Introduction to ATPDraw version 5

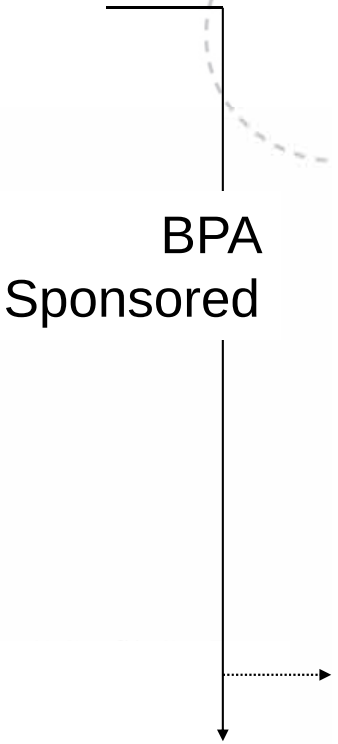
- Introduction to ATPDraw
- Layout and dialogs
- Main menu options
- Transformer modeling
- Machine modeling
- Multi-phase circuits
- Vector graphics
- Grouping
- Models
- Lines&Cables modeling

Introduction

- ATPDraw is a graphical, mouse-driven, dynamic preprocessor to ATP on the Windows platform
- Handles node names and creates the ATP input file based on ”what you see is what you get”
- Freeware
- Supports
  - All types of editing operations
  - ~100 standard components
  - ~40 TACS components
  - MODELS
  - $INCLUDE and User Specified Components

Introduction- ATPDraw history

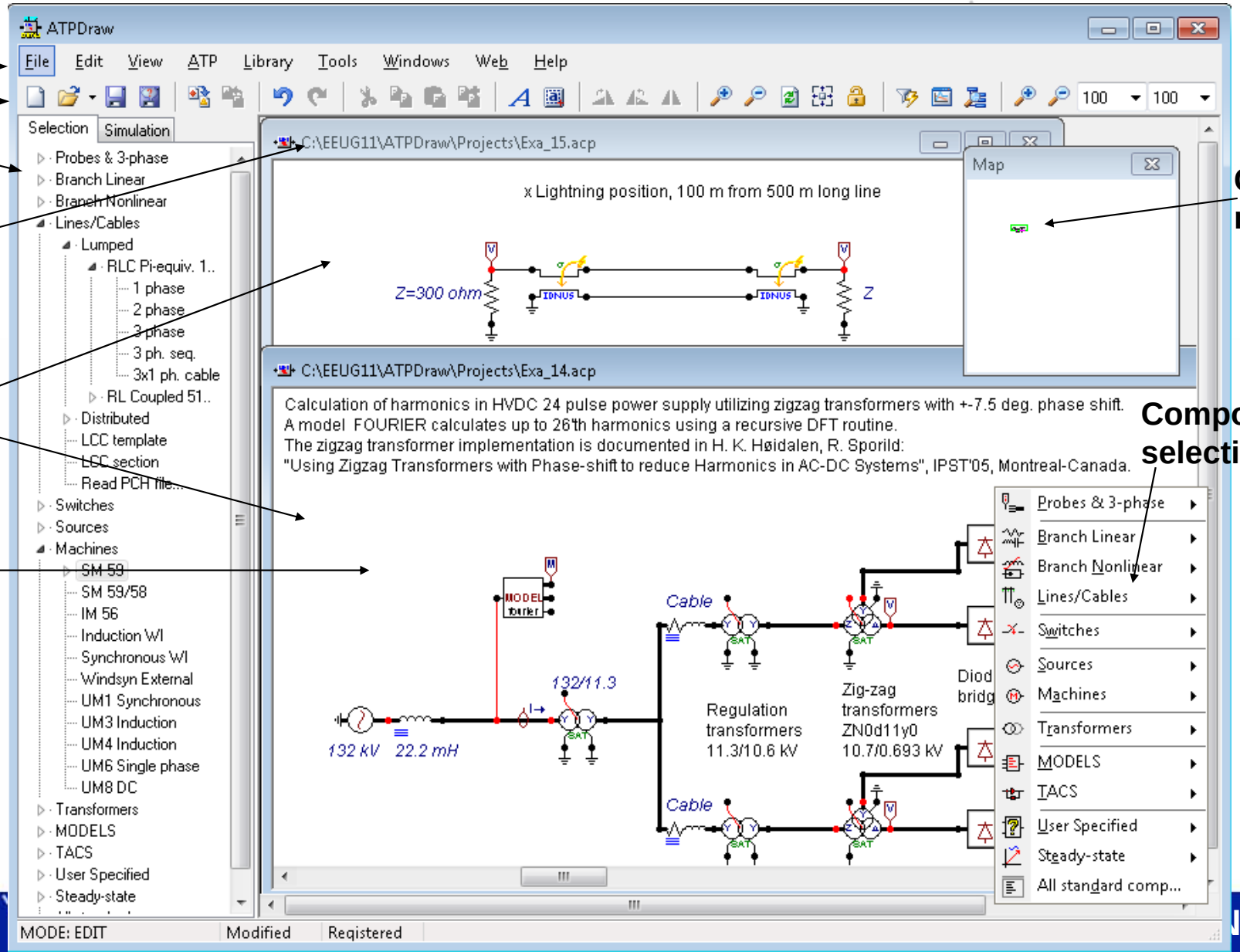
- Simple DOS version
  - Leuven EMTP Centre, fall meeting 1991, 1992
- Extended DOS versions, 1994-95
- Windows version 1.0, July 1997
  - Line/Cable modelling program ATP_LCC
  - User Manual
- Windows version 2.0, Sept. 1999
  - MODELS, more components (UM, SatTrafo ++)
  - Integrated line/cable support (Line Constants + Cable Parameters)



Introduction- ATPDraw history

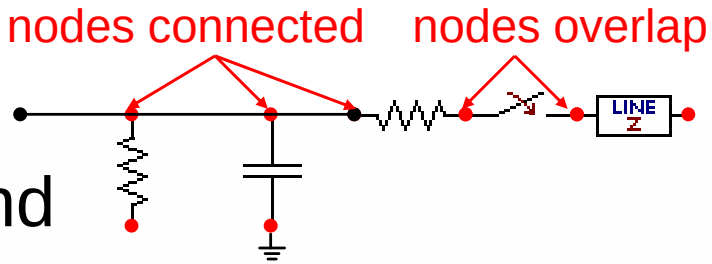
- Windows version 3, Dec. 2001
  - Grouping/Compress
  - Data Variables, $Parameter + PCVP
  - LCC Verify + Cable Constants
  - BCTRAN
  - User Manual @ version 3.5
- Windows version 4, July 2004
  - Line Check
  - Hybrid Transformer model
  - Zigzag Saturable transformer
- Windows version 5, Sept. 2006
  - Vector graphics, multi-phase cirucits, new file handling

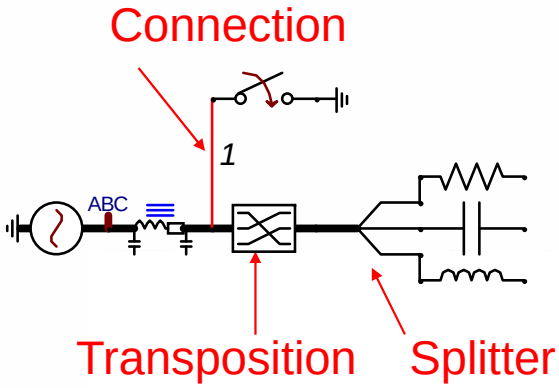
ATPDraw main windows



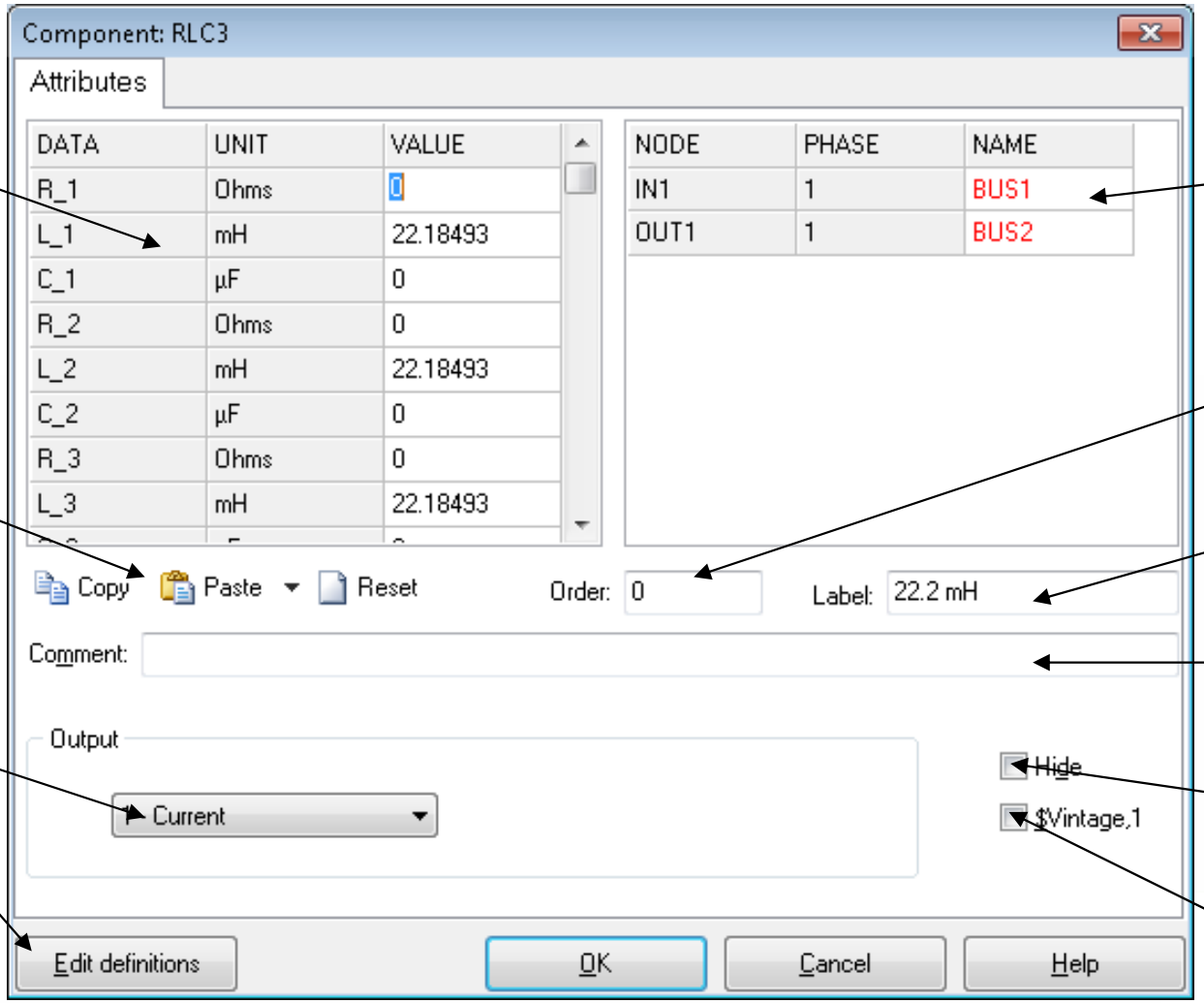
ATPDraw node naming

- "What you see is what you get"
- Connected nodes automatically get the same name
  - Direct node overlap
  - Positioned on connection
- Warnings in case of duplicates and disconnections
- 3-phase and *n*-phase nodes
  - Extensions A..Z added automatically
  - Objects for transposition and splitting
  - Connection between *n*- and single phase





ATPDraw Component dialog



Editable data values

Windows Clipboard support

Branch output

Edit local definitions Icon/help/ pos/name/ units

Node names (red=user spec.)

Used for sorting

Label on screen

Comment in ATP file

Component not to ATP

High precision

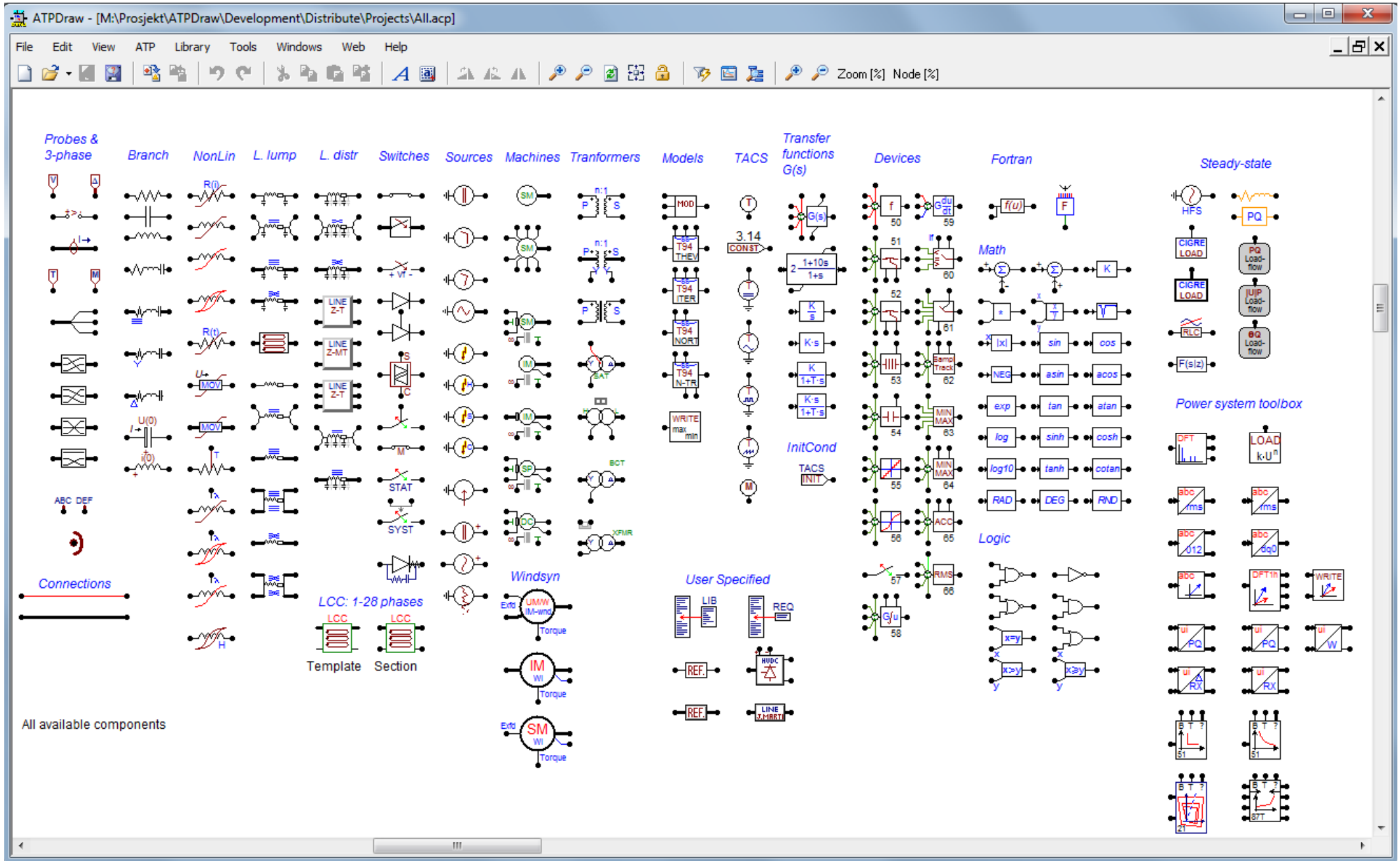
ATPDraw capability

- 30.000 nodes
- 10.000 components
- 10.000 connections
- 1.000 text strings
- Up to 64 data and 32 nodes per component
- Up to 26 phases per node (A..Z extension)
- 28 phases in LCC module
- Circuit world is 10.000x10.000 pixels (user; 25-400%)
- 100 UnDo/ReDo steps

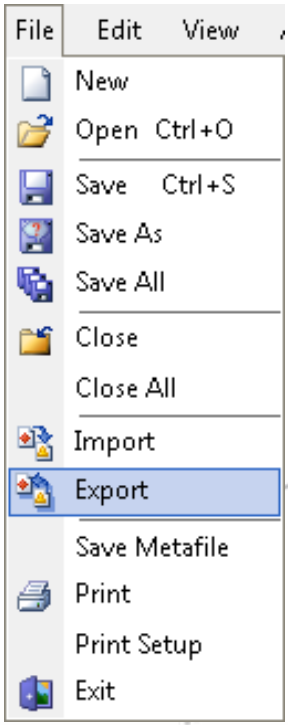
Files in ATPDraw

- Project file (acp): Contains all circuit data.
- Support file (sup): Component definitions. Used only when a component is added to the project.
  - Standard components: ATPDraw.scl
  - User defined components: Optionally in global library
- Data file (alc/bct/xfm): Contain special data
  - Stored internally in data structure
  - Optionally in global library
- Help file (sup/txt): User specified help text
  - Global help stored in sup-file or /HLP directory (txt file)
  - Local help created under *Edit definitions*

All standard components:



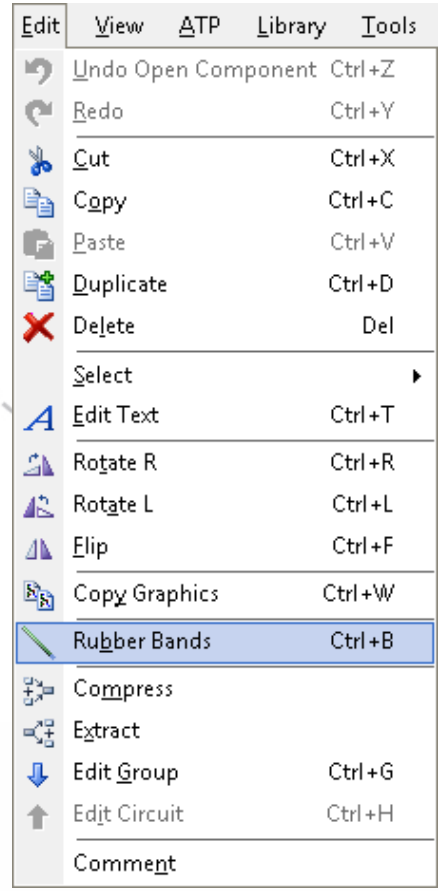
ATPDraw File options



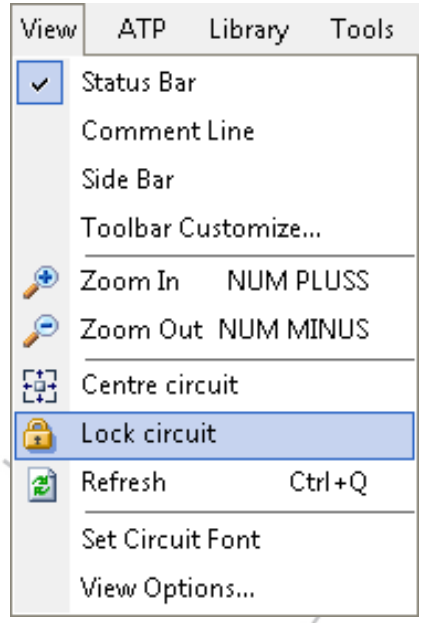
- Project stored in a single binary file (*.acp)
- Entire project stored in memory and ATP-files are written to disk on demand.
- Make ATP files under the ATP item.
- Sub-circuits can be imported/exported.

ATPDraw Edit options

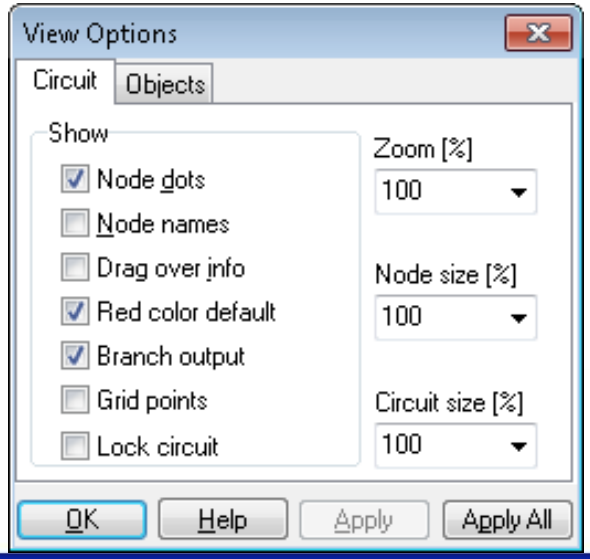
- Multiple documents
  - several circuit windows
  - large circuit windows (map+scroll)
  - grid snapping
- Circuit editing
  - Copy/Paste, Export/Import, Rotate/Flip,
  - Undo/Redo (100),
  - Compress/Extract (multilevel):
    - Merge a collection into single icon, select nodes and data
  - Edit group
    - Dive down into the groups's content and inspect or edit
    - Edit circuit; go one level up
  - Windows Clipboard: Circuit drawings, icons, text, circuit data
  - Rubber bands



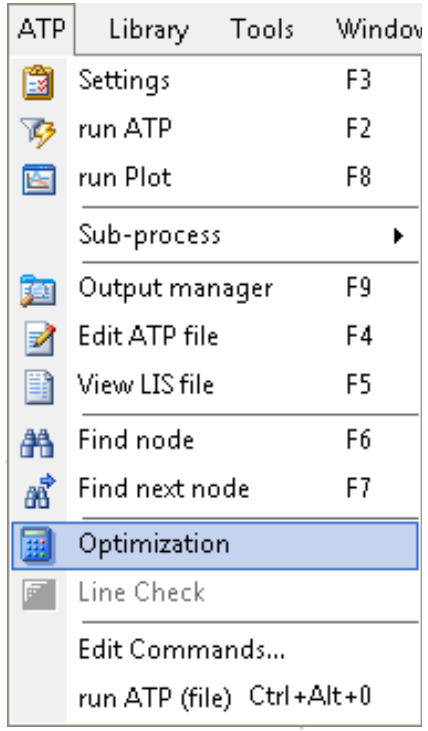
ATPDraw View options



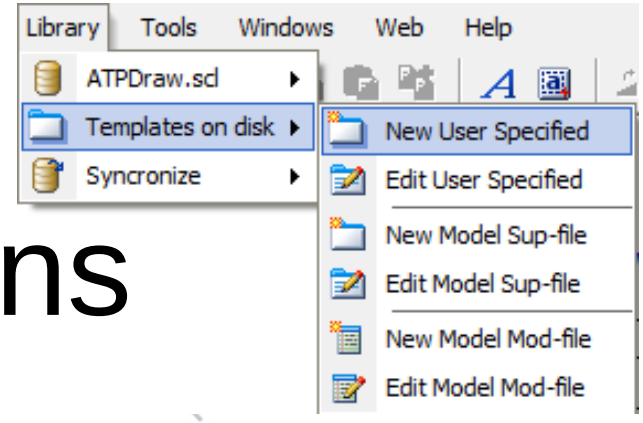
- Turn on/off side bar and status bars
- Customize main tool bar
- Zooming
- Centre circuit in window
- Lock the circuit for moving («child» safety)
- Default view options:



ATPDraw ATP options



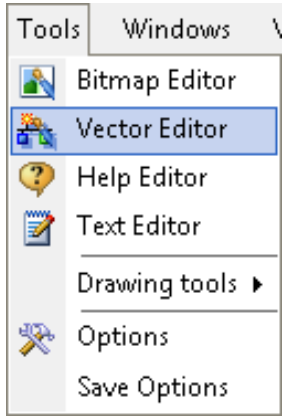
- **Settings (important!)**
  - Simulation; Time step, cap/ind units, frequency scan
  - Output; printout control, auto-detect error messages
  - Format; Sorting, ATP cards
  - Univeral Machine, switch and Load flow settings
  - Output control, variables ($Parameters)
- Output manager (lists all outputs, Find and Edit)
- Inspect ATP and LIS file
- Optimization (writeminmax object function to optimize variables, GA, Gradient, Annealing methods)
- Line Check (calculate sequence parameters of multiple transmission line segments)
- User customized commands



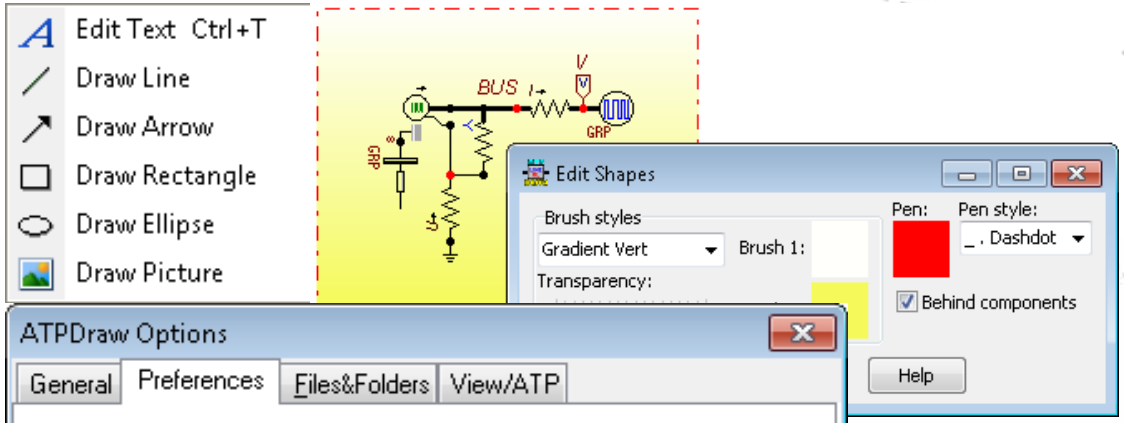
ATPDraw Library options

- New objects
  - User specified
  - MODELS (but this should better me made from Default Model in the Selection menu)
- Edit objects
  - Standard; Edit the ATPDraw.scl component selection. Not for the average user as the file becomes overwritten in a new installation. User defined help can instead be added as text files in the /HLP directory.
  - User specified (requires an external DBM file) and Models
- Synchronize
  - Reload standard icons from ATPDraw.scl (turn an old circuit into vector graphic)

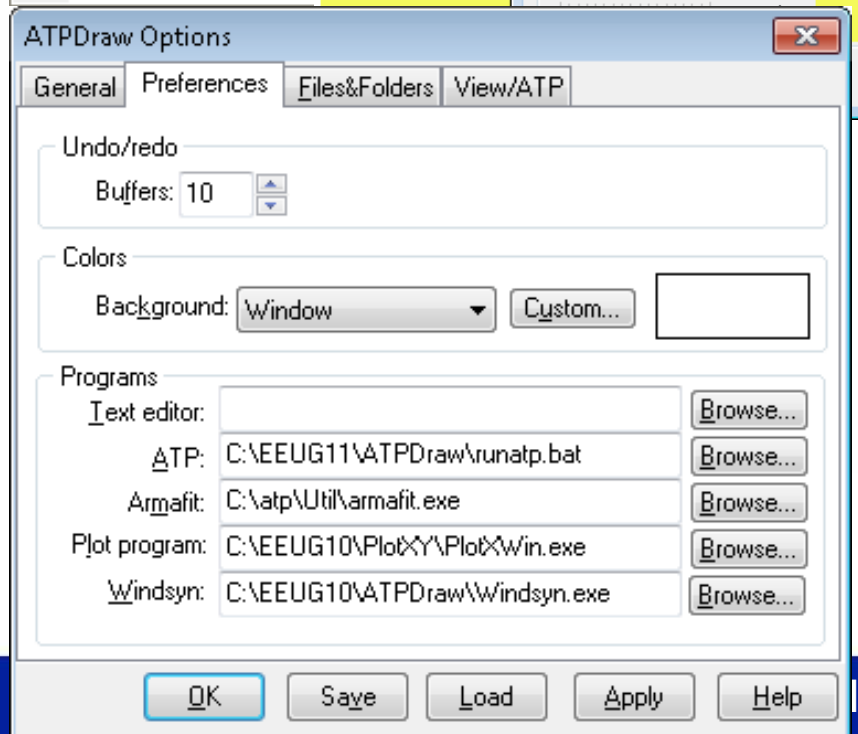
ATPDraw Tools options



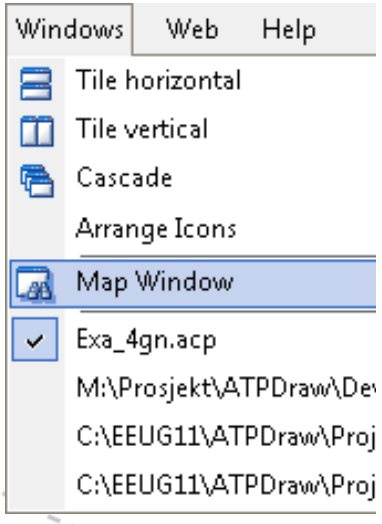
- Bitmap, vector graphic and help stand-alone editors.
- Text editor, embedded with line and column number.
- Drawing tools:



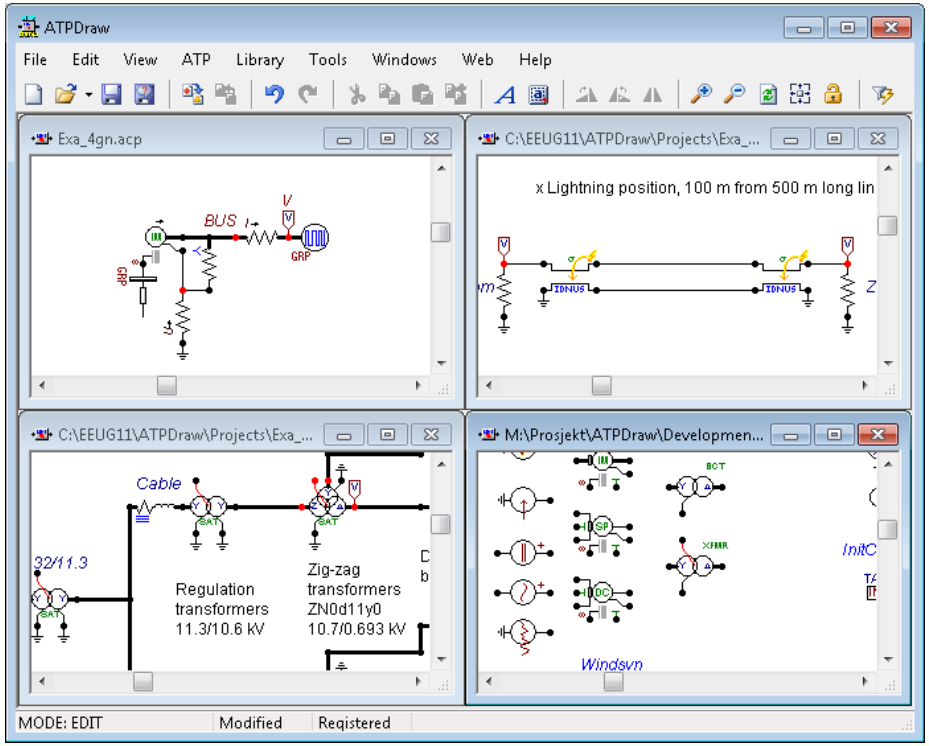
- **Options (important!)**
  - General
    - Autosave and backup
    - Save ini file on exit
  - Preferences
    - Undo/redo steps
    - **Link to ATP and plot**
  - Files&Folders
    - Default folders incl.
    - ATP folder

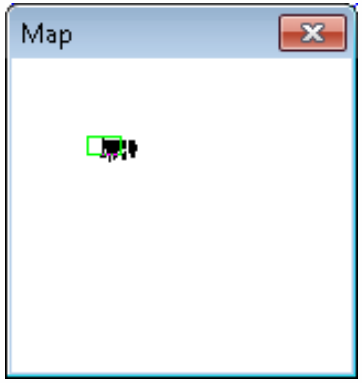


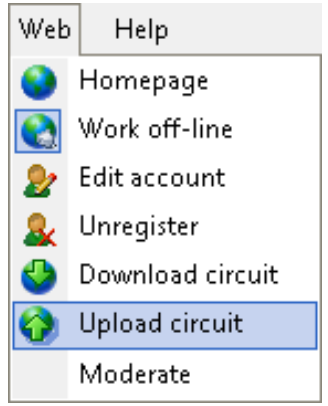
ATPDraw Windows options



- Arrange multiple document windows
- Show the Map windows
- List all circuit projects loads and select active project window

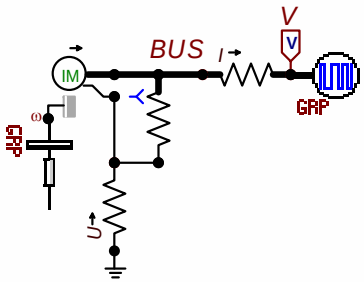


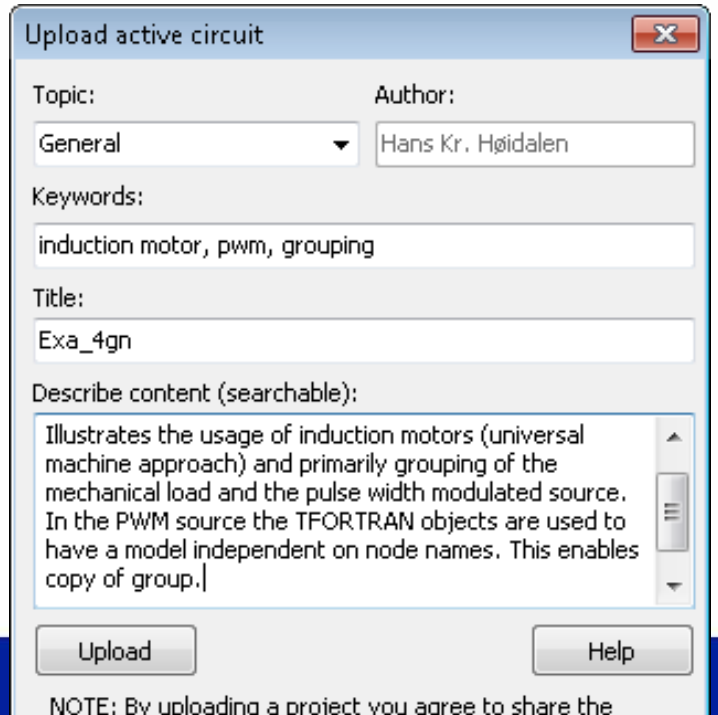


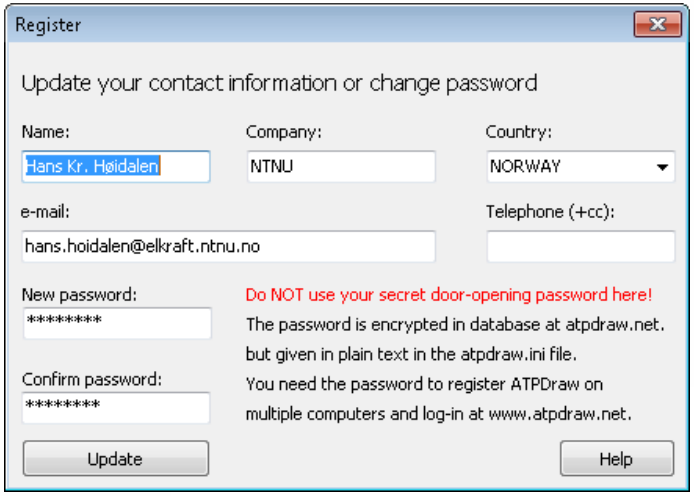


ATPDraw Web options

- Register at www.atpdraw.net from ATPDraw
- Direct access to MySQL databases from ATPDraw
- Upload and download of circuits.
  - Direct support (one click + provide information)
  - Author cited both in ATPDraw and web-page.

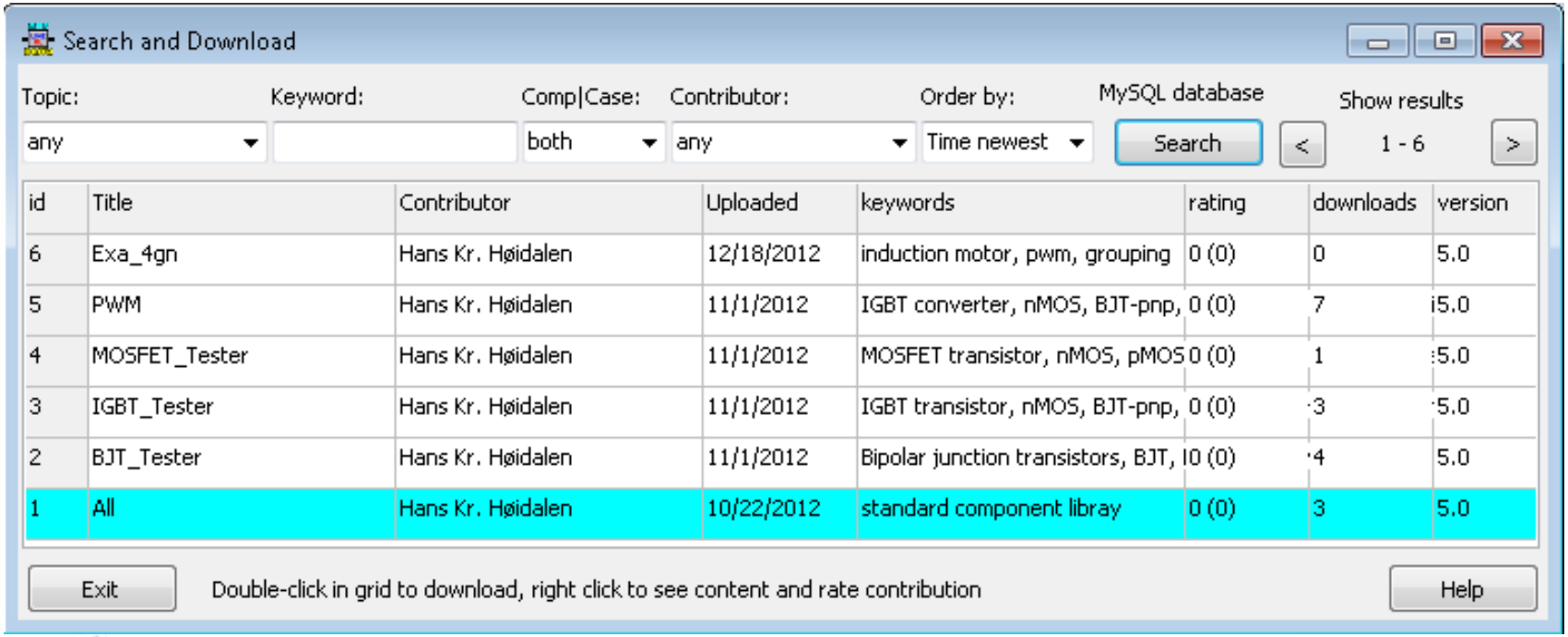






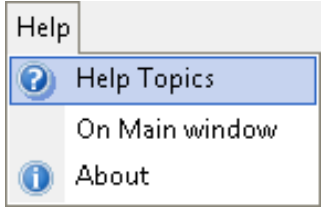
Download and contribute

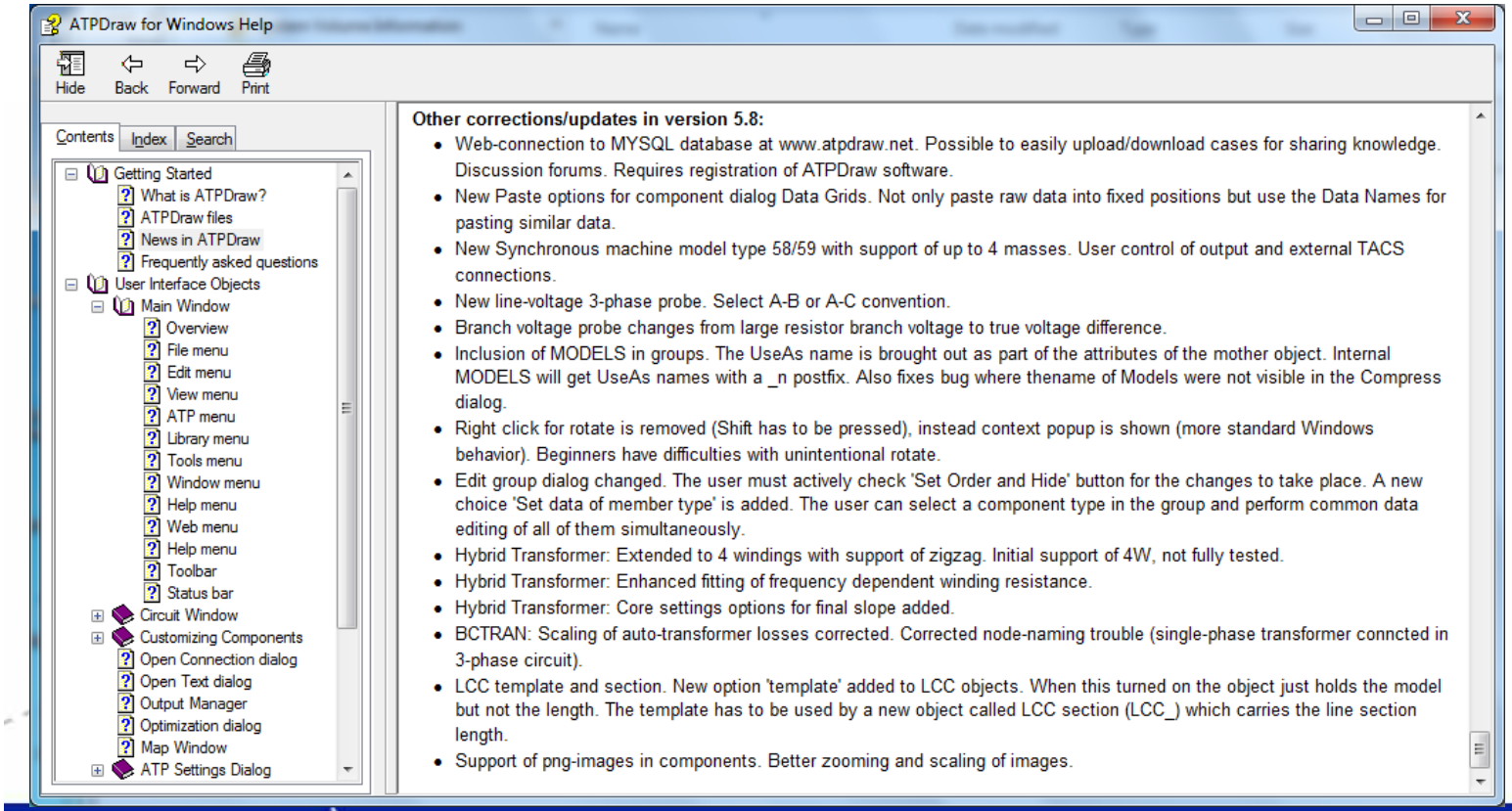
- Download dialog with sorting and search options.
- Upload your own cases to assist other users
  - All cases are moderated.
  - Contributor cited both in ATPDraw and on www.atpdraw.net



ATPDraw Help options

- Show main help
- Local help inside every dialog
- About with web registration info



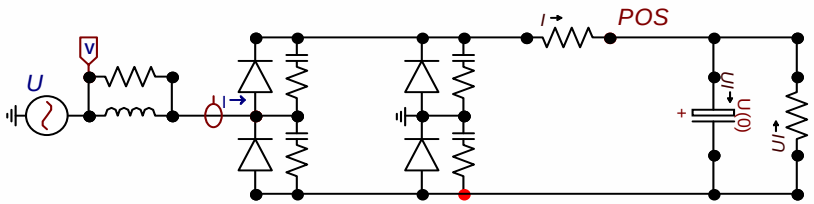


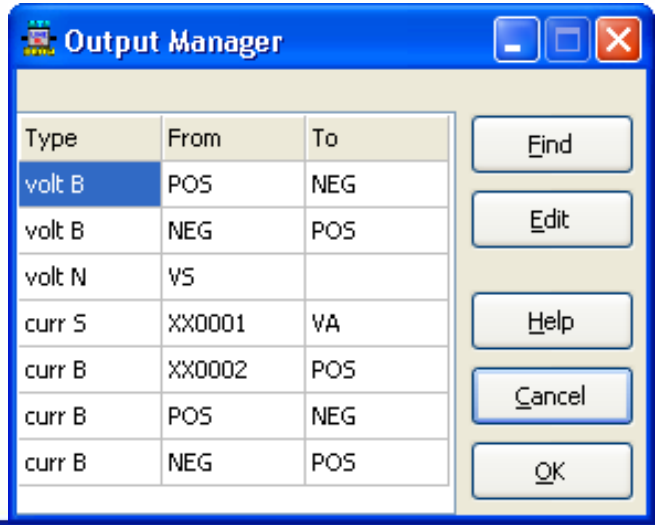
User's manual

- Documents version 5.6 of ATPDraw (269 pages), pdf
- Written by Laszlo Prikler and H. K. Høidalen
- Content
  - Intro: To ATP and ATPDraw + Installation
  - Introductory manual: Mouse+Edit, MyFirstCircuit
  - Reference manual: All menus and components
  - Advanced manual: Grouping/LCC/Models/BCTRAN + create new components
  - Application manual: 9 real examples

Output manager (F9)

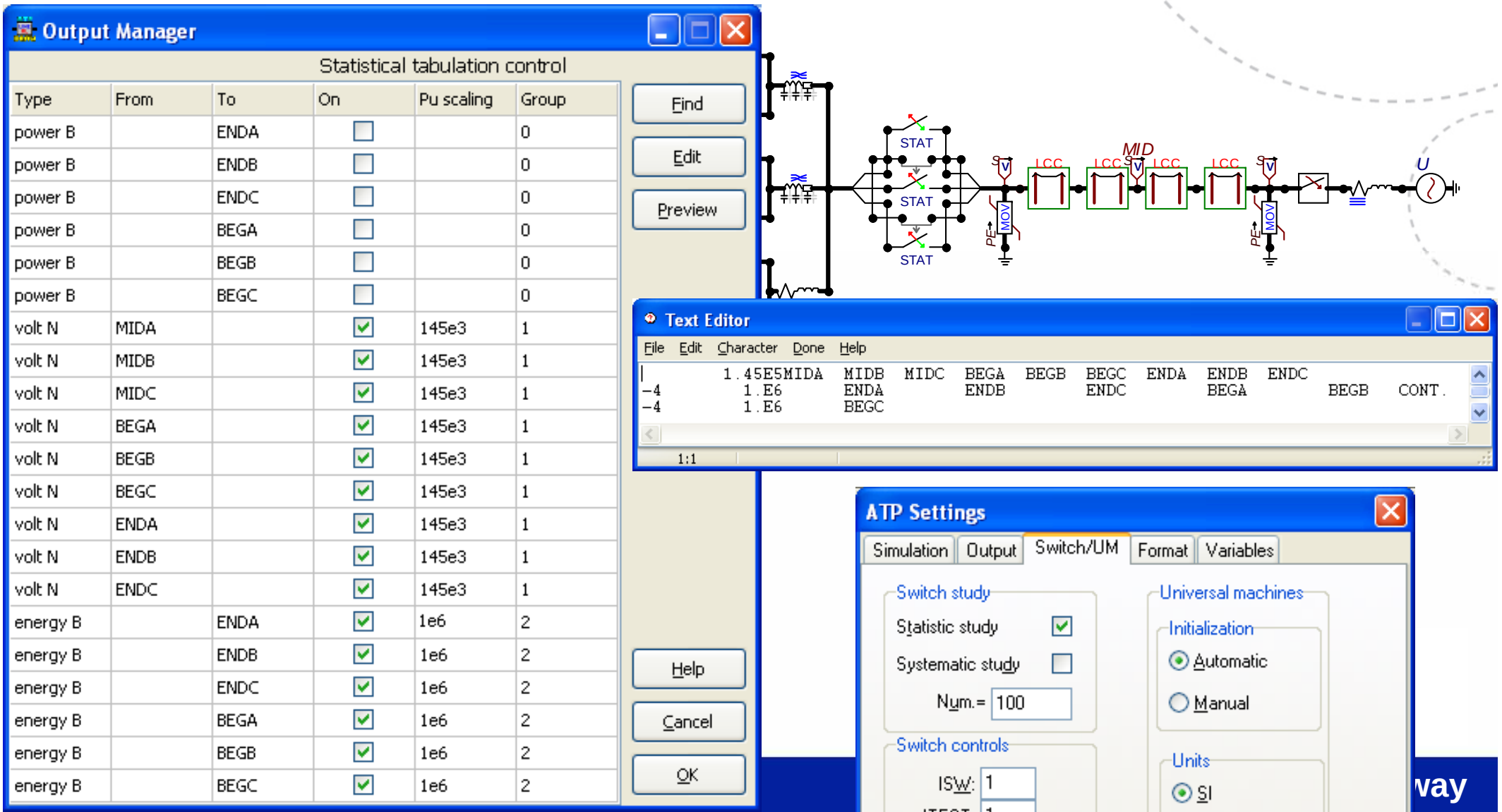
- Gives an overview of all output requests in the circuit
- Stay on top window
- Lists output in same order as in pl4 file
  - Volt/Power Branch, Volt/Power Switch, Volt Node
  - Curr/Energy Switch, Curr/Energy Branch
  - SM,TACS, MODELS,UM
- Goes into User Specified, Additional cards, and Windsyn
- Find+Edit





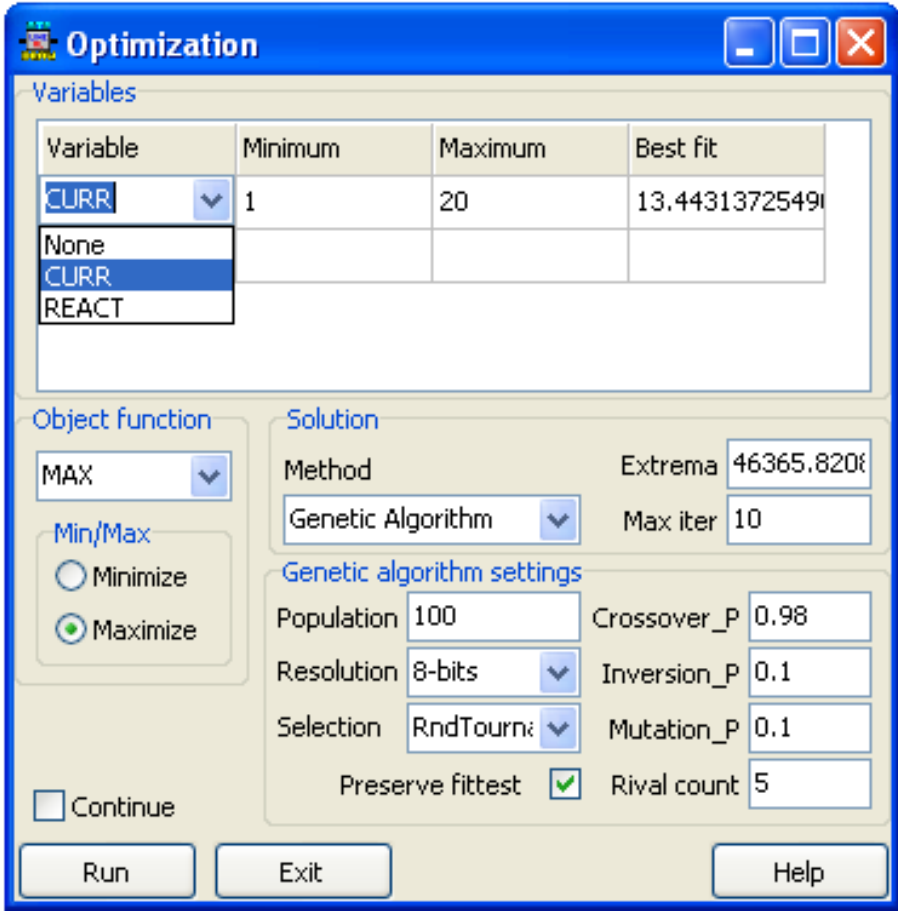
Statistical tabulation

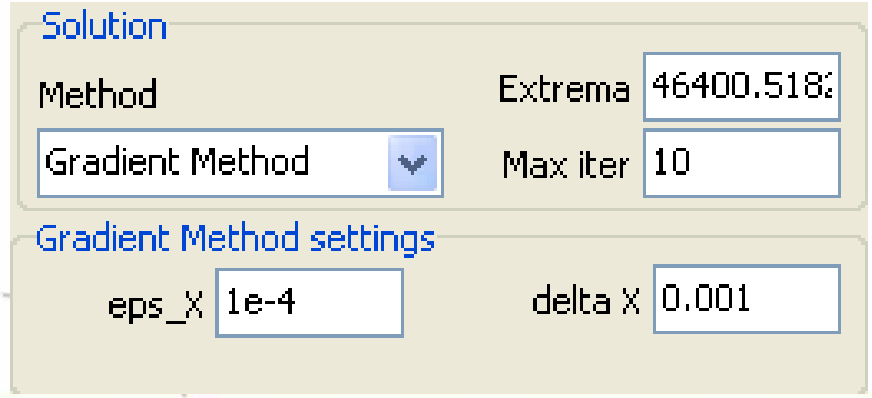
- Addition to output manager

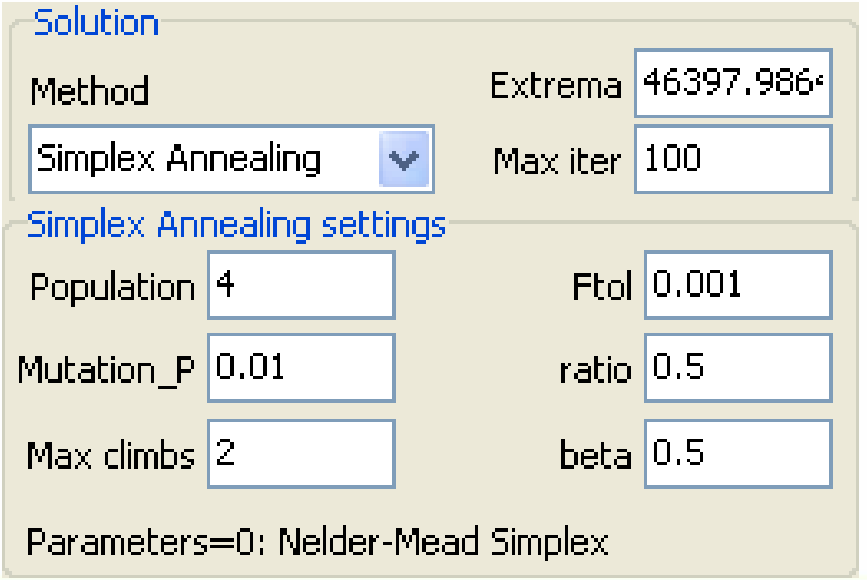


Optimization module

- Gradient Method
- Genetic Algorithm
- Simplex Annealing
- Select variables (with limits) and cost function
- Loops ATP (serial/parallel)
- Writes back final variable values

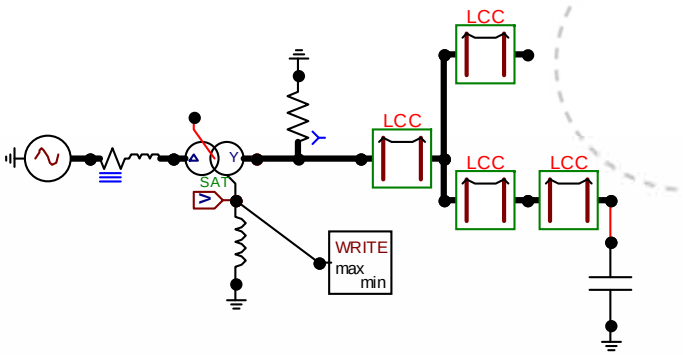


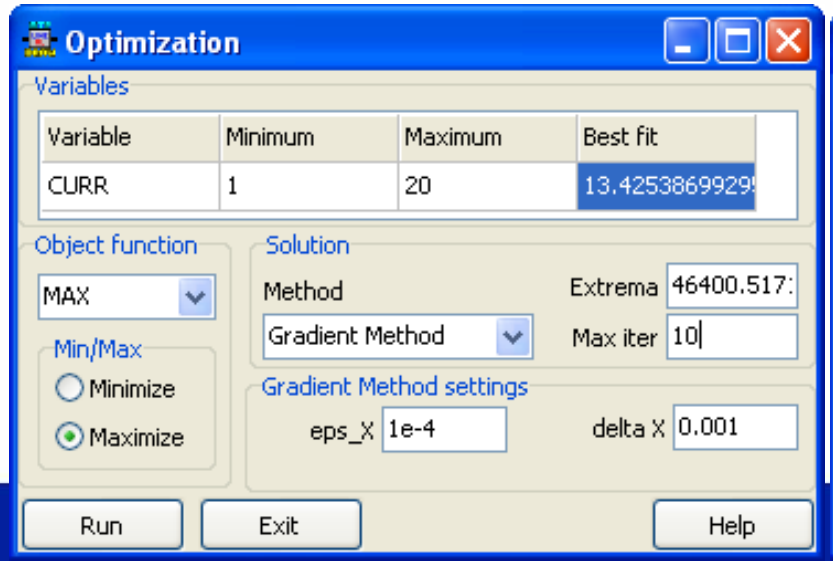


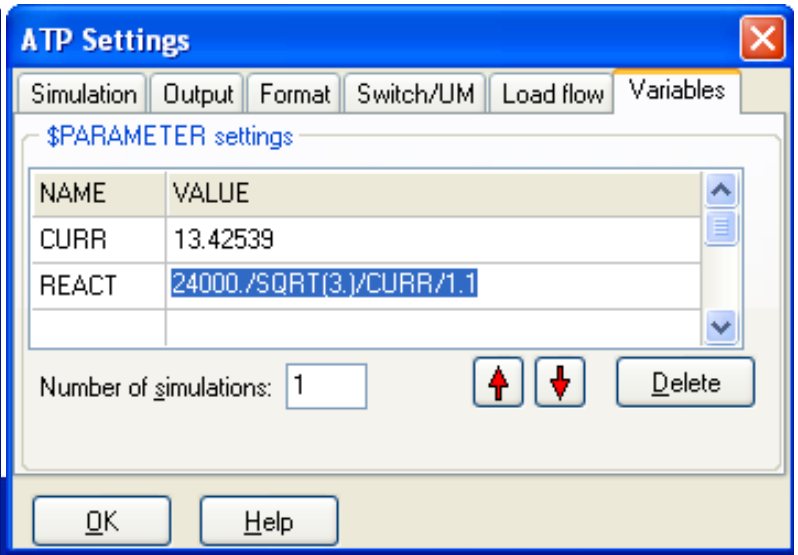


Example I: Resonance coil tuning

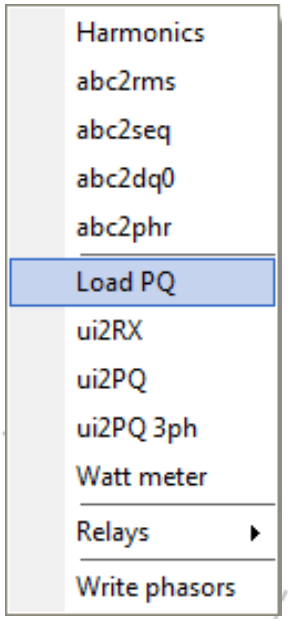
- How to set the coil to 10 % over-compensation?
- 1: Define reactance REACT of coil as variable
- 2: Define CURR as a local variable
- 3: Add cost function to neutral voltage
- 4: Run Optimization
- 5: Divide REACT by 1.1



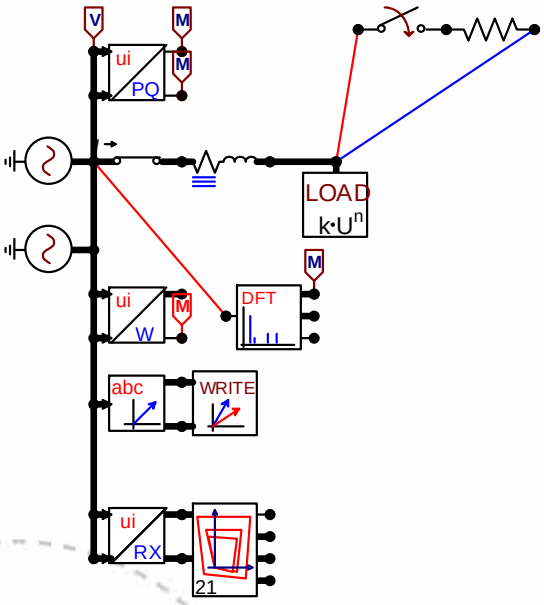


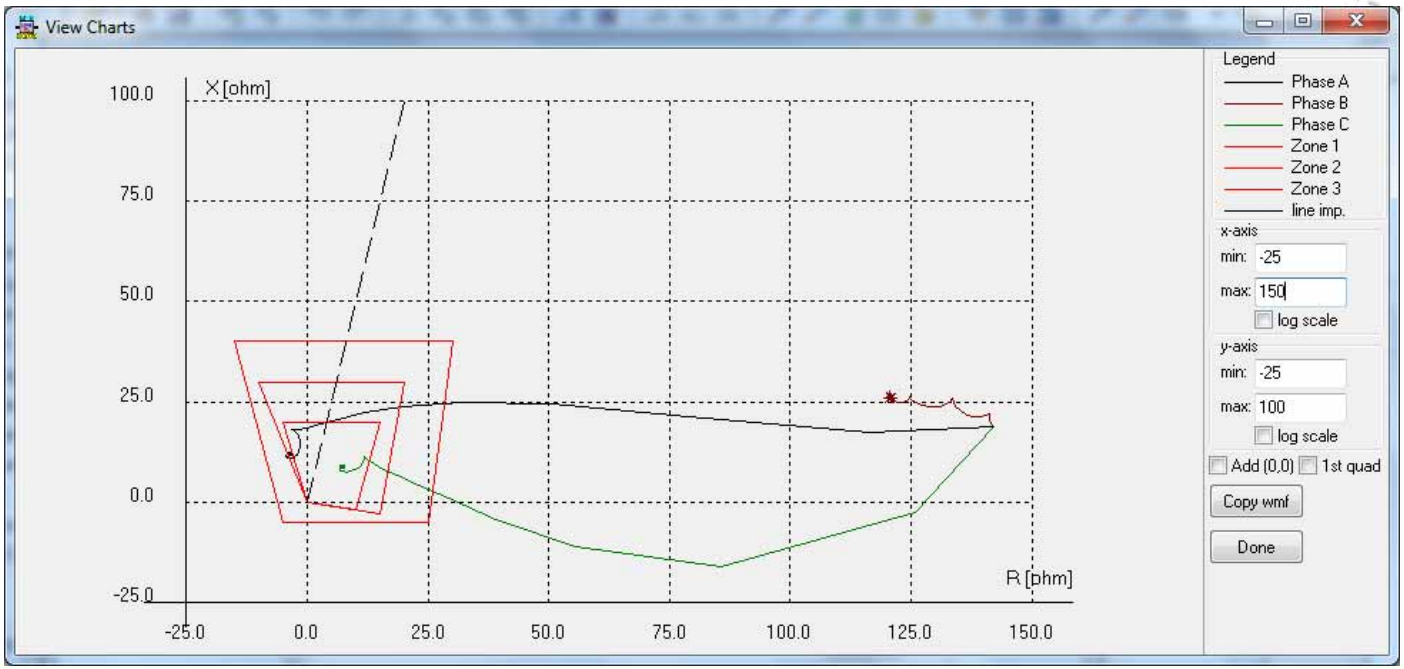


Latest news version 5.9



- Power system tools
  - Phasors, power and RX calculation with DFT
  - Plot phasors
  - Distance and differential relay trajectories





Latest news version 5.9

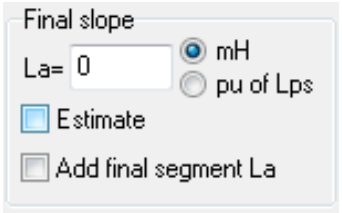
- Internal parser (TbcParser)
  - Assign a global variable to component data. Can be a function of the simulation number; KNT in multiple runs.
  - Alternative to ATP's $PARAMETERS. Almost transparent except for the logical operators.
  - Benefit; allows parameterization of all data also those involved in internal calculations (source amplitudes and phase shifts, line lengths etc.). Relaxed restrictions in the @FILE and @[] syntax.
- Sidebar shoutbox
  - Chat with all online users.
- Synchronous machine improvements
- Plot window enhancements

Latest news version 5.8

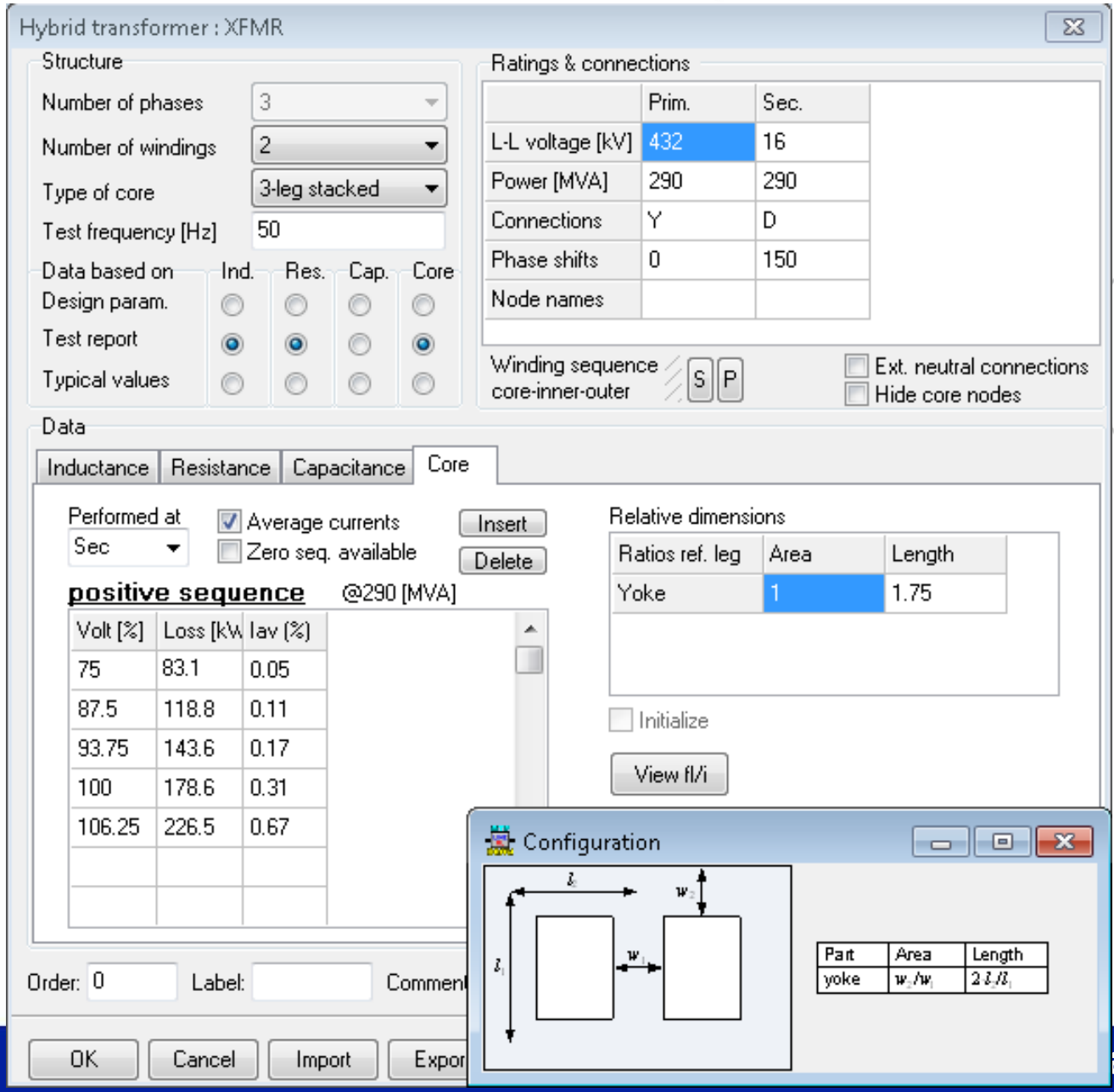
- Hybrid transformer further developed (4 windings, zigzag, enhanced core settings, new R(f) options)
- New synchronous machine 58/59 with multi-masses and output control.
- LCC template. Cross section in a template object, length in a new LCC section object referencing the template. Optional single phase view of LCC section.
- BCTRAN corrections.
- Grouping of MODELS. UseAs surfaced.
- Enhanced voltage probes.
- Web and MySQL connection. Upload/download, forum.
- Support of png images. Far better zooming of images.

Hybrid transformer

- Extended to 4 windings
- Y, D, Auto, Zigzag
- New winding sequence specifier
- Core node select
- Final slope enhancements

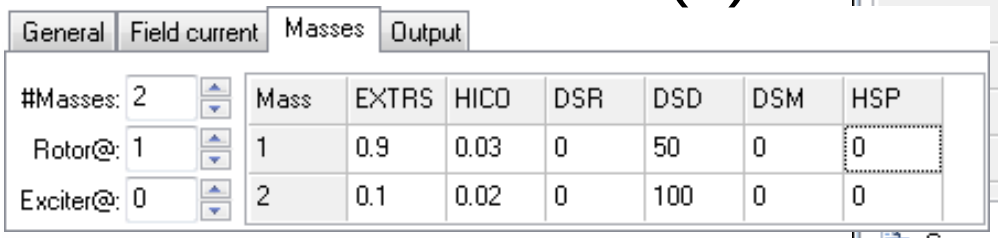


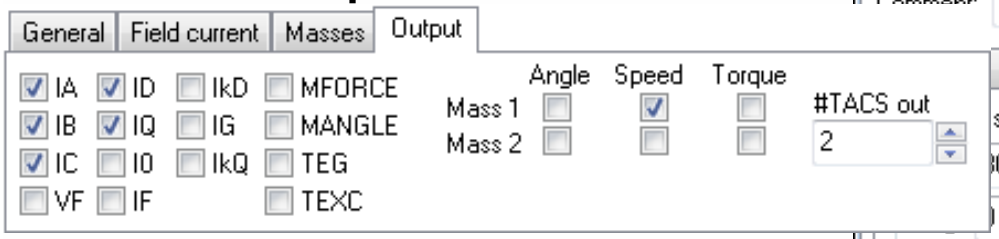
- Copper loss enhancements

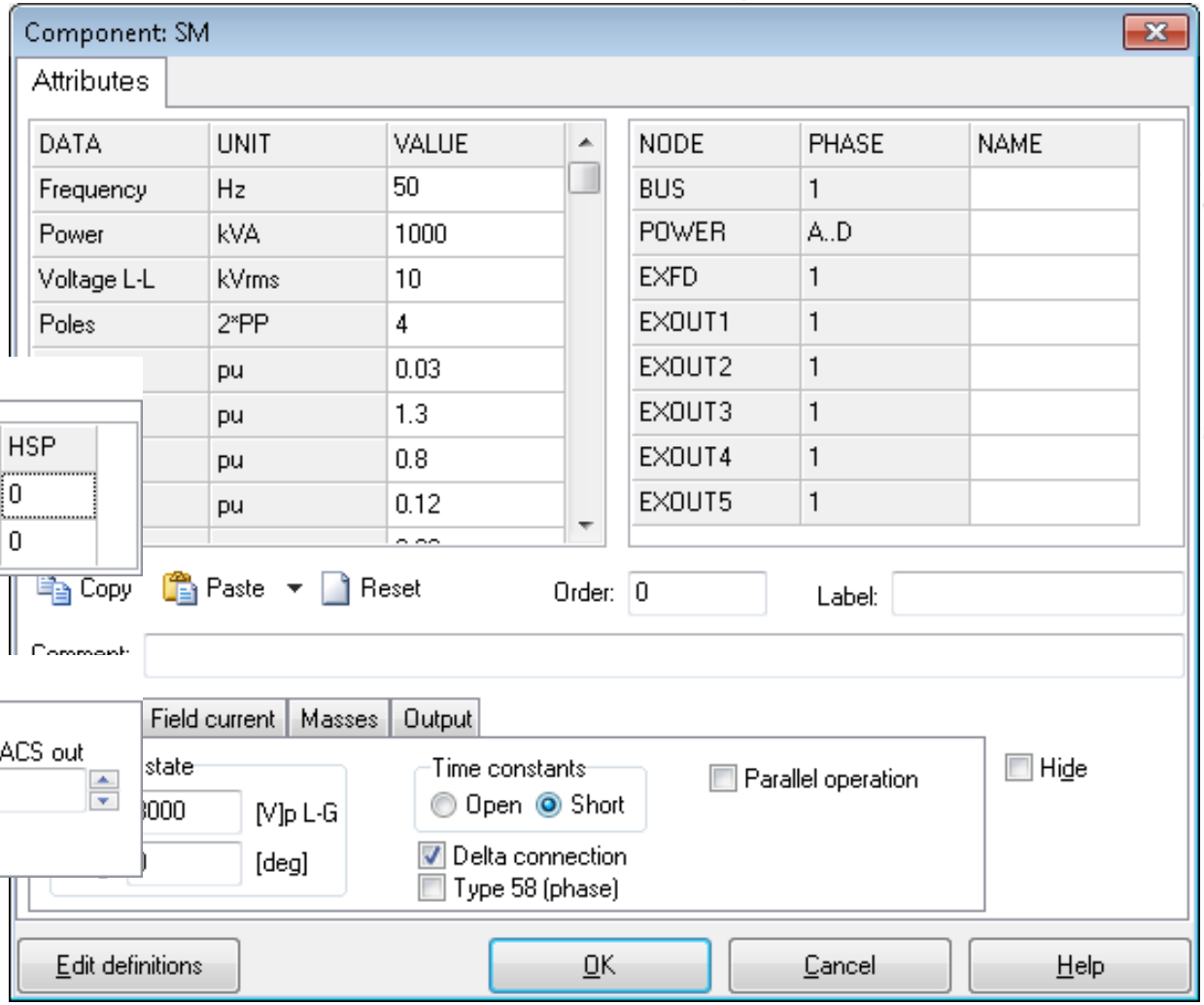


New synchronous machine

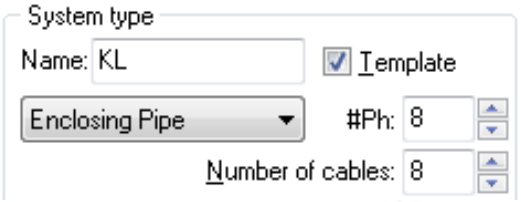
- Manufacturers input similar to UM
- Support of type 58
- Multi-masses (4)
- Output control
- Dynamic TACS output (5)



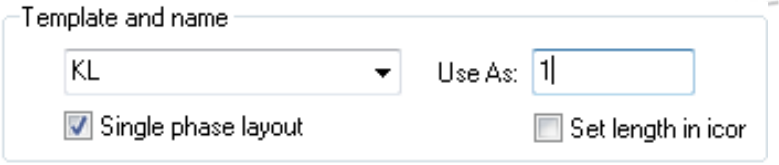




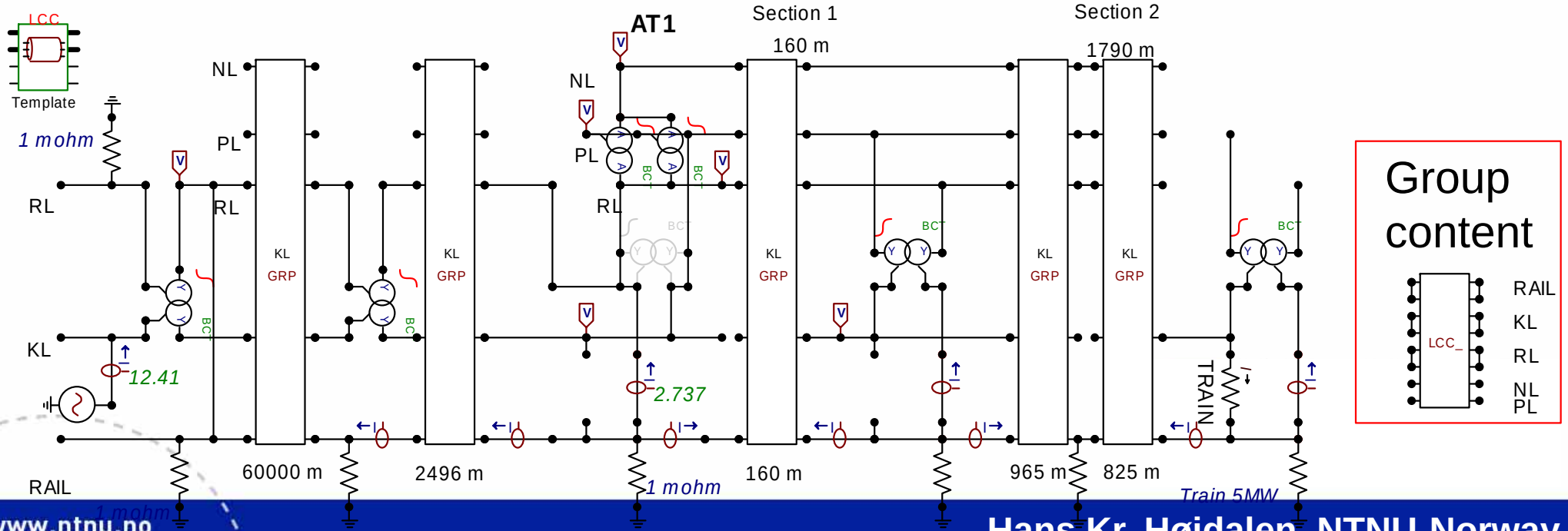
LCC template/section



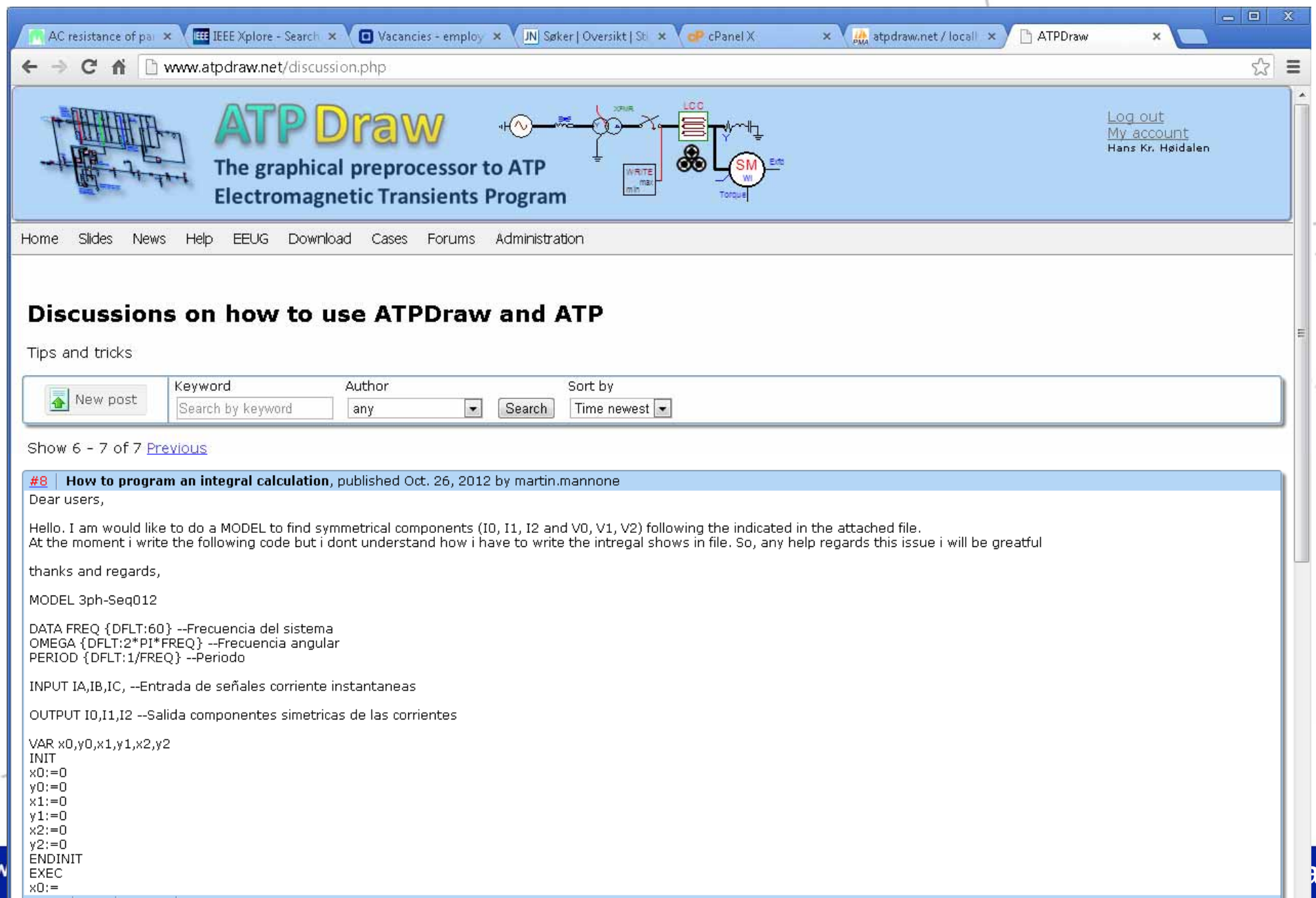
- LCC object has property Template
  - If ‘on’ the object becomes a dummy component not written to the ATP-file
- New LCC section reference by Name.
  - Holds section length. Single phase option.



- Complicated railway study where new approach is useful:

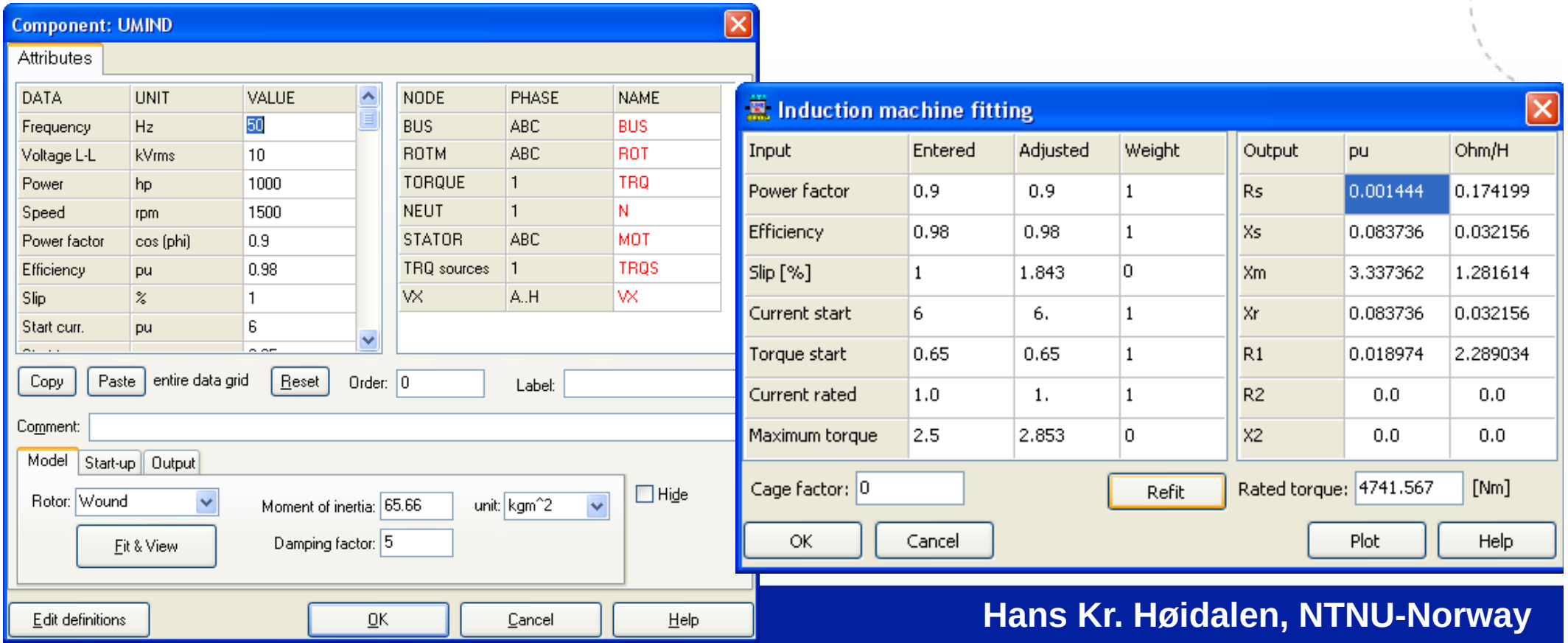


Web – page and forum



Embedded Windsyn

- Direct support of Windsyn features
  - ATPDraw has embedded induction machine fitting with extended user control (incl. Tmax fitting)
  - Convergent gradient method for fitting cost function
  - More flexible start-up, output control and T/ω plotting

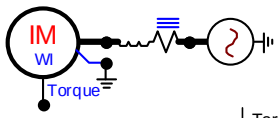


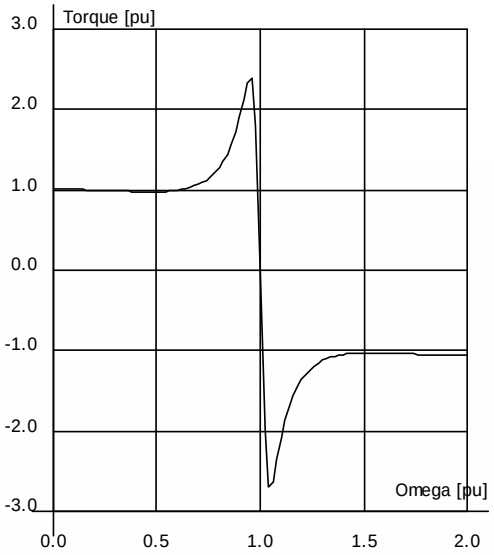
Windsyn in ATPDraw

- Windsyn relaxes the fitting of the slip while ATPDraw now offers this as a part of the cost function
- Windsyn does the fitting iteratively without adjusting the stator resistance when slip, efficiency or power factor becomes different
- Bug fixes (hp conversion, round-off error, mechanical vs. electrical power, motor vs. generator efficiency)
- The TACS section made smoother with less variables (kVAR, kWAT, PUVT, PUTM, Slip)
- Only relevant nodes presented in the icon (no field voltage node, only rotor winding node for wound rotor)
- No need to rerun the fitting when the type of initialization or compensation/prediction change

Example

- Create double-cage IM model





Induction machine fitting

Input	Entered	Adjusted	Weight
Power factor	0.9	0.783	1
Efficiency	0.98	0.979	1
Slip [%]	1	0.697	0.01
Current start	6	6.113	1
Torque start	1	1.006	1
Current rated	1.0	0.981	10
Maximum torque	2.5	2.411	0

Output	pu	Ohm/H
Rs	0.011808	1.238828
Xs	0.069449	0.023193
Xm	1.848059	0.617172
Xr	0.069449	0.023193
R1	0.047356	4.96841
R2	0.009116	0.956439
X2	0.056472	0.018859

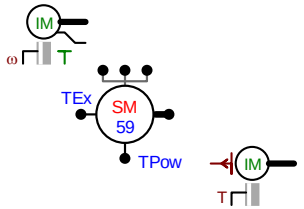
Cage factor: 1 | Refit | Rated torque: 4680.207 [Nm]

OK | Cancel | Plot | Help

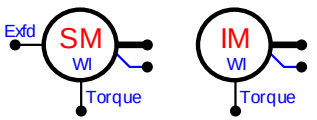
- Tuning of weight factors required to get rated current.

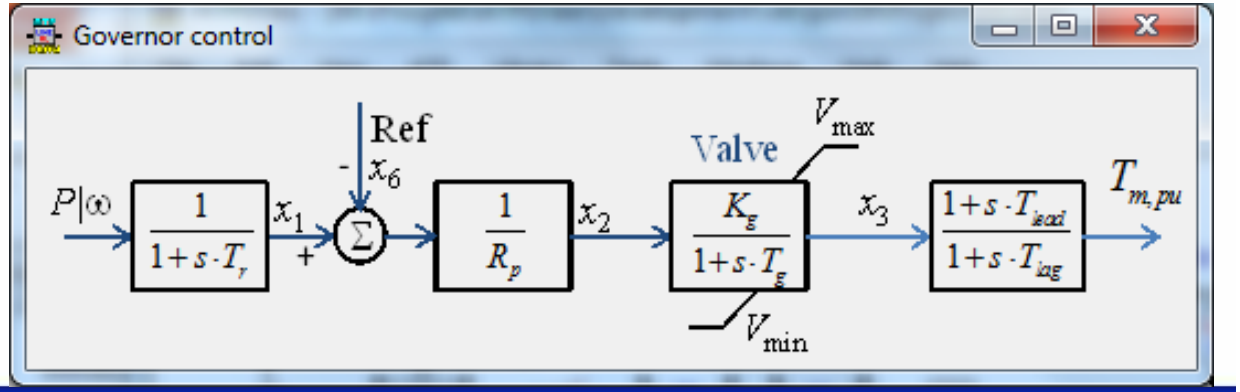
Machines

- The following types are supported
  - Universal machine
  - Type 59/58 synchronous machine
  - Type 56 induction machine



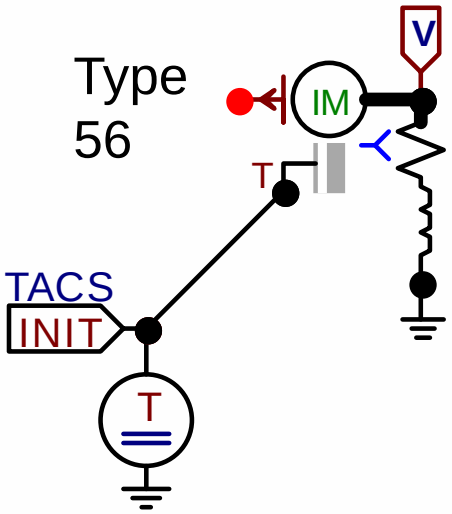
- Embedded, adapted Windsyn support
  - Manufacturer data input
  - Start-up facilities
  - Embedded controls (exciter, governor)

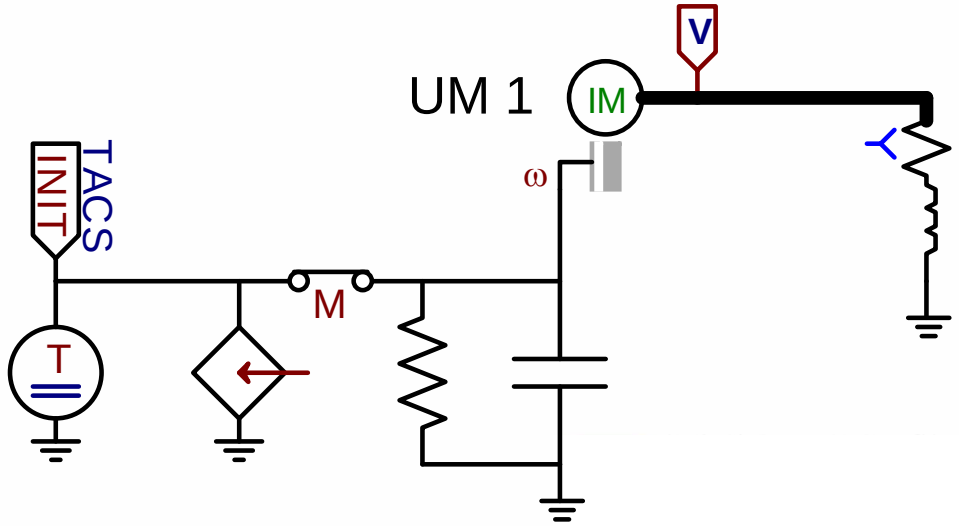




Type 56 machine

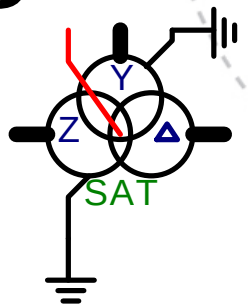
- Initial support in ATPDraw
  - Improvements required (TACS control, combination with UM)
- Brand new versions of ATP and PlotXY required
- More numerically stable (phase domain)
- Limitations on the mechanical side and in rotor coils

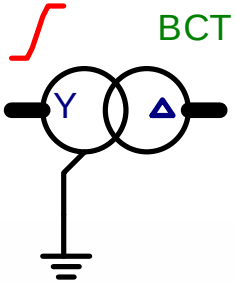


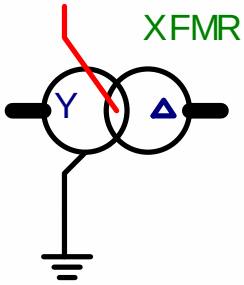


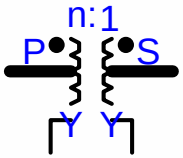
Transformer modeling

- Saturable Transformer
- BCTRAN
- Hybrid Transformer
- Ideal







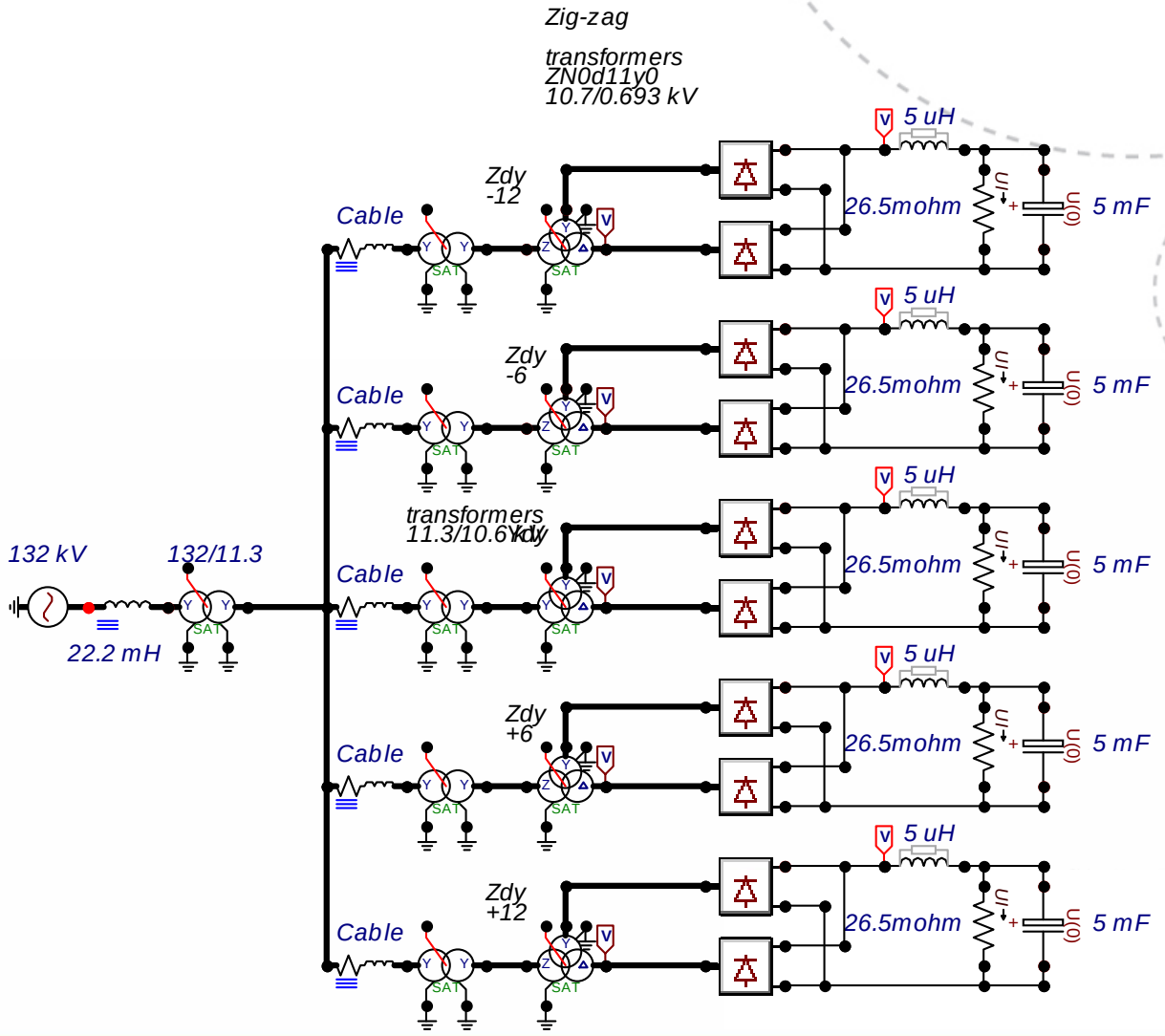


Saturable transformer

- Zigzag supported

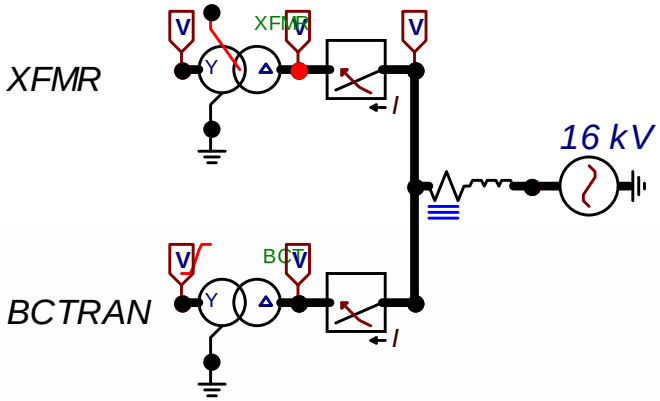
	Prim.	Sec.	Tert.
U [V]	85.92	2.11	1.23
R [ohm]	-0.064193	0.00019	6.6E-5
L [mH,ohm]	1.2260045	0.00973	0.00331
Coupling	Z	D	Y
Phase shift	-12	330	0

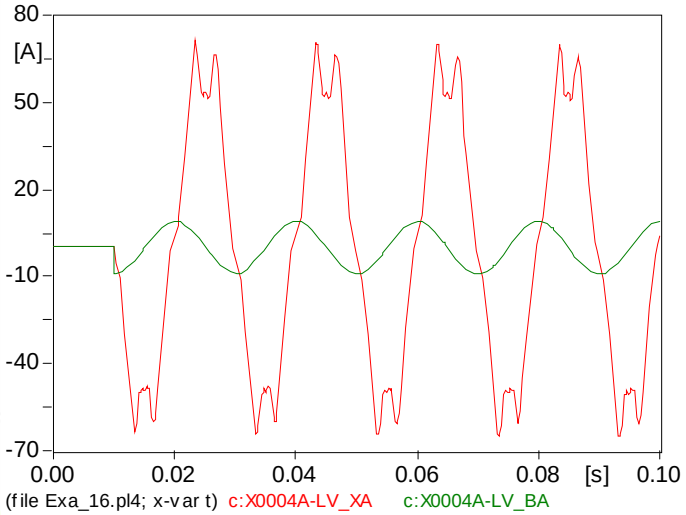
I(0)= 0 Rm= 0 3-leg core
F(0)= 0 R0= 1E12 RMS
3-winding

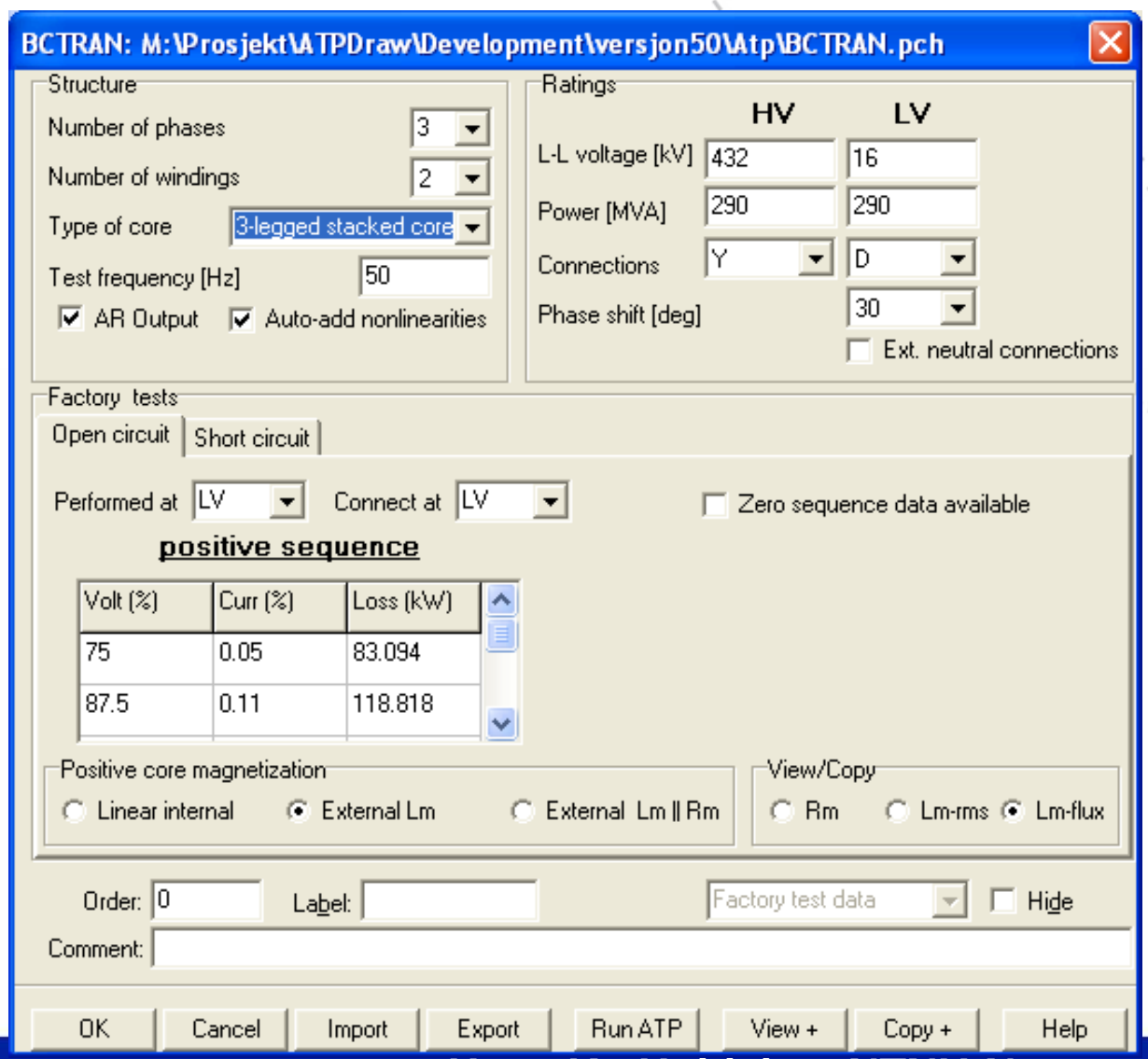


BCTRAN

- Automatic inclusion of external magnetization characteristic





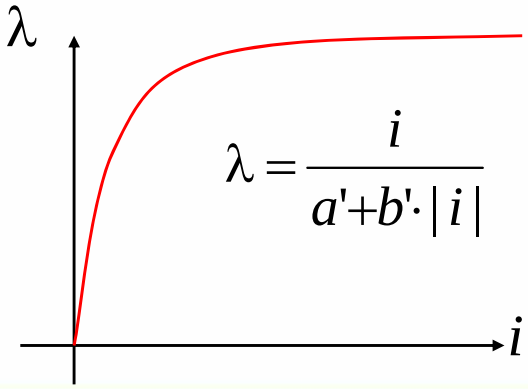


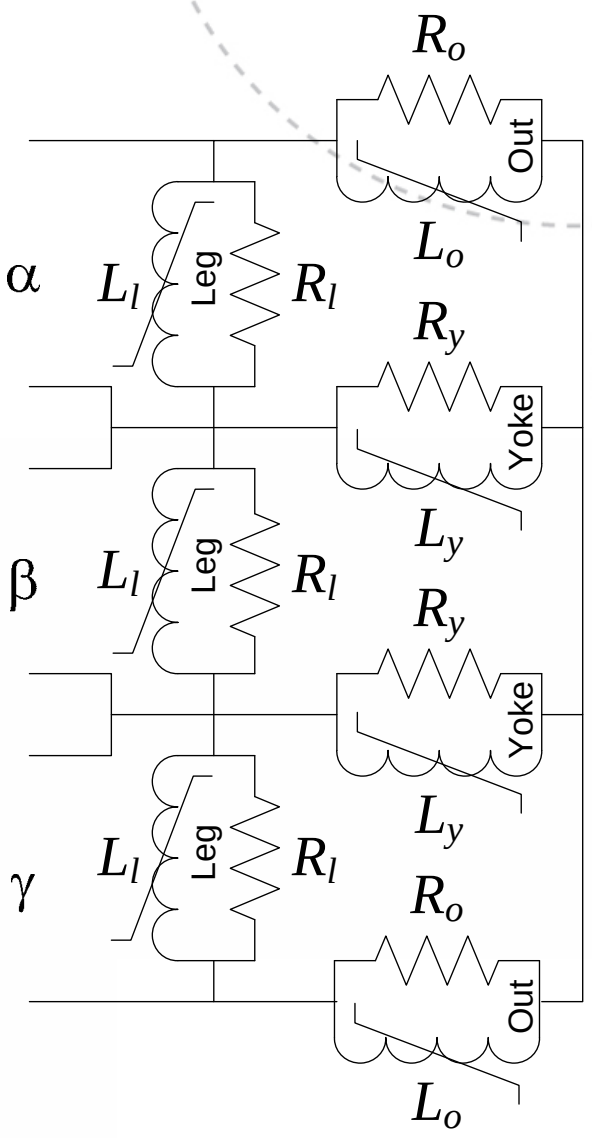
Hybrid Transformer model - XFMR

- Topologically correct
- The model includes:
  - an inverse inductance matrix for the leakage description,
  - frequency dependent winding resistance,
  - capacitive coupling,
  - and a topologically correct core model with individual saturation and losses in legs and yokes. Triplex, 3,5, shell-form cores.
  - Fitting to test report data, given relative core dimensions.
- The user can base the transformer model on three sources of data:
  - **Design parameter**: specify geometry and material parameters of the core and windings.
  - **Test report**: standard transformer tests.
  - **Typical values**: typical values based on the voltage and power ratings.

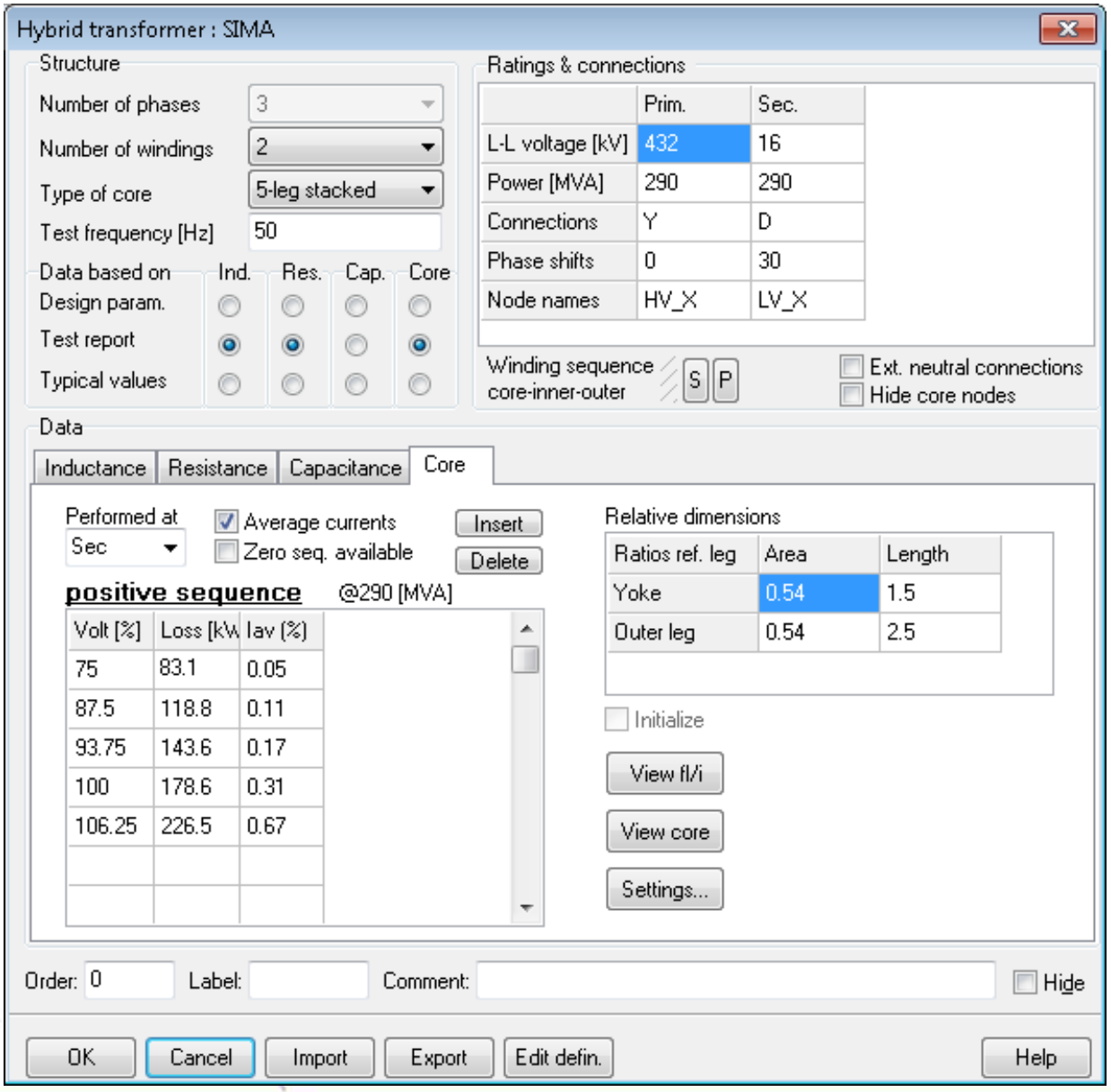
– Core representation

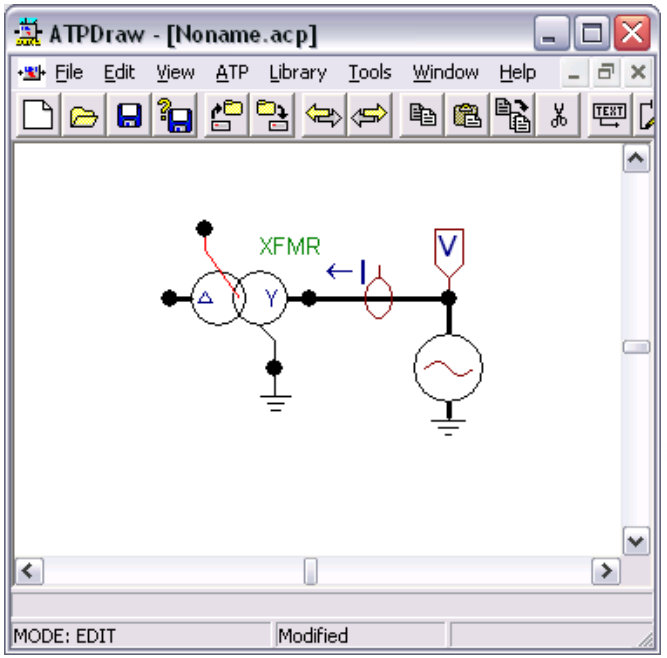
- Attached to the fictitious N+1th winding
- Topologically “correct” core model, with nonlinear inductances representing each leg and limb
  - Triplex
  - 3- and 5-legged core
- Flux linkage-current relation by Frolich equation and relative lengths and areas.
- Fitting to Test Report

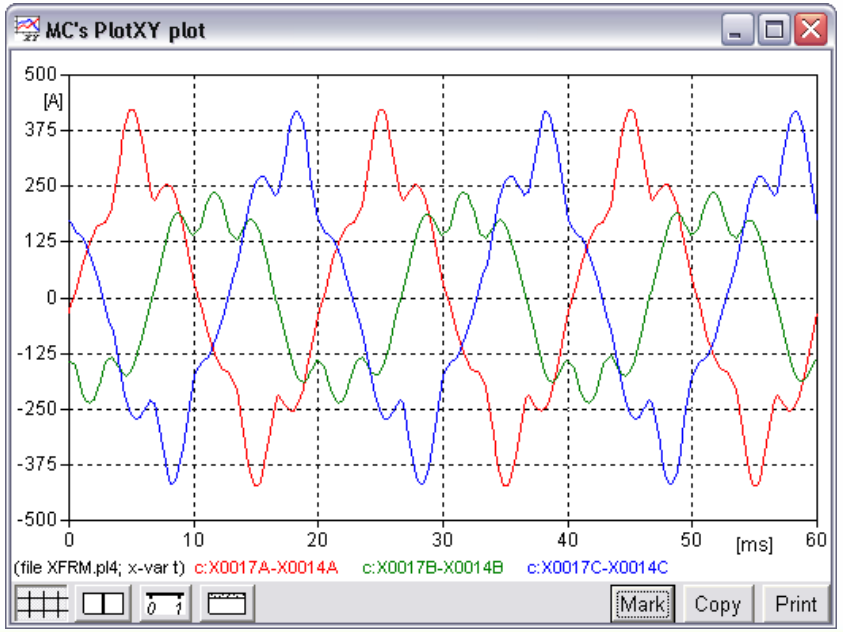




Snapshots

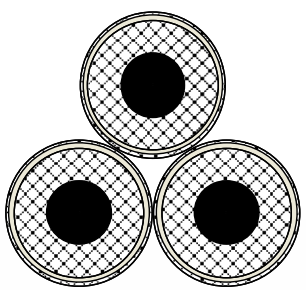

Hybrid transformer : SIMA
Structure
Number of phases
3
Number of windings
2
Type of core
5-leg stacked
Test frequency [Hz]
50
Data based on
Ind.
Res.
Cap.
Core
Design param.
Test report
Typical values
Ratings & connections
Prim.
Sec.
L-L voltage [kV]
432
16
Power [MVA]
290
290
Connections
Y
D
Phase shifts
0
30
Node names
HV_X
LV_X
Winding sequence
core-inner-outer
S
P
Ext. neutral connections
Hide core nodes
Data
Inductance
Resistance
Capacitance
Core
Performed at
Sec
Average currents
Zero seq. available
Insert
Delete
positive sequence
@290 [MVA]
Volt [%]
Loss [kW
Iav [%]
75
83.1
0.05
87.5
118.8
0.11
93.75
143.6
0.17
100
178.6
0.31
106.25
226.5
0.67
Relative dimensions
Ratios ref. leg
Area
Length
Yoke
0.54
1.5
Outer leg
0.54
2.5
Initialize
View fl/i
View core
Settings...
Order:
0
Label:
Comment:
Hide
OK
Cancel
Import
Export
Edit defin.
Help

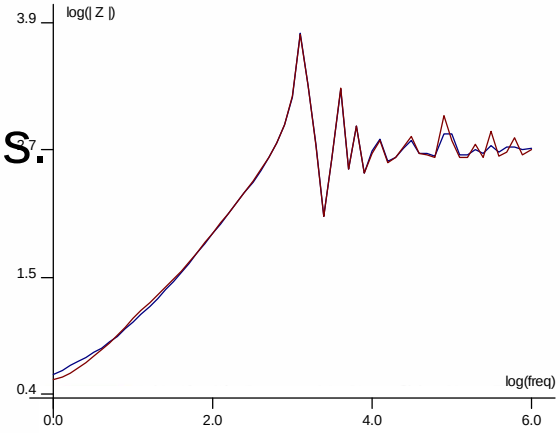

ATPDraw - [Noname.acp]
File
Edit
View
ATP
Library
Tools
Window
Help
XFMR
V
MODE: EDIT
Modified


MC's PlotXY plot
500
[A]
375
250
125
0
-125
-250
-375
-500
0
10
20
30
40
50
[ms]
60
(file XFRM.pl4; x-var t) c:X0017A-X0014A c:X0017B-X0014B c:X0017C-X0014C
Mark
Copy
Print

Line/Cable modeling

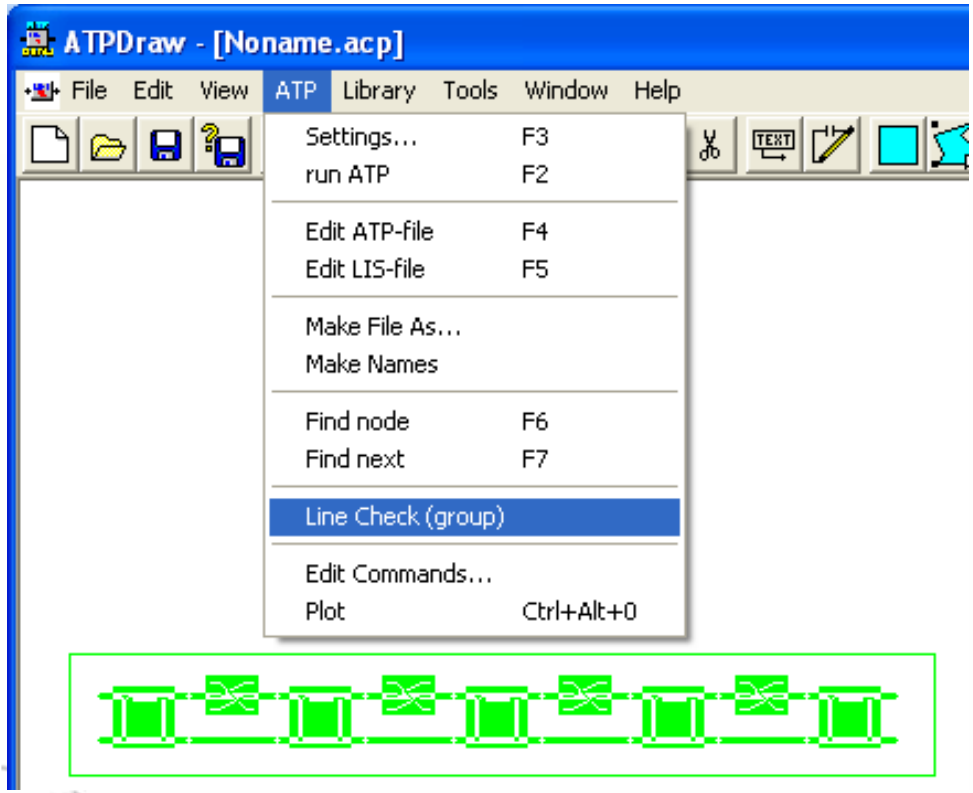
- Line/Cable Constants, Cable Parameters
  - Bergeron, PI, JMarti, Semlyen, Noda(?)
- View
  - Cross section, grounding
- Verify
  - Frequency response, power frequency params.
- Line Check
  - Power freq. test of line/cable sections

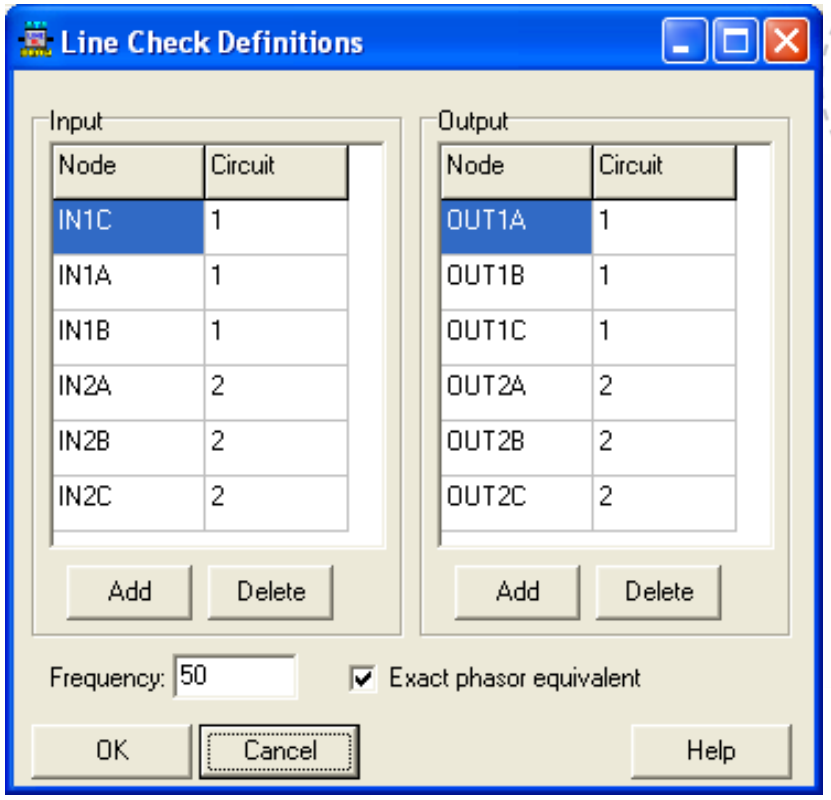




Line Check

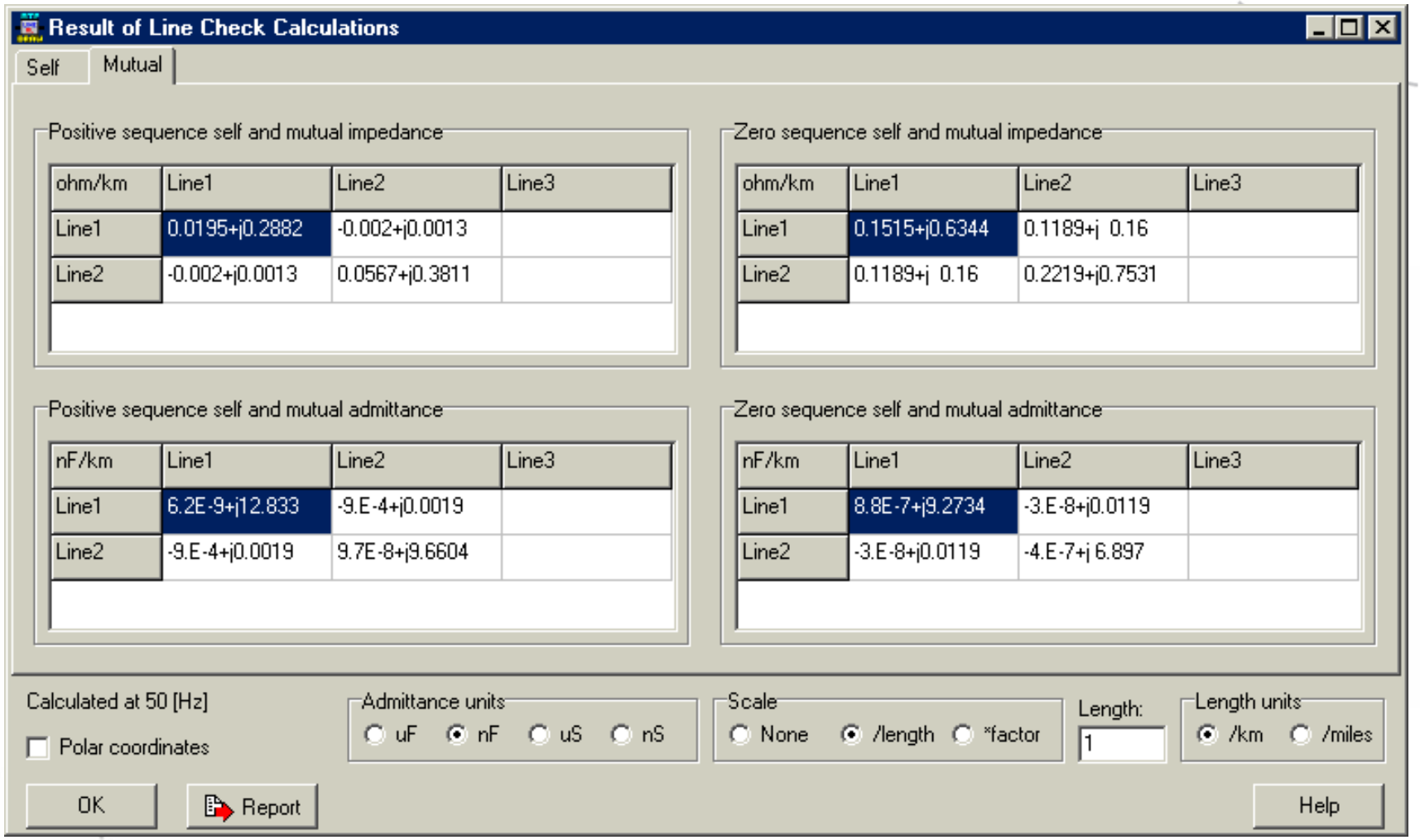
- The user selects a group in the circuit
- ATPDraw identifies the inputs and outputs (user modifiable)





Line Check cont.

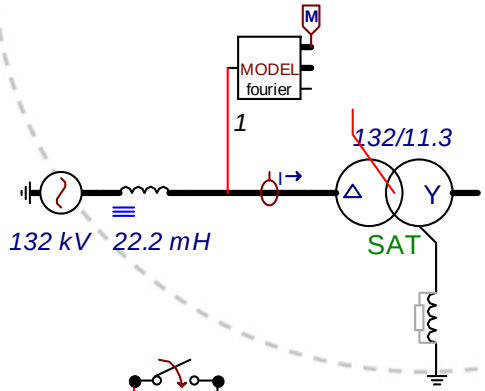
- ATPDraw reads the lis-file and calculates the series impedance and shunt admittance

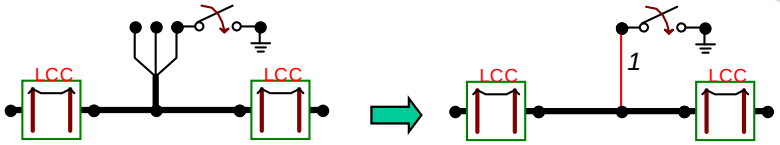


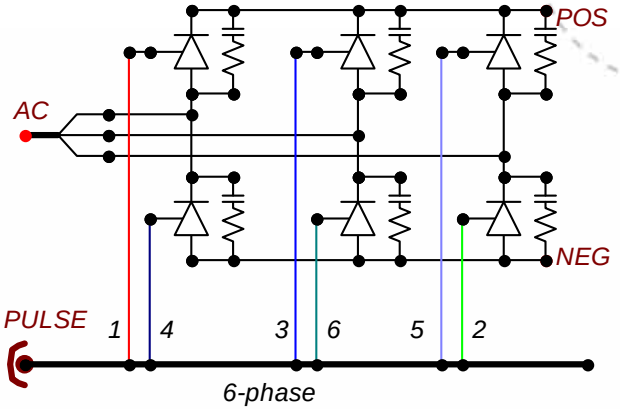
Latest news, Version 5.0 available from October 2006

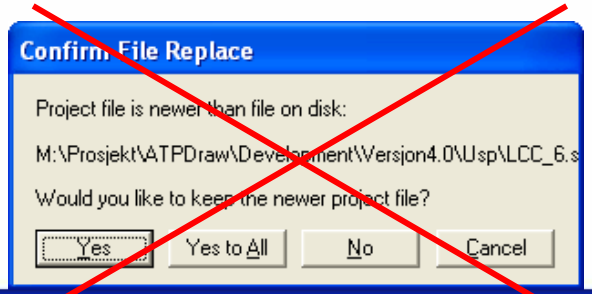
Sponsored by BPA & EEUG

- **Vector graphics**
  - Improved zoom
  - Larger, dynamic icon; RLC, transformer, switch…
  - Individual selection area
- **Multi-phase nodes**
  - 1..26 phases, A..Z extension
  - MODELS input/output X[1..26]
  - Connection between *n*-phase and single phase
  - 21 phases in LCC components
- **New file management**
  - Project file follows the PKZIP 2 format. Improved compression. acp-extension.
  - Sup-file only used when a component is created.
  - External data moved from files to memory.
  - Individual, editable help strings for all components.



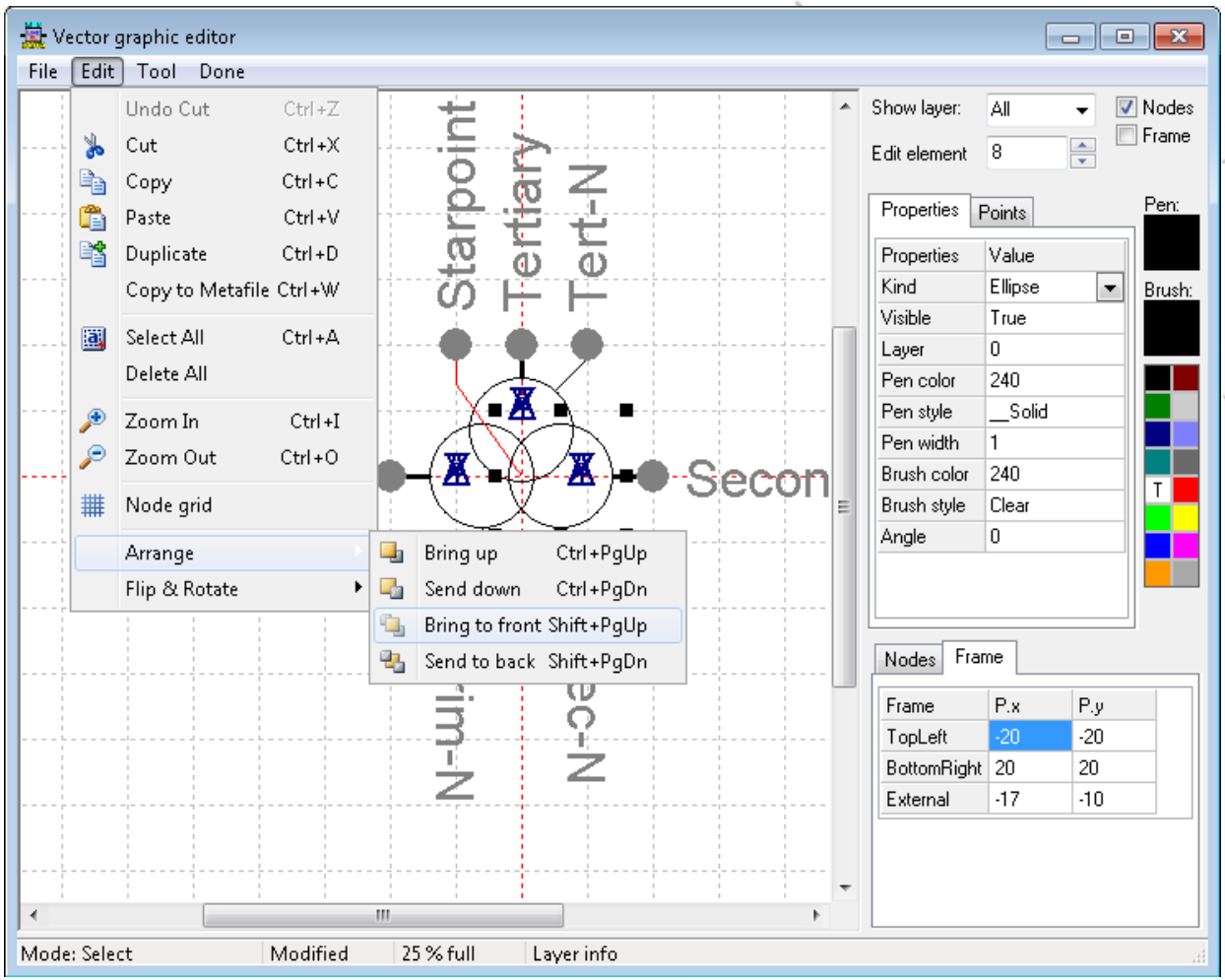






Vector graphic editor

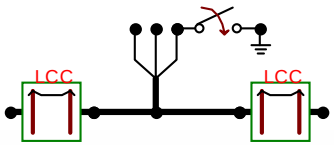
- Shapes (line, rectangle, polyline, polygon, ellipse, arc, pie, bezier, arrow)
- Text
- Nodes and frame
- Inspect by element id or layer
- Edit point, drag, edit values and properties
- Arrange, rotate/flip
- Grouping for move/copy



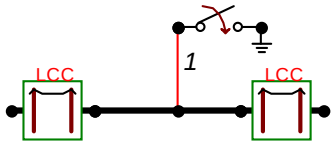
Example 1

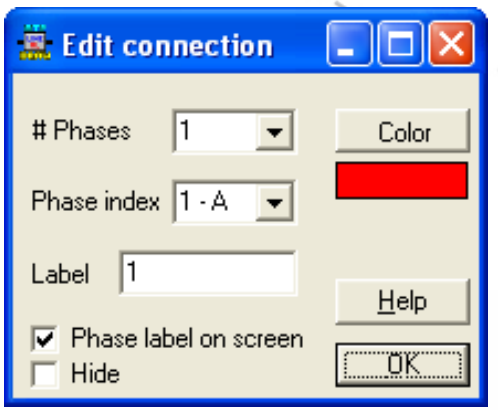
- Single phase to 3-phase connection

Old:



New:

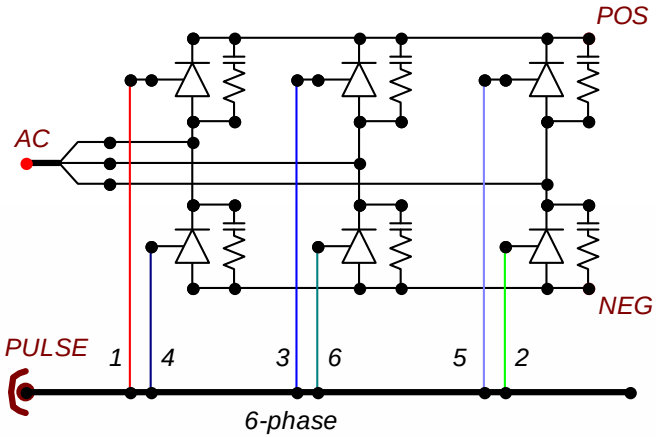


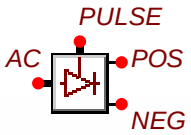


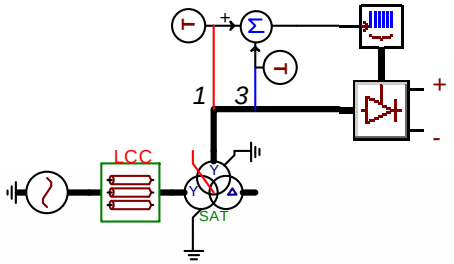
- The Splitter carries Transpositions the single phase connection not.

Example 2

- Multi-phase groups



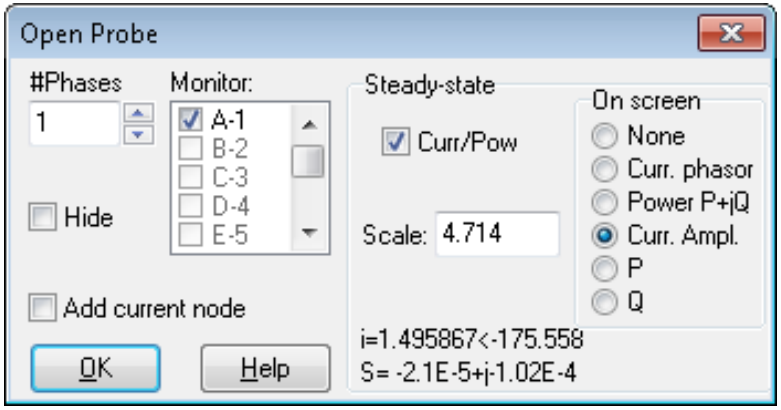


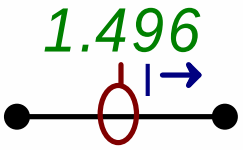


- New component: Collector

Extended probe capabilities

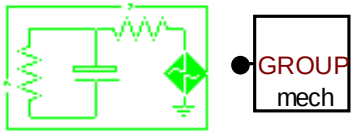
- Steady-state performance
- Reads the LIS file
  - Monitor 1-26 phases
  - Display scaled steady-state values

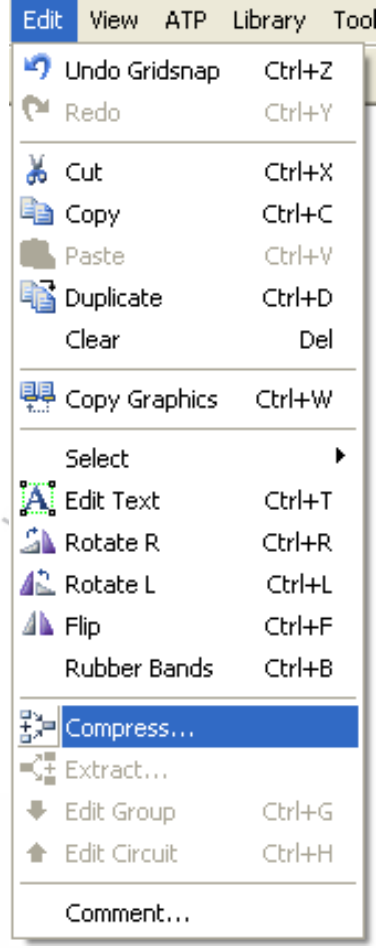


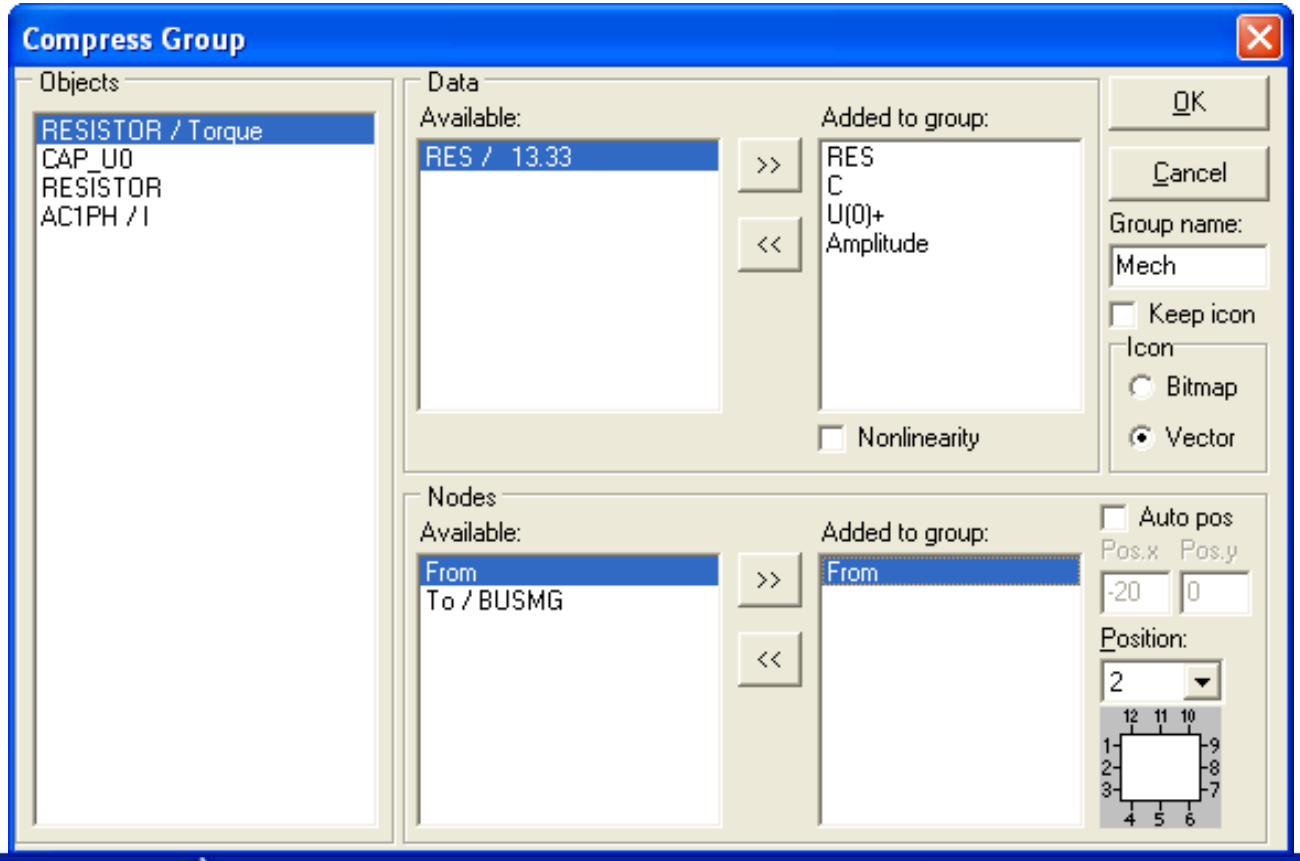


Grouping

- Select a group (components, connections, text)
- Click on Edit|Compress
- Select external data/nodes

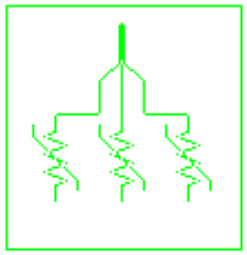


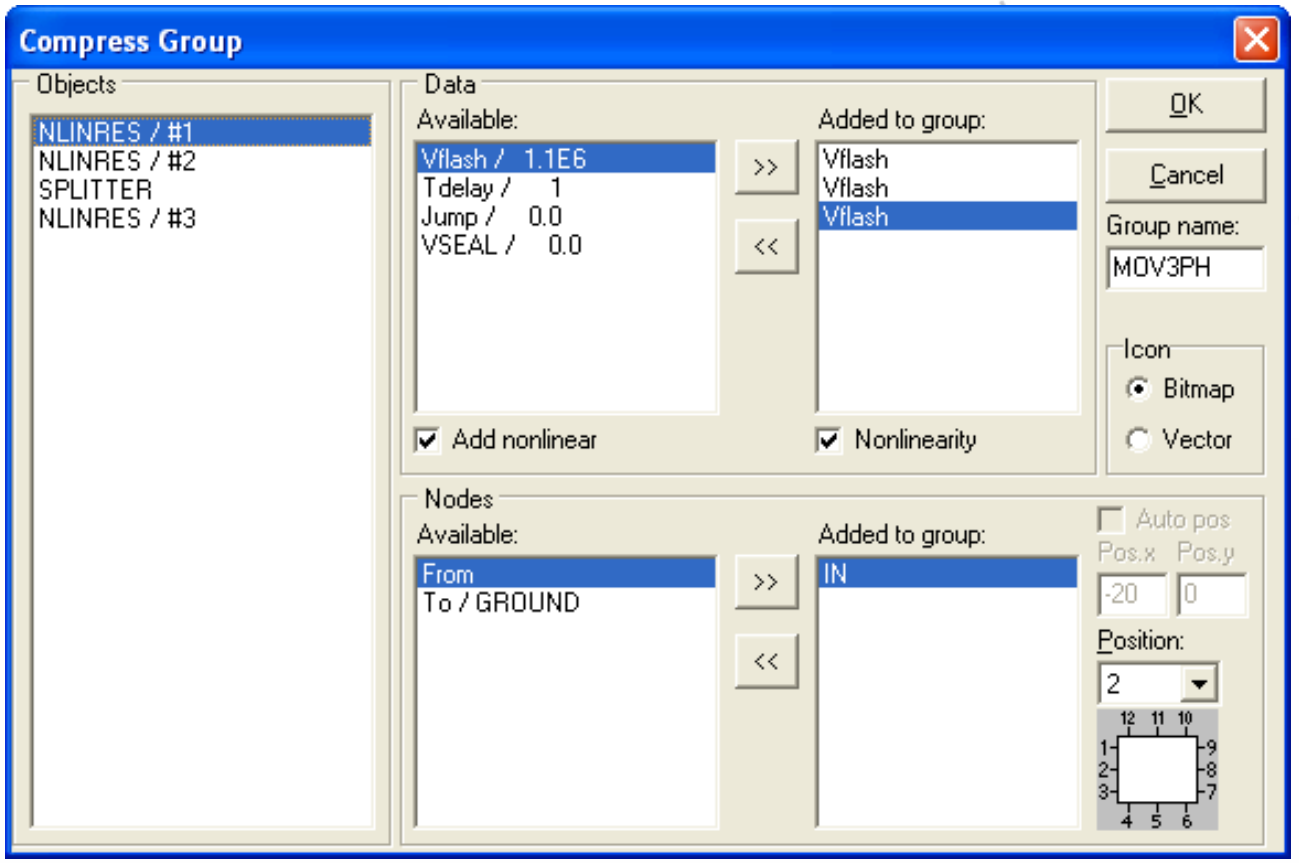


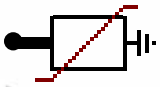


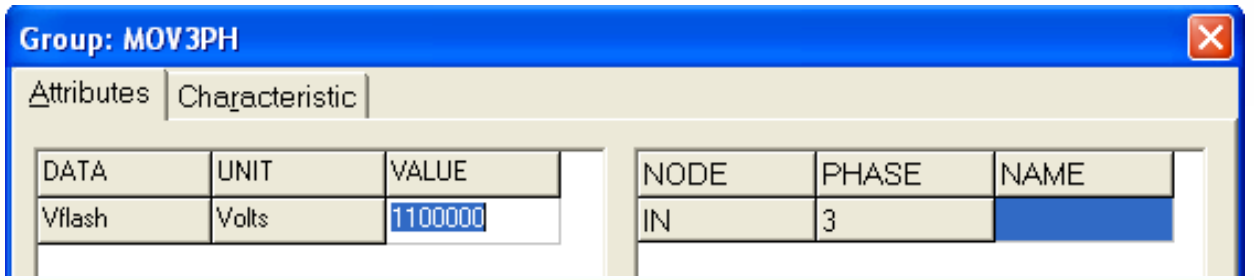
- Data with the same name appear only once in the input dialog
- Double click on name to change
- Nonlinear characteristic supported

Example Create 3-phase MOV



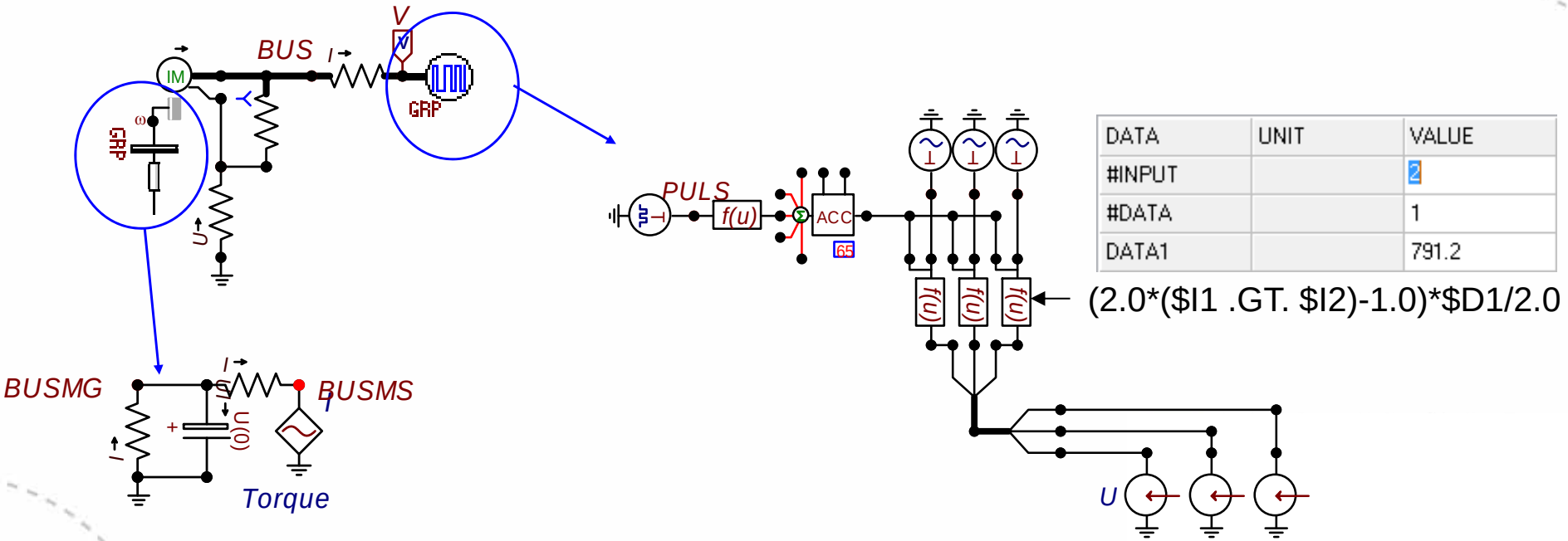






Example – Induction motor

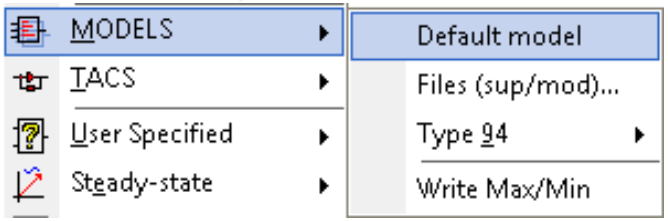
- Induction motor fed by a pulse width modulated voltage source
- External mechanical load
- TFORTRAN components in TACS $I1..9, $D1..9 (group becomes transparent and possible to copy)

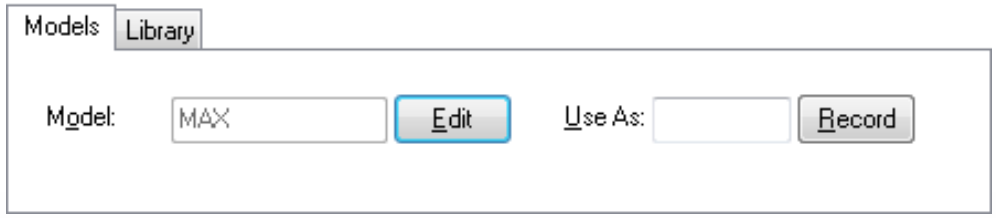


DATA	UNIT	VALUE
#INPUT		2
#DATA		1
DATA1		791.2

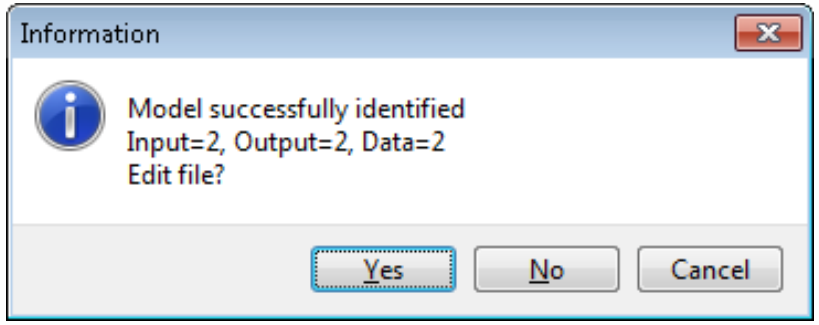
Models

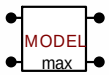
- Select Models|Default model
- Edit the Models text





- ATPDraw reads the Model text and identifies the circuit components with input/output/data





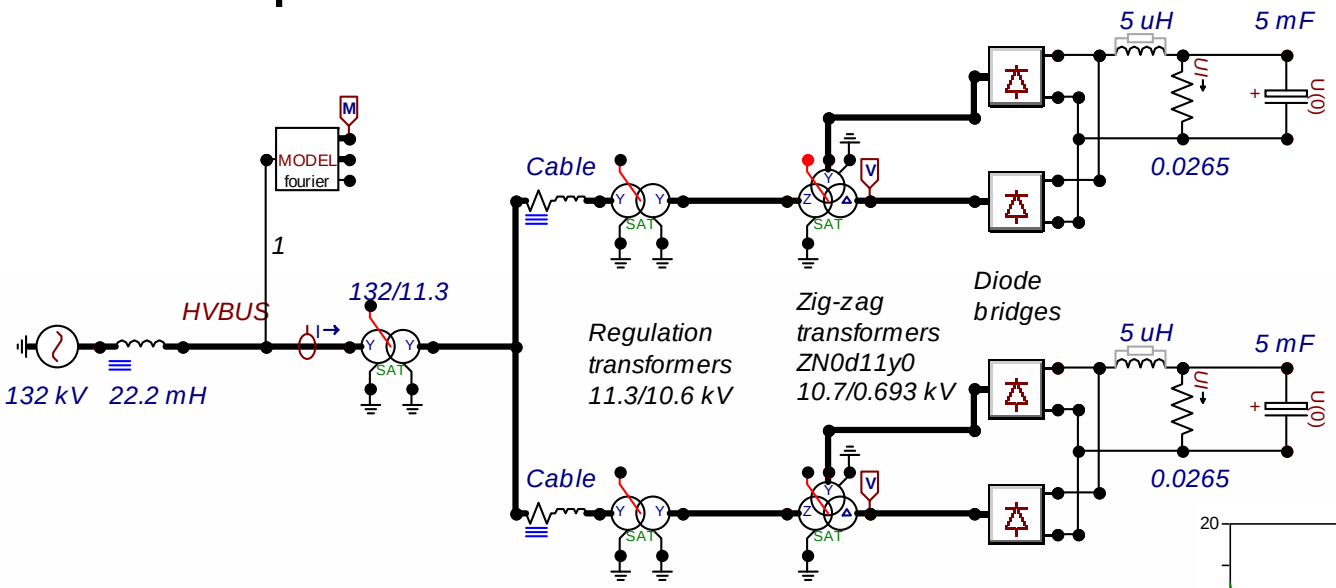
- Multi-phase nodes (26) and indexed data supported

Example

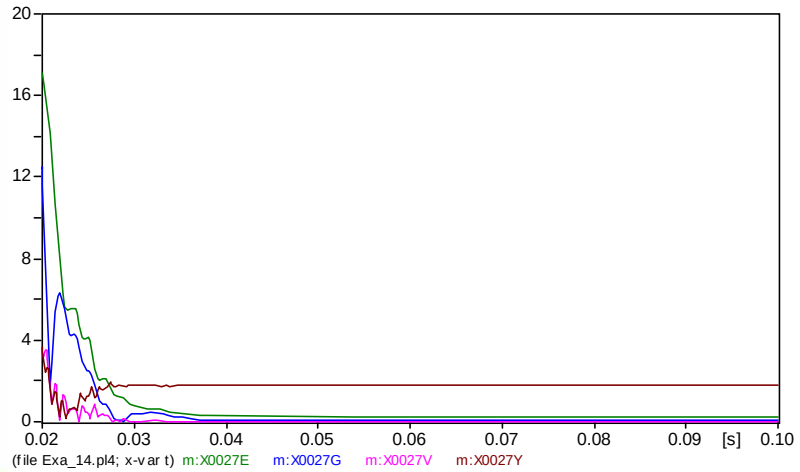
```
MODEL FOURIER
INPUT X                --input signal to be transformed
DATA  FREQ {DFLT:50}   --power frequency
      n {DFLT:26}      --number of harmonics to calculate

OUTPUT absF[1..26], angF[1..26],F0 --DFT signals
VAR    absF[1..26], angF[1..26],F0,reF[1..26], imF[1..26],
       i,NSAMPL,OMEGA,D,F1,F2,F3,F4
```

- Multi-phase Models

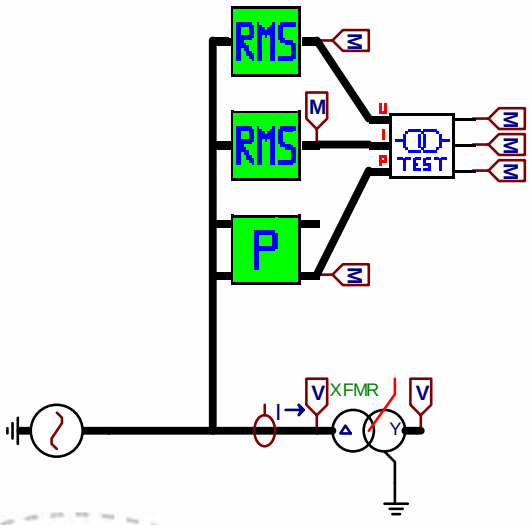


- New Model probe



Example – Transformer tester

- Pocket calculator
- RMS and Power calculation
- TTester: Averaging, printout

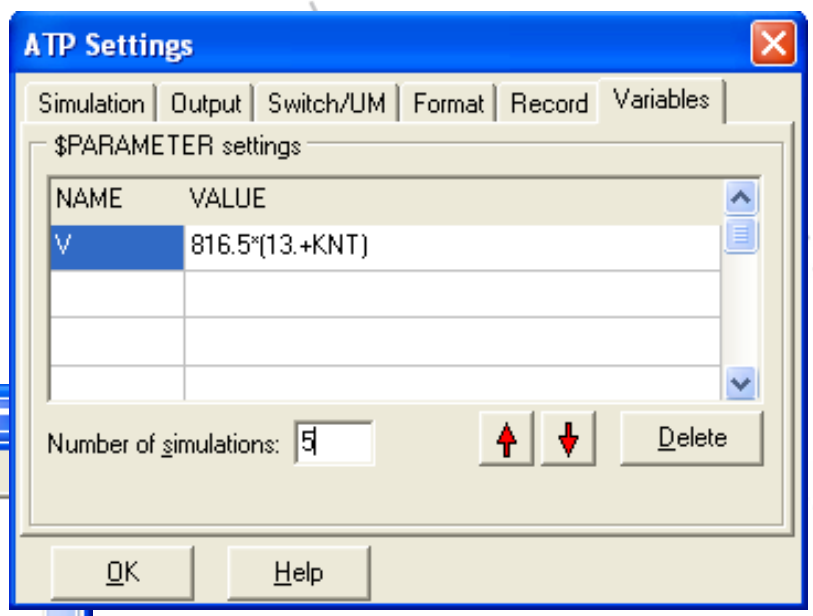


Text Editor

File Edit Character Done Help

```
MODEL TTester
DATA FREQ, np, Us,Is,Ps
INPUT U[1..3],I[1..3],AP[1..3]
OUTPUT Volt, Curr, Pow
VAR Volt, Curr, Pow, Flag
INIT
  Flag:=0
ENDINIT
EXEC
  Volt:=0
  Curr:=0
  Pow:=0
  FOR p:=1 to np DO
    Volt:=Volt+sqrt(3)*U[p]/np/Us
    Curr:=Curr+I[p]/np/Is
    Pow:=Pow+AP[p]/Ps
  ENDFOR
  IF t>=2*recip(FREQ) AND Flag=0 THEN
    Flag:=1
    write1(Volt,' ', Curr,' ', Pow)
  ENDIF
ENDEXEC
ENDMODEL
```

1:1



ResultDir\model.1

87.5003664	.17121764	131.434758
93.7503926	.220581306	151.751037
100.000419	.35109472	173.603833
106.250445	.743208151	196.896531
112.500471	2.85953651	221.288092