection coordination assistant (distance)
- Visualization of protection devices
  - CTs, VTs in overview diagrams/substation diagrams
  - Detailed view for connecting
Eigenvalue Analysis

- Eigenvalue Analysis (Small Signal)
  - **QZ factorization method** to support models not previously supported by the QR-method
    - ElmAsm, ElmVscmono, ElmVsc, DDIG machine, DC-machine, CD-line, complex load, DC shut, surge arrester, DC valve, DC series reactor
  - Output results to Matlab:
Calculation Functions

- D-A-CH guideline
Virtual Instruments

- Arithmetic post-processing of simulation variables
  - User defined result variables (DSL-syntax)
Graphics

- User-configurable annotation (transparent) layers
  - Support of SVG, SGI graphics
  - Dedicated freeze mode
  - Import/Export support of annotation layers (incl. GPS coordinates)
Scripting Language

• Python Scripts
  – Non-proprietary programming language
    • Open source license
    • Extensive standard libraries and third party modules for virtually every task
    • Debugger
  – Quicker and more effective integration of external systems
    • Interfaces to external databases and MS-Office like applications
    • Web-services, etc.
  – Integration of compiled scripts in PF
    • Hence no further needs for script encryption
  – Scripts execution from outside PF also possible
Enhanced Windows 8 Compatibility

- PF Installation folders
  - C:\Program Files\DiGSIlENT (installation files)
  - C:\Users\Username (user’s files, i.e. projects)

- User workspaces
  - Contains all user relevant information
  - Export/Import of workspaces as .zip file
  - Backup & Restore workspace

- Help option
  - Create „Support package“
New Models

- PV systems (*ElmPVsys*)
  - System geographical location: latitude, longitude (GPS coordinates from the busbar) and time zone
  - Orientation angle and tilt angle
  - Mounting system: fixed/stationary, dual axis tracking system, etc.
  - Operating point: active power or acc. to irradiance

- Impulse source (*ElmImpulse*)
  - Waveforms: two-exponential, Heidler, acc. to IEC62305-1 (time functions of the lightning current for analysis purposes: first positive, first negative and subsequent impulses)

- DC Battery (*ElmBattery*)
  - As DC element, for the calculation of DC short-circuit currents

- DC-machine (*ElmDcm*)
  - Motor/generator
Model Enhancements

- Two-windings transformer
  - Two tap changers now supported (in ElmTr2)
  - Extended phase shifter model
    - Ideal phase shifter (voltage magnitude does not change)
    - New symmetrical phase shifter (taps on HV and LV side)

\[ t_{hv} = \cos(n\text{ntap}_{int} \cdot \text{dphitap}) + j \cdot \sin(n\text{ntap}_{int} \cdot \text{dphitap}) \]

\[ t_{lv} = 1 - n\text{ntap}_{int} \cdot du \cdot (\cos(\text{phitr}) + j \cdot \sin(\text{phitr})) \]

\[ t_{hv} = 1 + n\text{ntap}_{int} \cdot du \cdot (\cos(\text{phitr}) + j \cdot \sin(\text{phitr})) \]
Model Enhancements

- Synchronous generators (*ElmSyn*)
  - Saturation curve: exponential and quadratic equations
  - New input signal “delta speed” (for instance required for SSR applications)
- Measurement tables for shunts (*ElmShnt*)
- Measurement devices (*StaPQmea, StaVmea, Stalmea*)
  - Single phase models now supported
- Neutral connection (*ElmSyn, ElmShunt, ElmXnet, ElmGenstat*)
  - Explicit neutral connection now supported
At last but not least...

- Vastly revised User Manual now presented in PDF format
- Application examples, including demonstration videos
Thanks for your attention