ACT: Electronic Transformer v2.0 for Maxwell 2021R1

January 2021

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Electronic Transformer Overview

- What does the “Electronic Transformer ACT” do?
  - → It automatically sets up a ready-to-solve Maxwell 3D Eddy Current design for magnetic components. Permeability is linear and frequency dependent. Steinmetz core loss coefficients are frequency dependent. A frequency dependent state-space model can be created for Simplorer (and Pspice using Network Data Explorer).
- What devices can be modeled?
  - → It is intended for electronic ferrite core transformers and inductors
- How easy is it to use?
  - → ACT consists of three input steps which can be setup in 5-10 minutes
- Are any manufacturer libraries included?
  - → Philips and Ferroxcube libraires with 15 core shapes are included in this release

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Electronic Transformer Release 2021R1: What's new?

1. Number of transformer windings (sides) is unlimited. Now you can create as many sides as you have layers such as: Primary, Secondary, Tertiary, etc
2. Winding sides can be connected in arbitrary series or parallel combinations
3. Thermal properties for windings are included for further two-way coupling with thermal tools like Icepak and Fluent
4. Auto skin layers: if thickness of the conductor is less than 3 values of skin depth then ACT will automatically generate additional layers for mesher to capture eddy effects
5. Calculates leakage inductance between all windings (sides) and automatically creates a report
6. Excitation strategy is expanded. Now you can have a voltage (or current) winding instead of only current sources
7. Load resistance for secondary windings can be input for loaded conditions
8. Creates field overlays: Mag(J), Ohmic-Loss for windings and Mag(B), Coreloss density for the core
9. By default, simulates a half-model for faster simulation time

Note: Due to added functionality .tab files from the older versions are not supported

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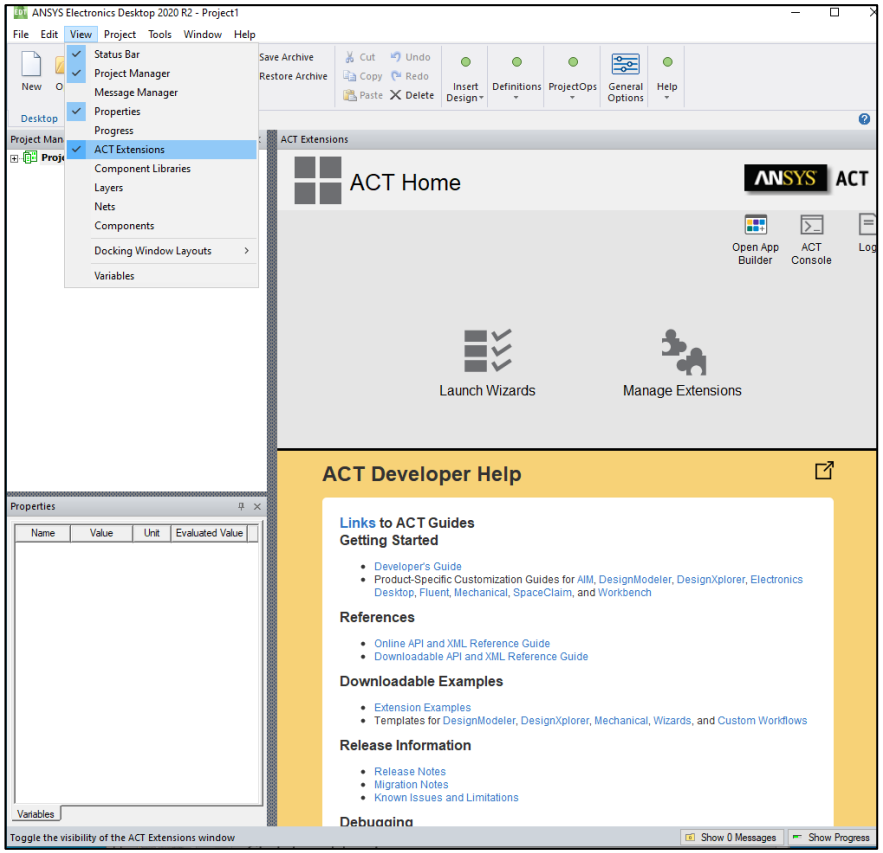
Install the Extension

- Open Electronics Desktop and activate the ACT through

  View -> ACT Extensions
- You can download latest release of Electronic Transformer ACT from GitHub or from Ansys App Store
- Once you have downloaded the app go to Manage Extensions and click on the “+” sign to install extensions, select the *wbex* file downloaded from the ANSYS ACT Application Store.



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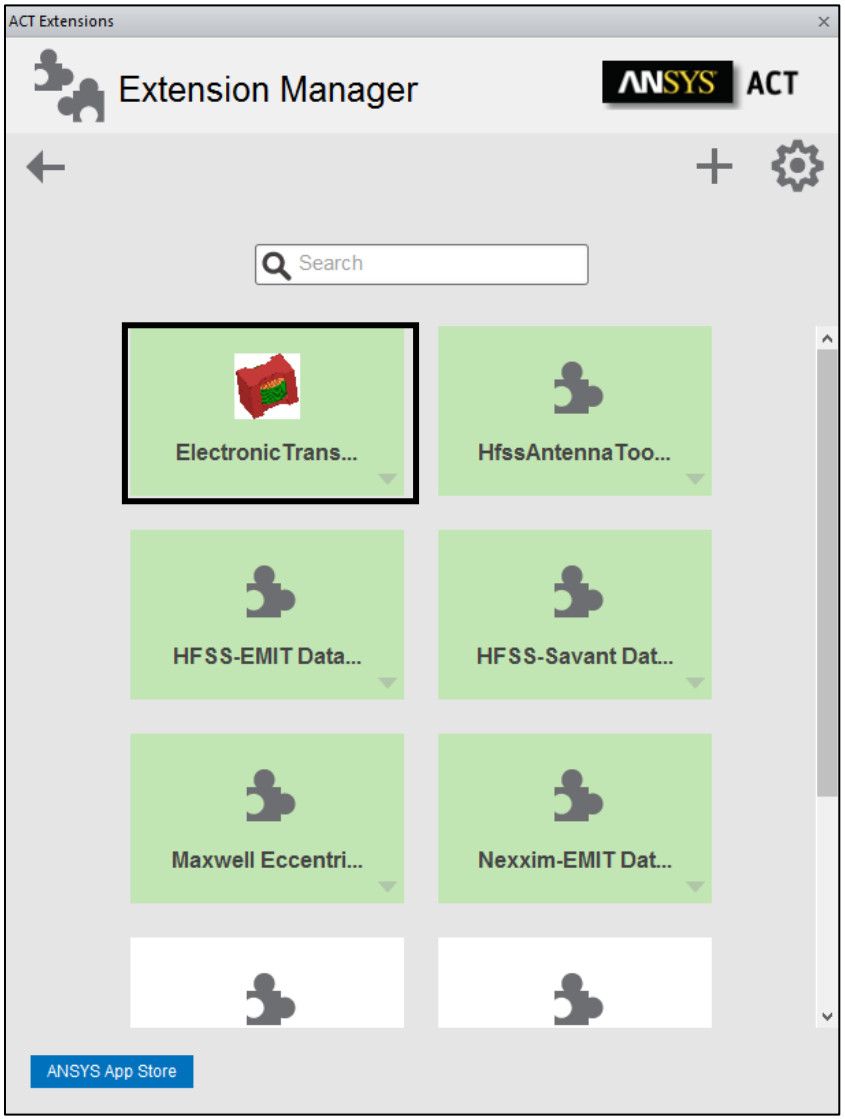
Install the Extension

- After installing, you will see the Electronic Transformer ACT extension shown
- Import extension appears in the Extension Manager with a white background, which means it has been installed but not yet loaded. To load the extension, you can just simply click on it. If the extension is loaded successfully, the icon's background should be green.
- Now you can leave the Extension Manager panel and run the ACT from the Launch Wizard panel



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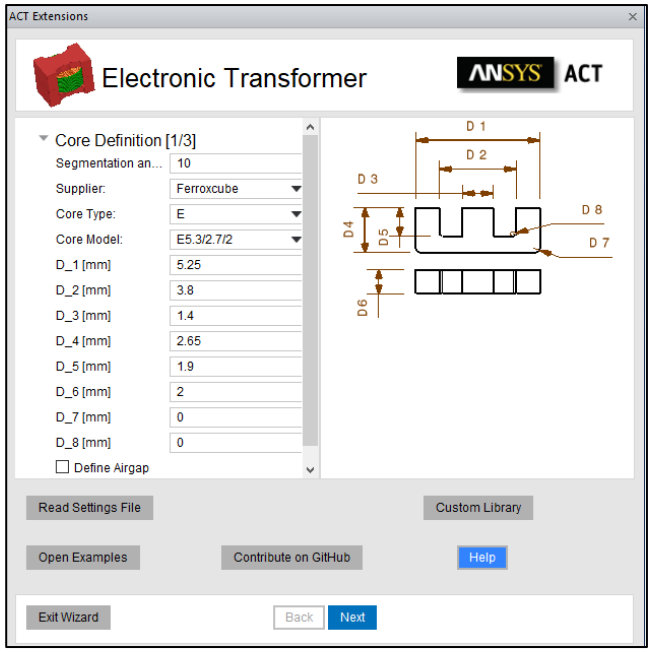
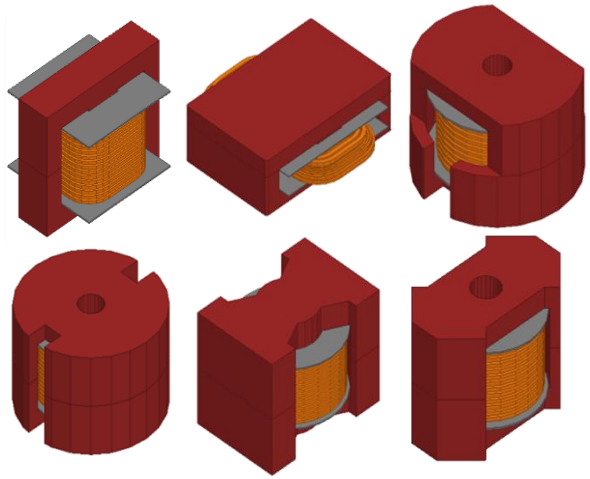
Input panel 1 of 3: Core Definition

- There are two options to set-up a transformer model:
  1. Create a totally new design
  2. Read input data from a previously recorded .json text file
- For new design, set Segmentation angle and Supplier, Core Type, Core Model
- Accept the default dimensions or manually modify
- The are (15) available core shapes from Philips/Ferroxcube





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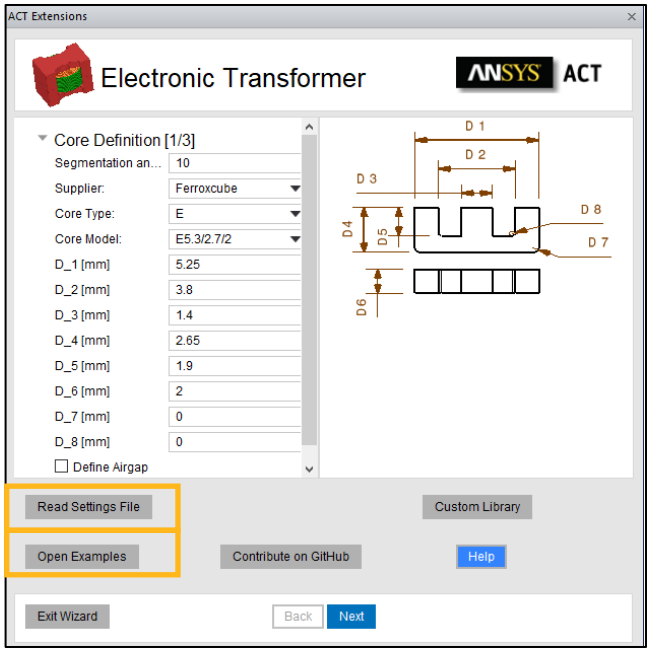
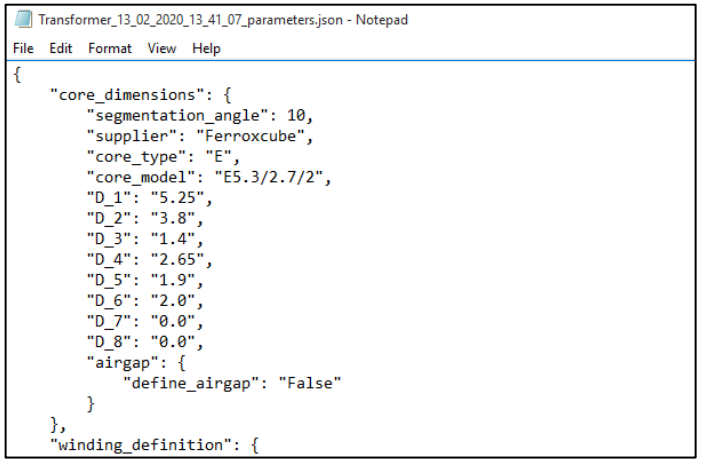
Recorded input file – used to recreate model in future

- An input text file (.json) is automatically recorded and saved in the Maxwell default project folder each time when analysis is set up
- For a previously recorded design, the input file can be re-run by selecting “Read Settings File” on the core definition input step *(note that the Core Model box will remain unchanged)*
- This input file can also be manually modified in text editor to make changes in parameters before re-running
- Click “Open Examples” to run demo input files

Note: Due to added functionality .tab files from the older versions are not supported





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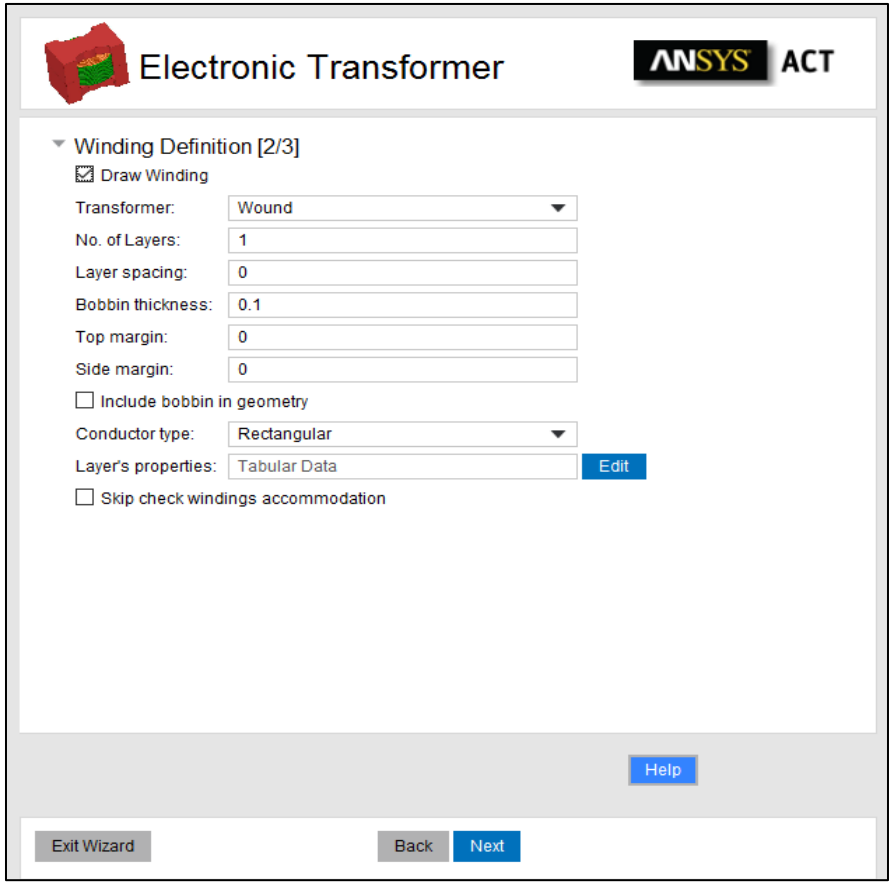
Input panel 2 of 3: Winding Definition

- Transformer type: Wound/Planar
- Number of Layers, Layer Spacing, Bobbin/Board Thickness, Top/Bottom Margin size, Side Margin size
- Layer Type: Top Down or Concentric
- Include bobbin (or not)
- Conductor Type: Rectangular or Circular (only for wound)
- Layer properties:
  - For rectangular: Conductor Width, Conductor Height, Number of Turns, Insulation thickness
  - For circular: Conductor Diameter, Number of segments, Number of Turns, Insulation Thickness
- Skip check windings (validates that windings will fit into the core)



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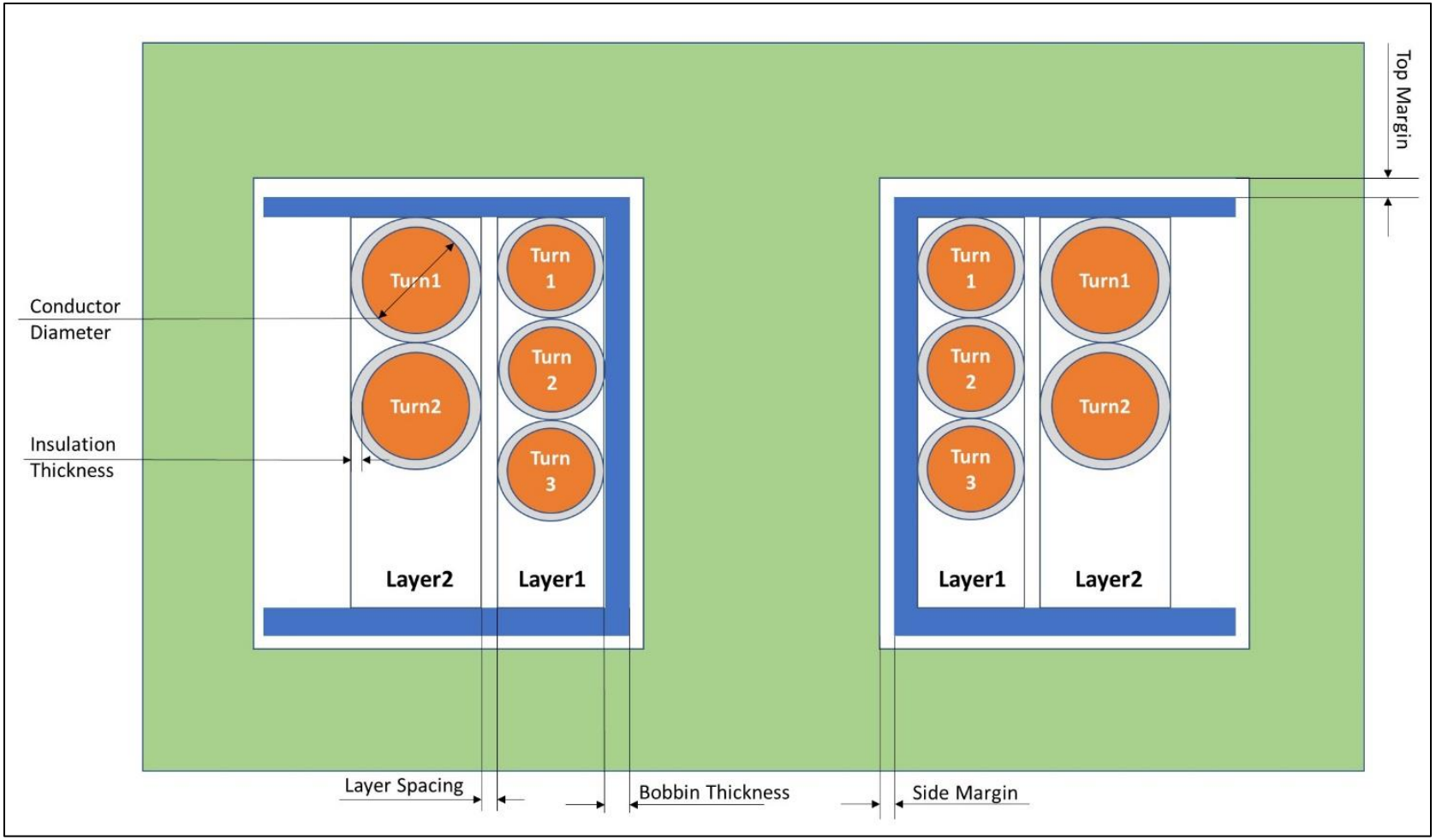
Wound Transformer



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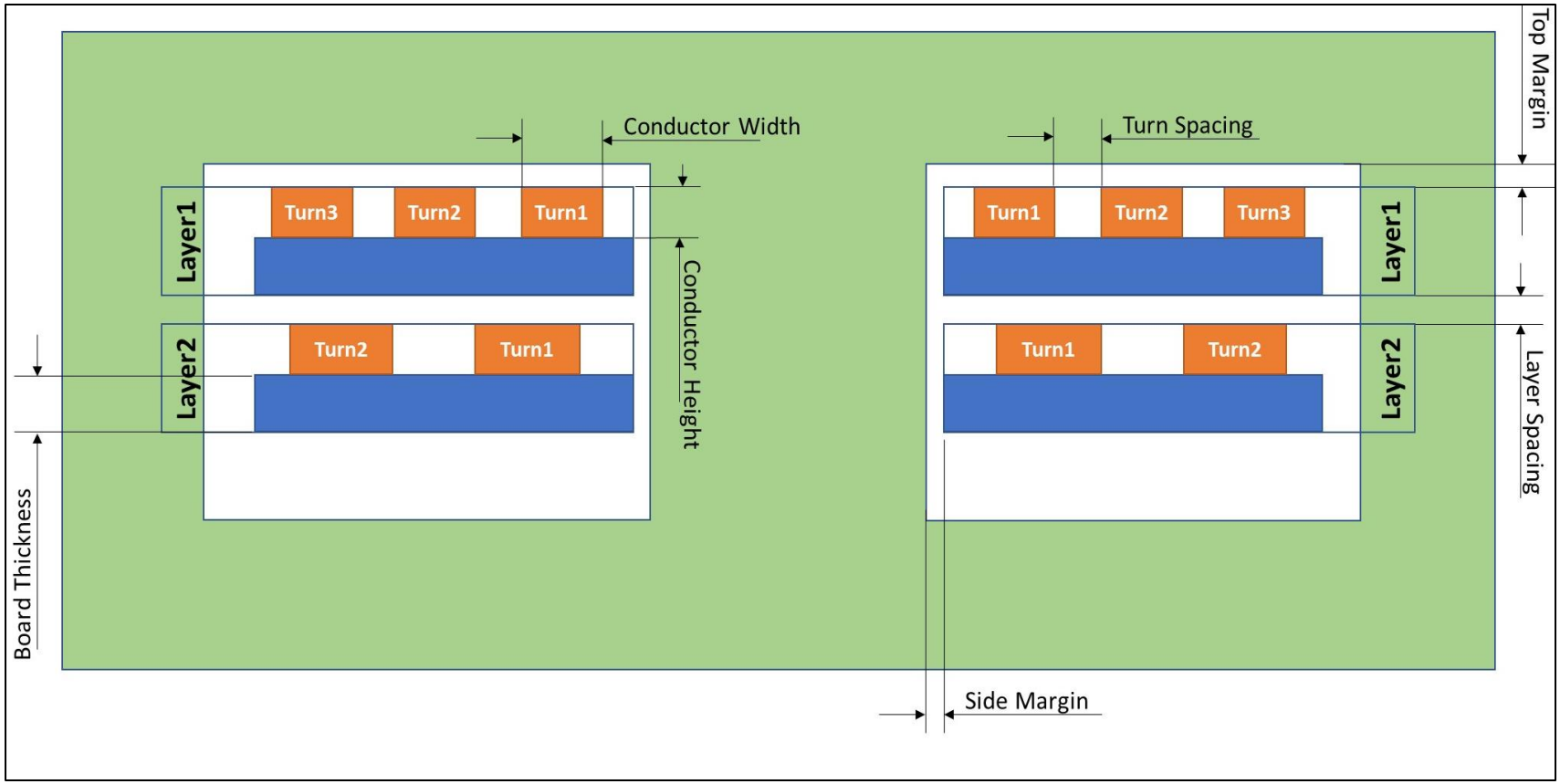
Planar Transformer



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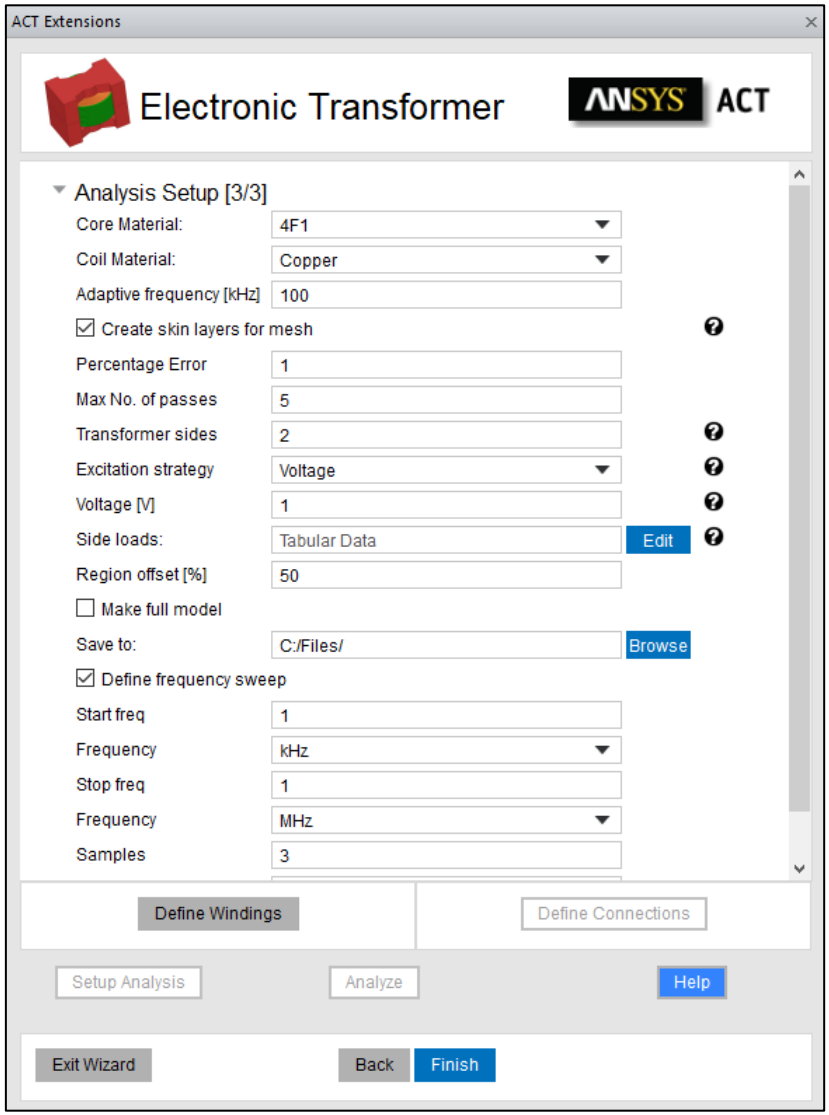
Input panel 3 of 3: Analysis Setup [step 1]

- Define Core Material and Coil Material
- Adaptive Frequency [kHz] for meshing (enable skin layers for mesh, if desired)
- Note: if thickness of the conductor is less than 3 values of skin depth then ACT will automatically generate additional layers for mesher to capture eddy effects
- % error and max number of adaptive passes
- Define number of transformer sides: 2 (for 1 Primary and 1 Secondary)
- Select Excitation strategy for Primary side (Voltage or Current source with magnitude)



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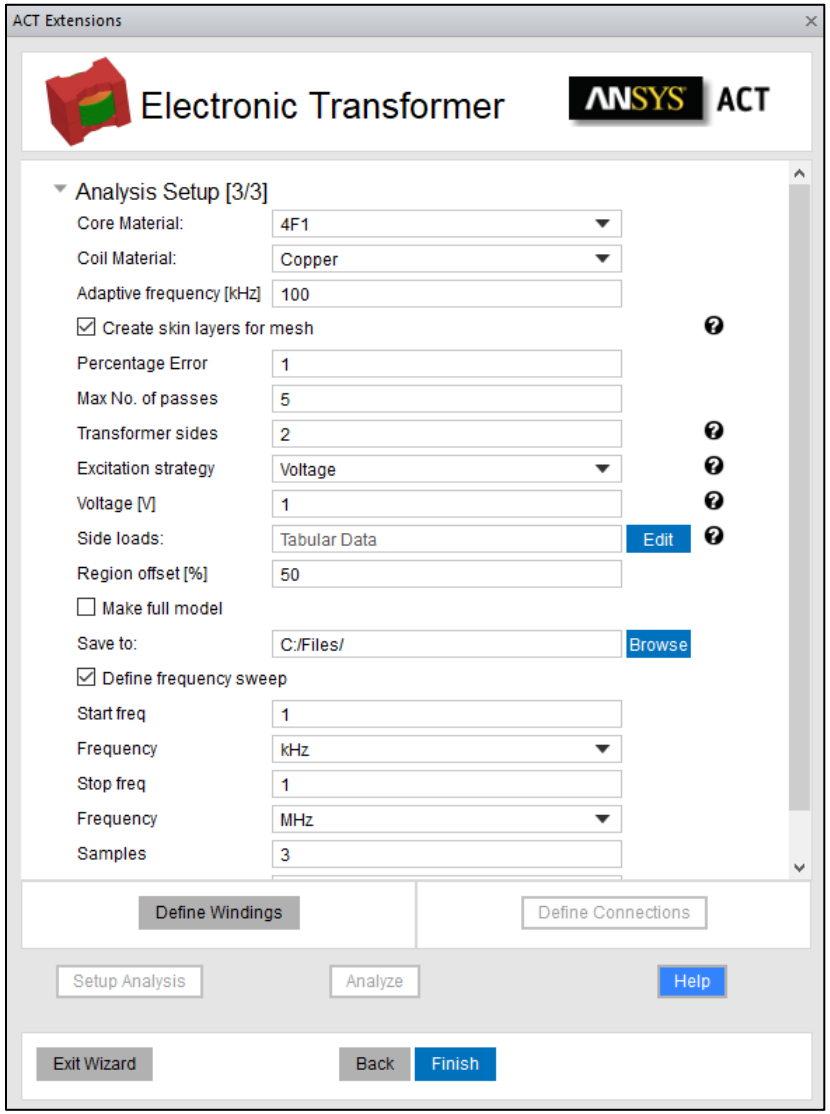
Input panel 3 of 3: Analysis Setup [step 2]

- Side loads sets the load resistance for each secondary (table)

TabularData	
Side #	Resistance [Ohm]
1	1E-06
2	1

- Set value of Regions offset
- Check Make Full Model to generate full model (default is a half model)
- Select Path where to Save the project
- Define frequency sweep (if desired) for start, stop and number samples
- Click Define Windings to assign each layer to the appropriate Winding (Side: 1,2,3…)



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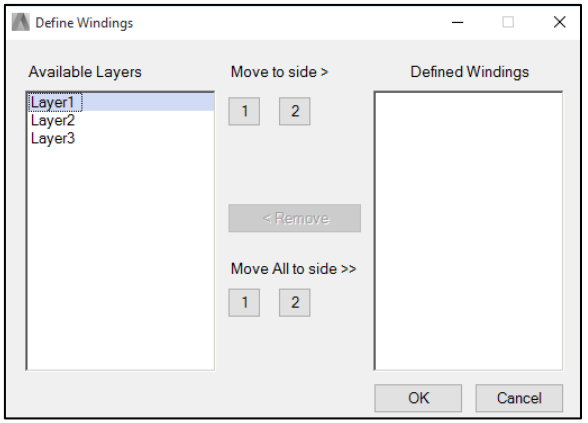
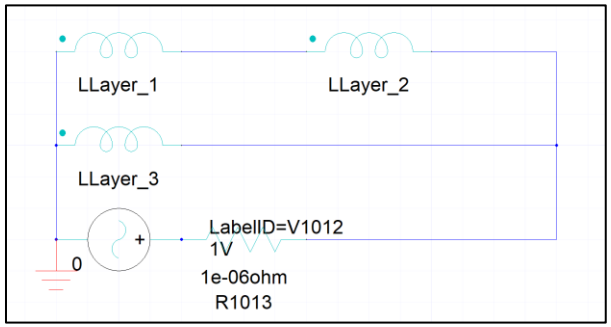
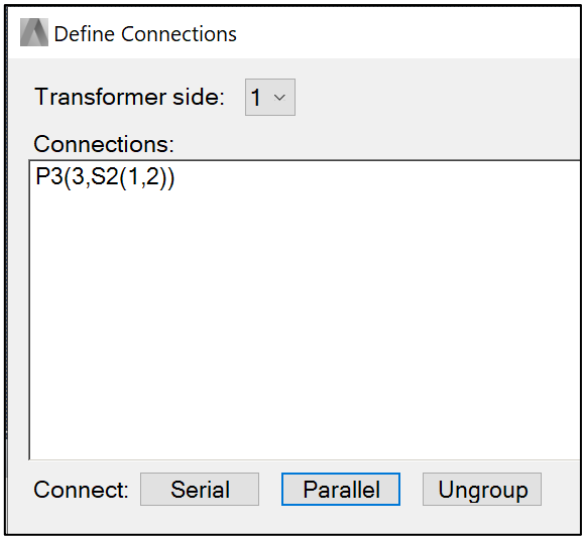
Input panel 3 of 3: Analysis Setup [step 3]

- Move each layer to the appropriate side
- Click Define Connections to set connections within each side: Parallel or Serial
- In the Maxwell Circuit below, you can see Layers 1 and 2 are connected in Series and then connected in Parallel to Layer 3







- Return to Analysis Setup [3/3 panel]
  - Setup Analysis to create design and stop
  - OR Analyze to setup and solve design
- Finish and Exit Wizard to close ETK

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Adding a New Core Material

In order to add a new core material, users can follow below steps:

1. Open ACT and click Custom Library button. It will open folder where you can modify material_properties.json file to add new materials
2. Add new material respecting JSON syntax. For each material you need to add Conductivity, Steinmetz coefficients (Cm, X, Y), density and permeability versus frequency

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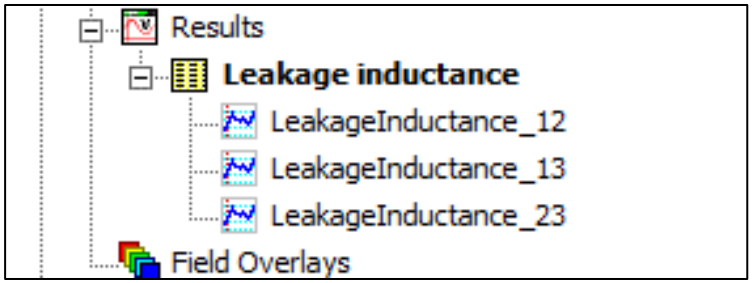
Maxwell Results – Leakage Inductance

- ACT will automatically generate Leakage Inductance report for you. It will calculate values between all sides.
- For example, for 3 sides (primary, secondary, tertiary) you will get a report frequency vs all Leakage values:



Leakage inductance

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	Freq [kHz]	LeakageInductance_12 [nH] Setup1 : LastAdaptive	LeakageInductance_13 [nH] Setup1 : LastAdaptive	LeakageInductance_23 [nH] Setup1 : LastAdaptive
1	1.000000	12.841827	25.512373	14.668848

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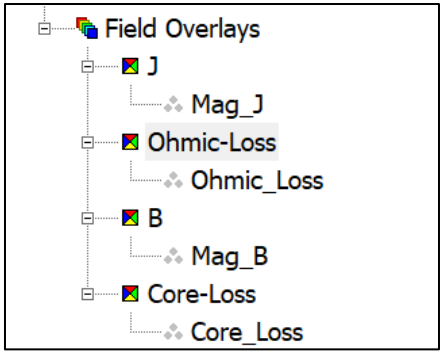
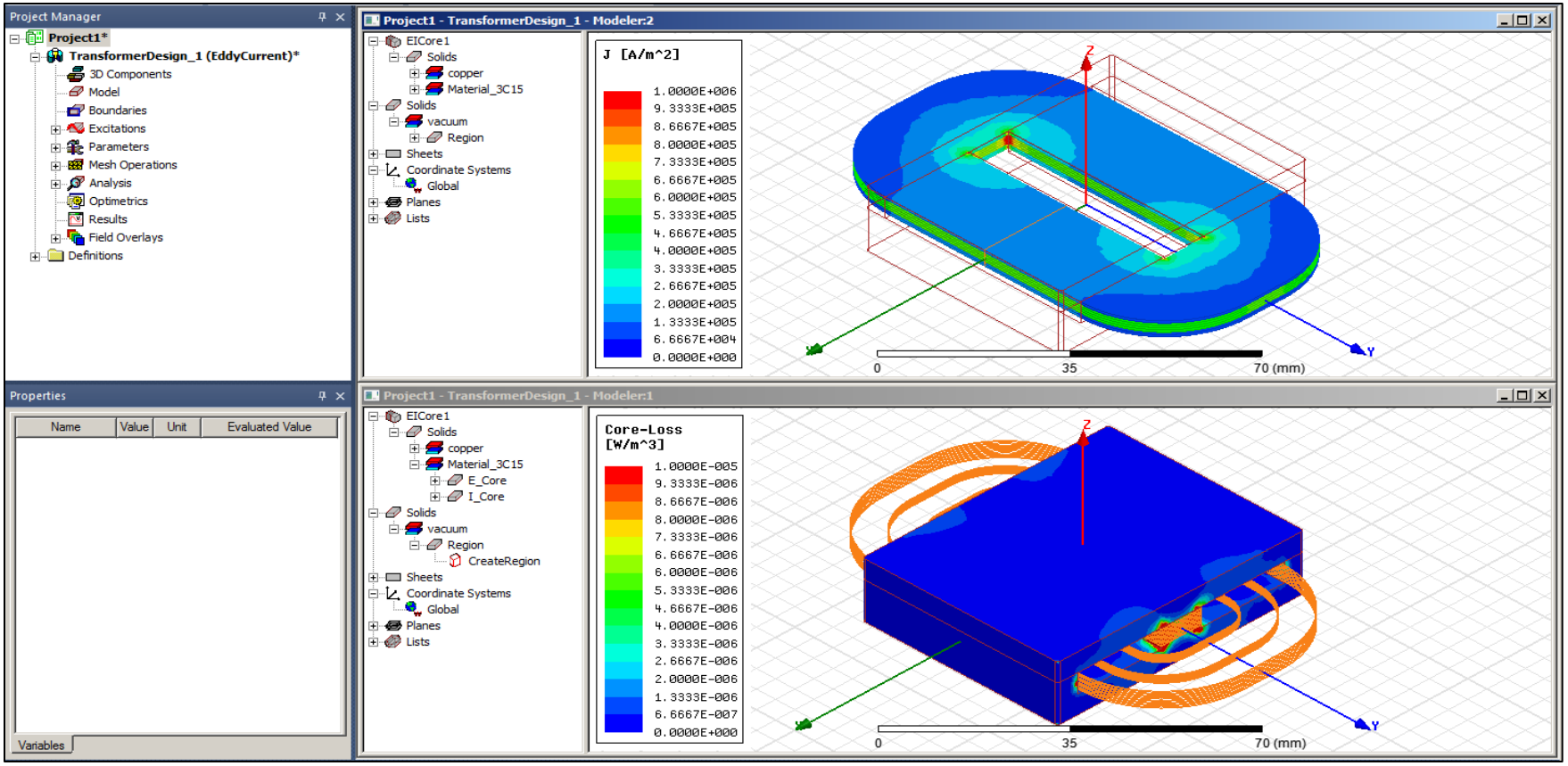
Maxwell Results - Plots

ACT will automatically create plots

1. MagJ, Ohmic Losses for Windings
2. MagB, Core Losses for the Core





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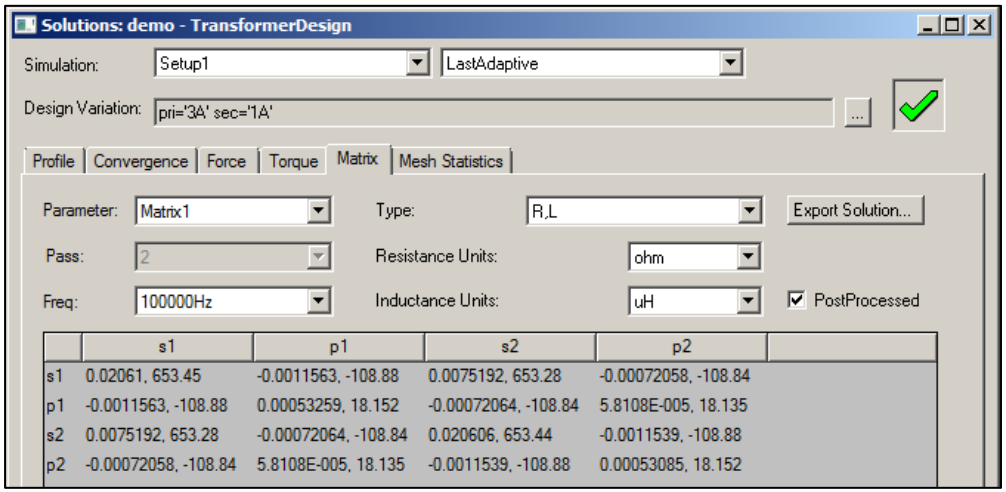
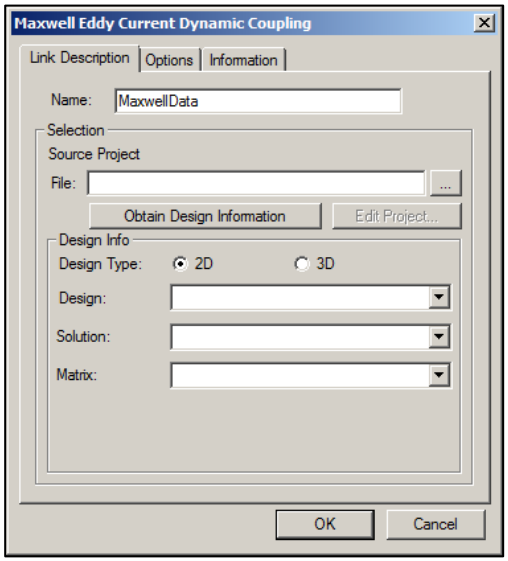
Maxwell Results – Matrix and Netlist

- Impedance Matrix results at solved frequencies

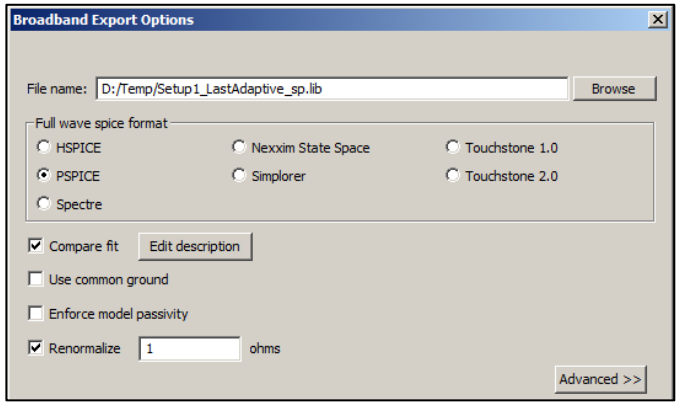


- Frequency dependent State Space model can be imported into Simplorer for circuit simulation using "Dynamic Eddy Current" link
- Frequency dependent netlist model can also be exported to PSpice using Network Data Explorer
  1. Right-click on Analysis / Setup1
  2. In the NDE window, click on Export Broadband
  3. Choose PSPICE (Renormalize to 1 ohm)

Maxwell to Simplorer



Maxwell to PSpice



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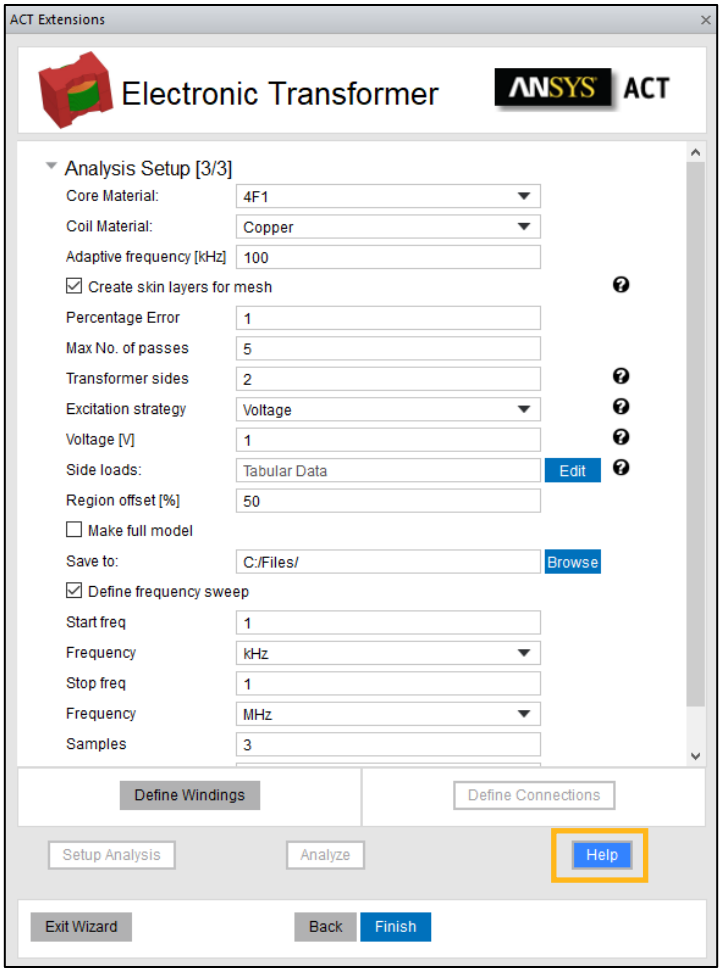
Help

- Help contains information about settings for each step
- Access with “Help” button on any ACT panel
- It is suggested to read help before starting to work with ACT since this presentation is giving only a short overview of ACT



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We are glad to see contributors to this project. If you want to add transformer shapes, new materials or any other enhancement please join us on GitHub

Report any issue or provide feedback related to this app please

- Open an issue on GitHub
- Or contact:

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