ACT:
Electronic Transformer
2020R1

Ansys

Copyright and Trademark Information

Copyright and Trademark Information

© 2018 ANSYS, Inc. All rights reserved. Unauthorized use, distribution or duplication is prohibited.

ANSYS, ANSYS Workbench, Ansoft, AUTODYN, EKM, Engineering Knowledge Manager, CFX, FLUENT, HFSS, AIM and any and all ANSYS, Inc. brand, product, service and feature names, logos and slogans are registered trademarks or trademarks of ANSYS, Inc. or its subsidiaries in the United States or other countries. ICEM CFD is a trademark used by ANSYS, Inc. under license. CFX is a trademark of Sony Corporation in Japan. All other brand, product, service and feature names or trademarks are the property of their respective owners.

Disclaimer Notice

THIS ANSYS SOFTWARE PRODUCT AND PROGRAM DOCUMENTATION INCLUDE TRADE SECRETS AND ARE CONFIDENTIAL AND PROPRIETARY PRODUCTS OF ANSYS, INC., ITS SUBSIDIARIES, OR LICENSORS. The software products and documentation are furnished by ANSYS, Inc., its subsidiaries, or affiliates under a software license agreement that contains provisions concerning non-disclosure, copying, length and nature of use, compliance with exporting laws, warranties, disclaimers, limitations of liability, and remedies, and other provisions. The software products and documentation may be used, disclosed, transferred, or copied only in accordance with the terms and conditions of that software license agreement.

Contains proprietary and confidential information of ANSYS, Inc. and its subsidiaries and affiliates.

Electronic Transformer Overview

- What does the “Electronic Transformer ACT” do?
  - → It automatically sets up a ready-to-solve Maxwell 3D Eddy Current design for planar 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 it model?
  - → It is intended for electronic ferrite core transformers and inductors in the 100kHz range (but NOT for oil-filled transformers in the 50-60Hz range).
- How easy is it to use?
  - → ACT consists of three input steps which can be setup in 10-15 minutes
- Are any manufacturer libraries included?
  - → Philips and Ferroxcube with 15 core shapes are included in the initial release.
- How is the “Electronic Transformer ACT” different from PExprt?
  - → The “Electronic Transformer ACT” is a script using only Maxwell 3D (PExprt uses both 2D and 3D). It provides only an FEA based solution (PExprt creates both analytical and FEA based) using pre-defined design inputs (PExprt totally creates designs). Litz and twisted wire cannot be considered in the ETK. Capacitance is not considered in the ETK unless a separate electrostatic design is created manually.

©2020 ANSYS, Inc. / Confidential

Electronic Transformer: What's new?

Release 2020R1

1. Enabling thermal properties for Windings for further two-way coupling with thermal tools like Icepak and Fluent
2. 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
3. Number of transformer windings (sides) is unlimited (now you can create as many sides as you have layers such as: Primary, Secondary, Tertiary, etc)
4. Create reports for leakage inductance. Auto report is setup to calculate Leakage between all windings (sides)
5. Excitation strategy is expanded. Now you can have a Voltage (or Current) winding instead of current sources
6. Create field overlays: Mag(J), Ohmic-Loss for windings and Mag(B), Core-Loss for the core
7. **By default** generates half of the model to reduce simulation time

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

©2020 ANSYS, Inc. / Confidential

ACT App Store

- https://catalog.ansys.com/
- Great place to get started
  - A library of helpful applications available to any ANSYS customer
  - New apps added regularly
  - Applications made available in either binary format (.wbex file) or binary plus scripted format (Python and XML files)
  - Scripted extensions are great examples
  - Documentation and training materials available on the ANSYS Customer Portal: https://support.ansys.com/AnsysCustomerPortal/en_us/Downloads/ACT+Resources

©2020 ANSYS, Inc. / Confidential

Information

- Please pay attention to paragraph 9 of the CLICKWRAP SOFTWARE LICENSE AGREEMENT FOR ACS EXTENSIONS regarding TECHNICAL ENHANCEMENTS AND CUSTOMER SUPPORT (TECS): “TECS is not included with the Program(s)”

- Report any issue or provide feedback related to this app please contact:

maksim.beliaev@ansys.com

mark.christini@ansys.com

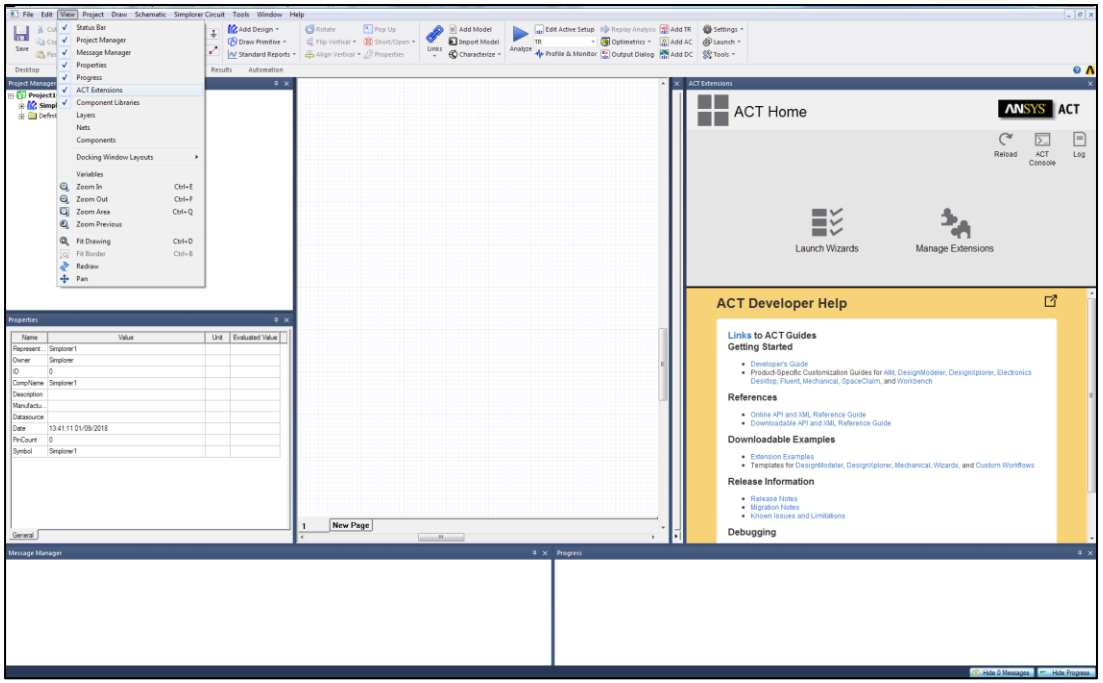
©2020 ANSYS, Inc. / Confidential

Install the Extension

- The extension can be downloaded from ANSYS ACT Application Store *https://catalog.ansys.com*
- To install extension:

Open Electronics Desktop and activate the ACT through

Then you be able to access the ACT Start Page as shown in the right figure.

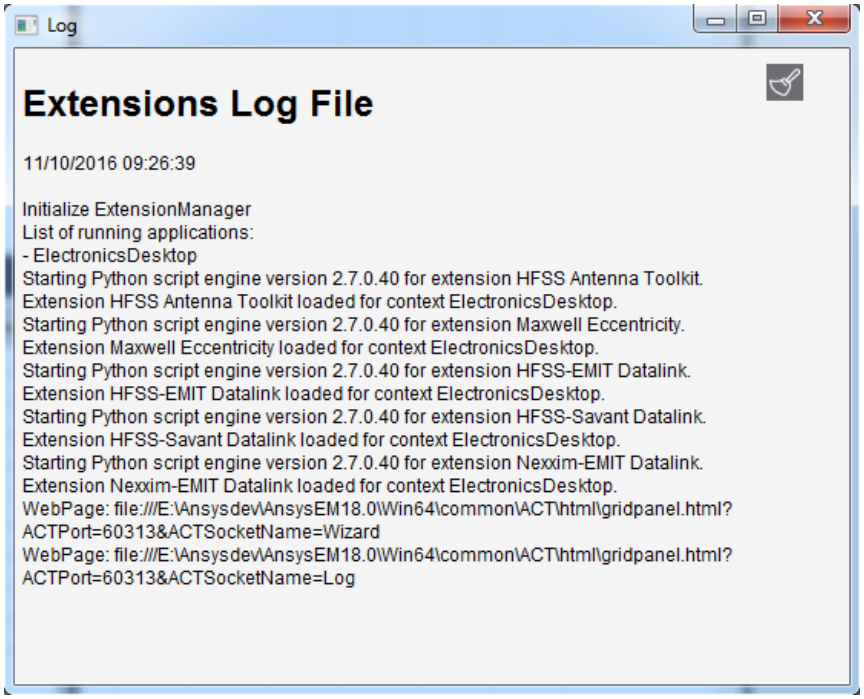


©2020 ANSYS, Inc. / Confidential

Install the Extension

- To view log information, click on the Log button. A log message window will appear.

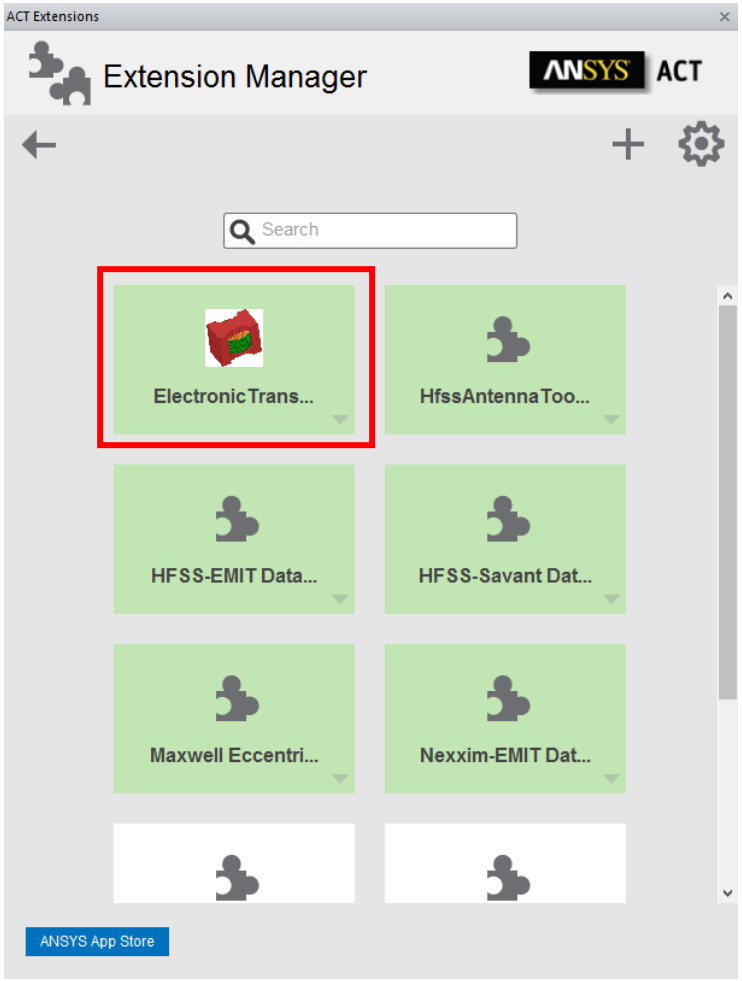
- Click on Extension Manager, click on the “+” sign to install extensions, select the *wbex* file downloaded from the ANSYS ACT Application Store.



©2020 ANSYS, Inc. / Confidential

Install the Extension

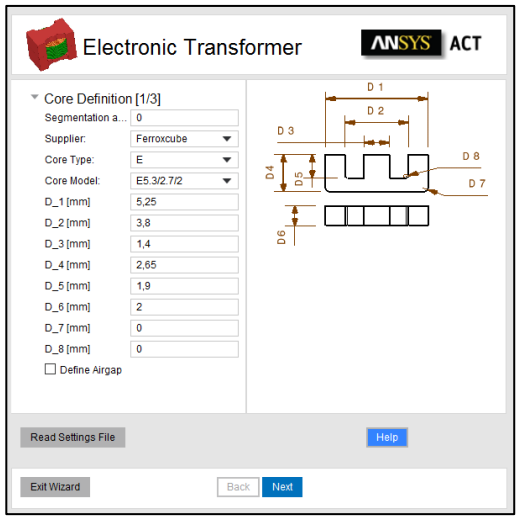
- After installing the extension, you will see the extension.
- Import extension appears in the Extension Manager with a white background, which means it has been installed but not yet loaded. To load the extension, you can just simply click on it. If the extension is loaded successfully, the icon's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

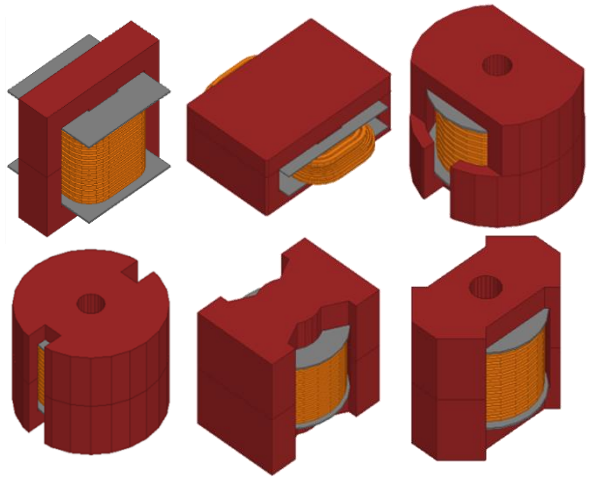


©2020 ANSYS, Inc. / Confidential

Input panel 1 of 3: Core Definition

- Two options to set-up a transformer model:
  1. Read input data from a previously recorded .tab text file
  2. Create a totally new design
- Select Supplier, Core Type, Core Model
- 15 available core shapes from Philips/Ferroxcube
- Choose default dimensions or manually modify



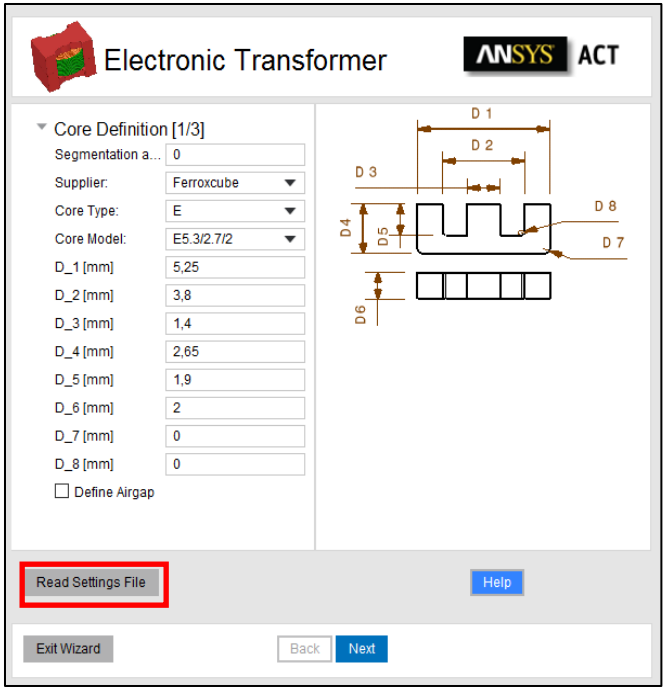


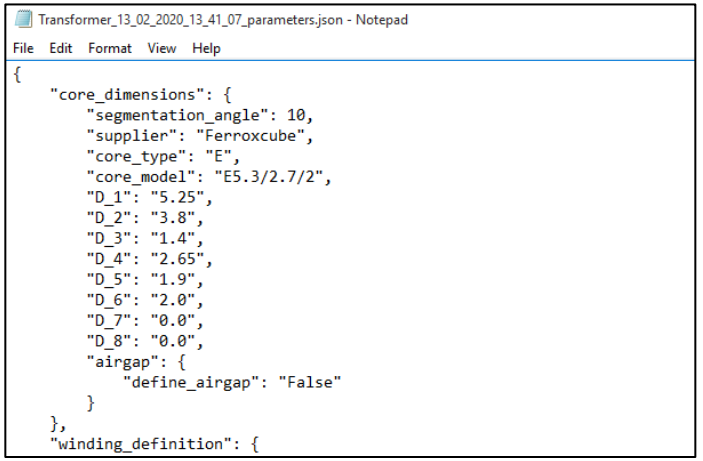
©2020 ANSYS, Inc. / Confidential

Recorded input file – used to recreate model in future

- **File is automatically recorded and saved in the Maxwell default project folder each time when analysis is setup**
- **Input file can be re-run by selecting “Read Settings File” on the core definition input step *(note Core Model box will remain unchanged)***
- **File can also be manually modified in text editor to make changes in parameters before re-running**
- **In example folder you can find demo files**

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

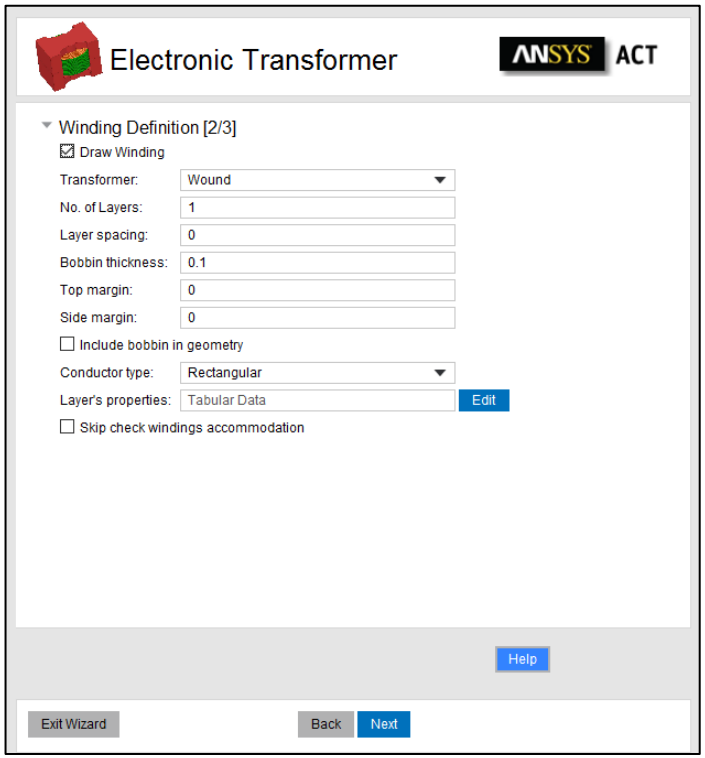




©2020 ANSYS, Inc. / Confidential

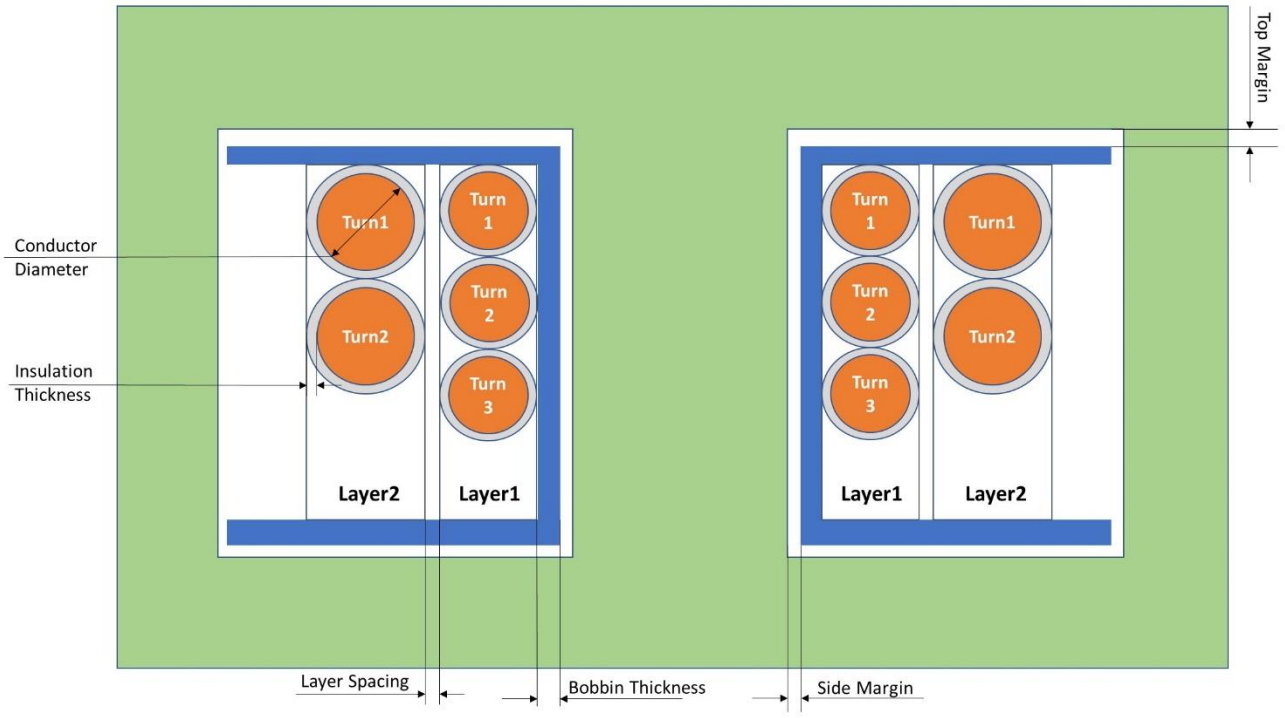
Input panel 2 of 3: Winding Definition

- 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
- Conductor Type: Rectangular or Circular (only for wound)
- For each layer: Conductor Width, Conductor Height, Number of Turns, and Insulation Thickness/Turn Spacing



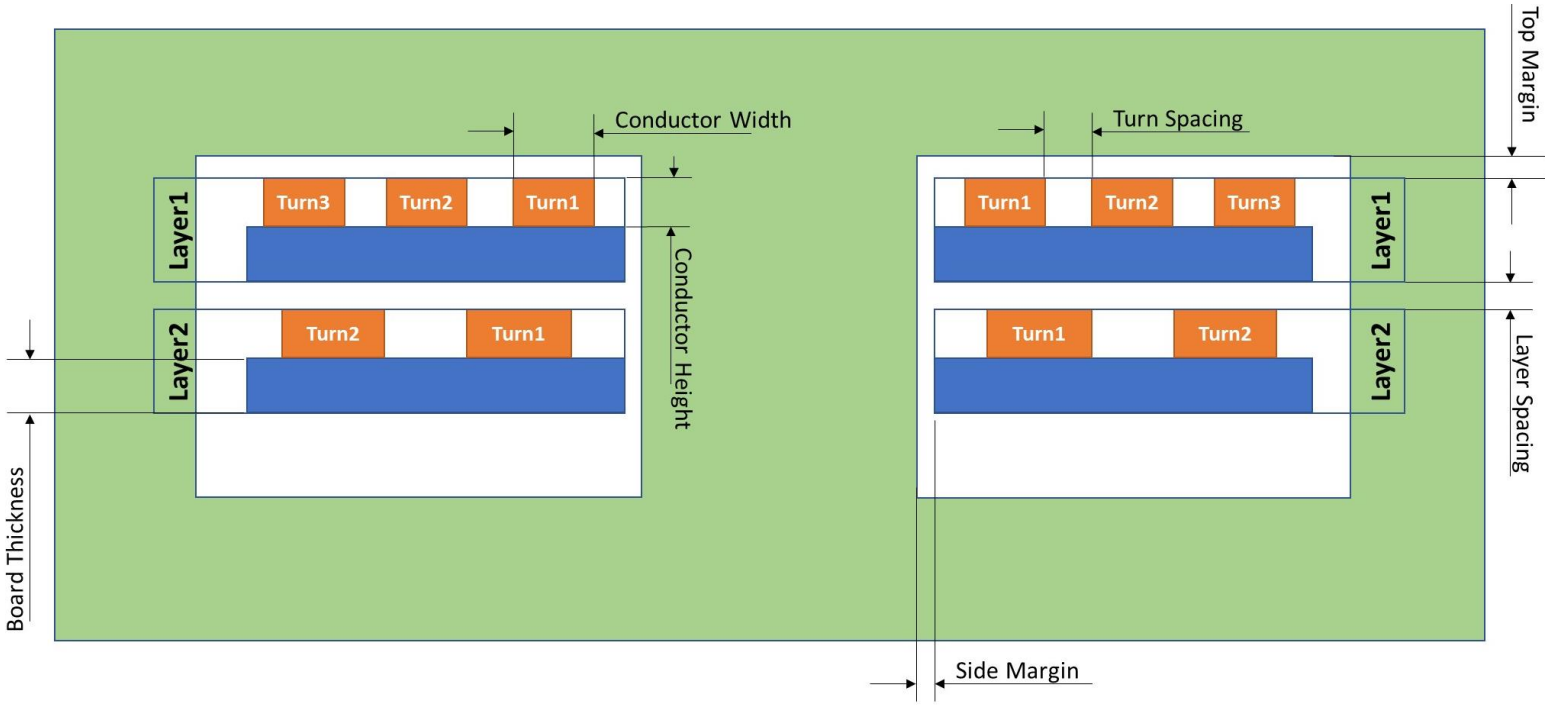
©2020 ANSYS, Inc. / Confidential

Wound Transformer



©2020 ANSYS, Inc. / Confidential

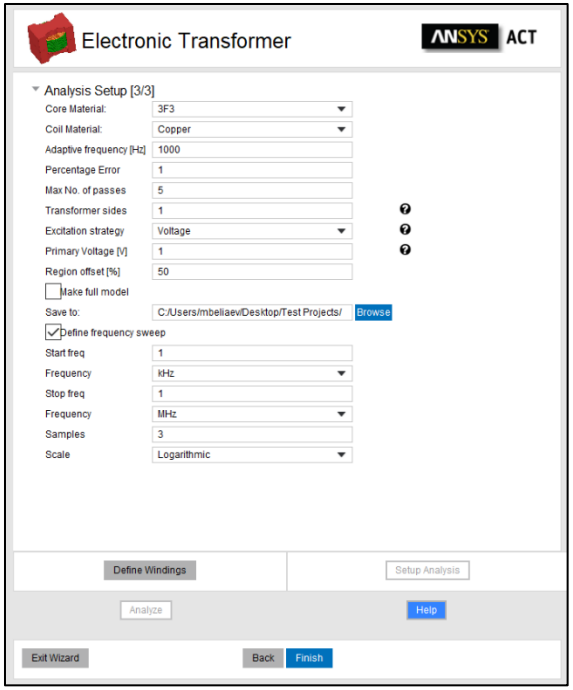
Planar Transformer

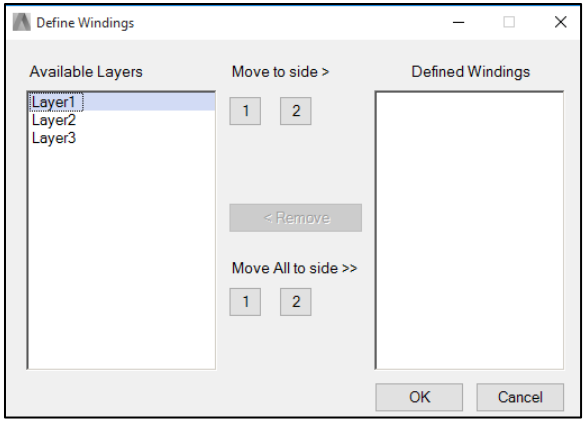


©2020 ANSYS, Inc. / Confidential

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

- **Define Core Material and Coil Material**
- **Define Primary and Secondary Windings**
- **Define number of transformer sides (eg 2 for Primary, Secondary)**
- **Select Excitations strategy for Primary side (Voltage or Current source) and set value of resistance for 2, 3, etc sides which would be defined as voltage winding**
- **Click Define Windings to assign each layer to the Winding**

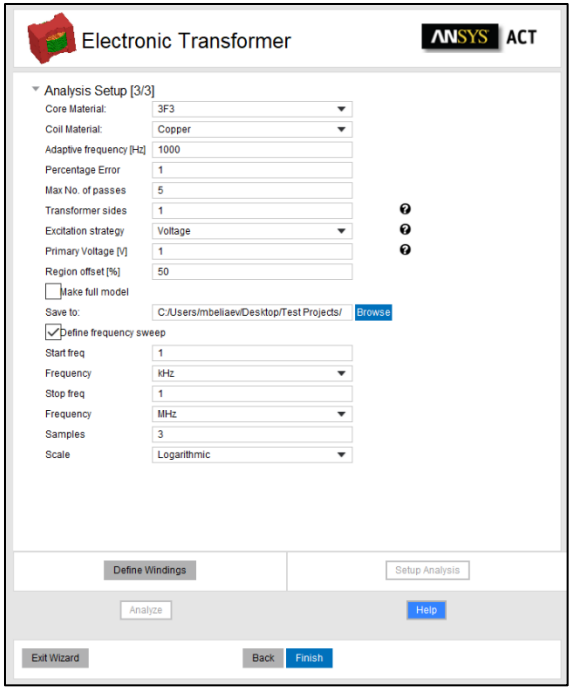




©2020 ANSYS, Inc. / Confidential

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

- **Define adaptive frequency, frequency sweep, % error and max number of passes**
- **Set value of regions offset**
- **Select Path where to Save the project**
- **Check Make Full Model to generate full model (default is half of the model)**
- **Setup Analysis to create design OR Analyze to setup and solve design**



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

©2020 ANSYS, Inc. / Confidential

Adding a New Core Material

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

1. **Make test run of the ACT to create geometry, this will create file folder *Materials* and file *matdata.tab* in personalLib folder defined in Electronics Desktop**
2. **Create a tab file for frequency versus permeability for the required core. Sheet Scan option available in Maxwell can help for creation of the tab fil.**
3. **Name the tab file same as the name of the material to be added**
4. **Place the tab file in that folder …*PersonalLib**Materials***
5. **Open "matdata.tab" file in Excel**
6. **Add a row for the material to be added and specify name and other material properties**
7. **Save the file with same name.**

Once this is done, the material should be available for selection for next run of the ACT

1	"X"	"Y"
2	0	1800
3	98459.681589469503	1805
4	128193.25309275401	1810
5	164335.10138502999	1815
6	197983.598439825	1836
7	246043.12589684501	1880
8	296421.78101870802	1923.2
9	346199.02680051897	2014.5999999999999
10	391975.05251181999	2086
11	450746.729490244	2160
12	502485.57112693402	2236.5
13	596047.538592714	2426

frequency versus permeability

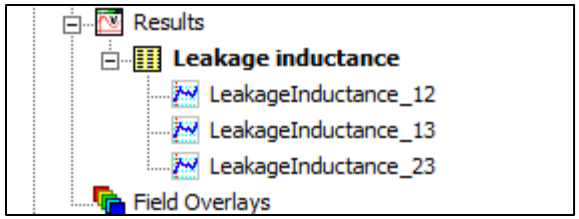
	Material N	Conductiv	Cm	x	y	density
2	3C15	1	0.535	1.615	2.766	4800
3	3C30	0.5	0.867	1.533	2.7	4800
4	3C34	0.2	1.06	1.5	2.8	4800
5	3C81	1	2.55	1.485	2.51	4800
6	3C91	0.2	1.9	1.5	2.875	4800
7	3C90	0.2	0.823	1.54	2.69	4800
8	3C94	0.2	2.18	1.44	2.725	4800
9	3C96	0.2	0.244	1.6	2.576	4800
10	3F3	0.5	0.195	1.561	2.15	4750
11	3F4	0.1	2.981	1.368	2.1	4700
12	3F35	0.1	0.718	1.577	2.744	4750
13	4F1	0.000001	15.358	1.29	2.181	4600

matdata.tab

©2020 ANSYS, Inc. / Confidential

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

ANSYS

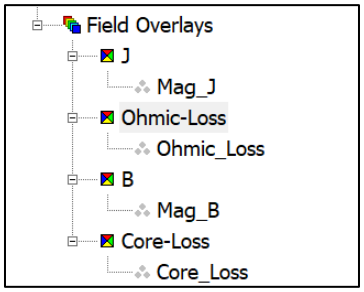
	Freq [kHz]	LeakageInductance_12 [nH] Setup1 : LastAdaptive	LeakageInductance_13 [nH] Setup1 : LastAdaptive	LeakageInductance_23 [nH] Setup1 : LastAdaptive
1	1.000000	12.841827	25.512373	14.668848

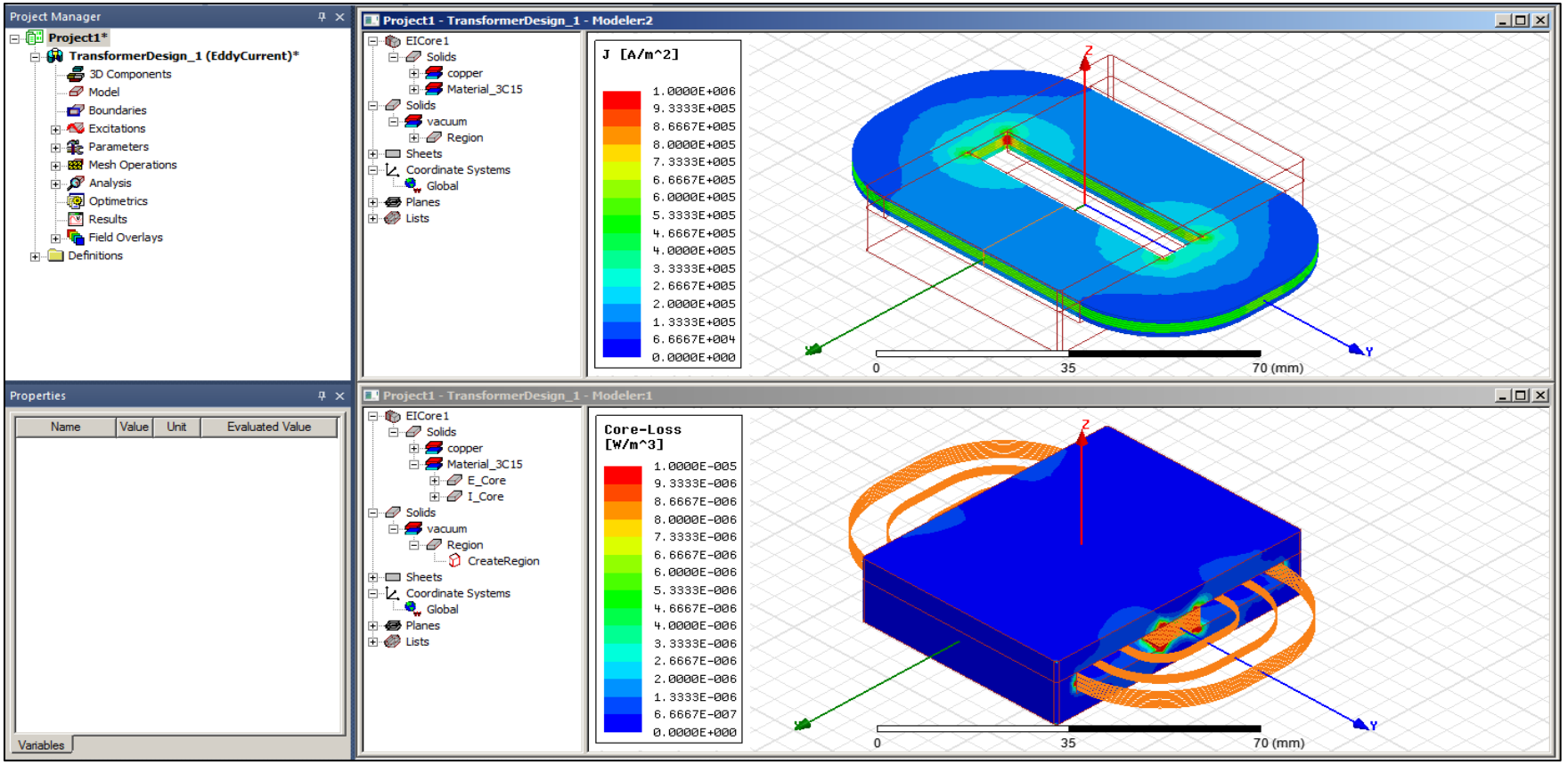
©2020 ANSYS, Inc. / Confidential

Maxwell Results - Plots

ACT will automatically create plots

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

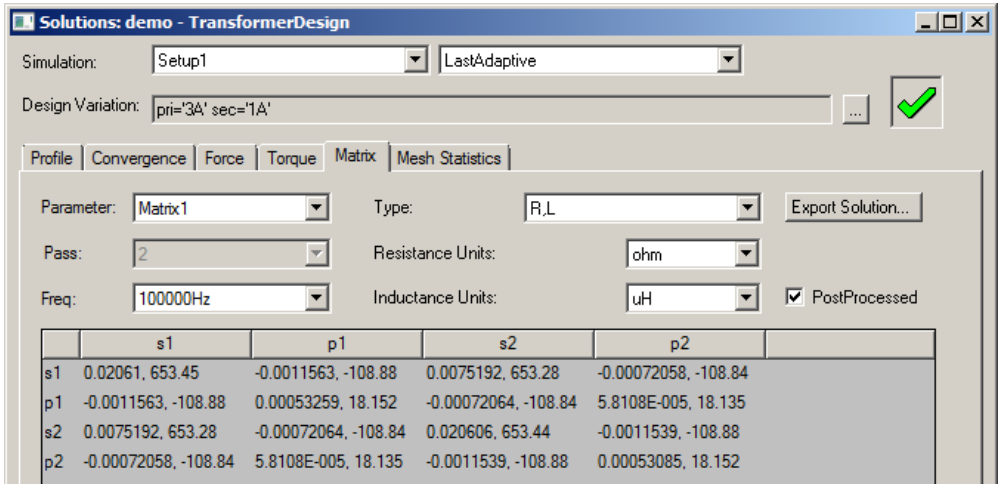




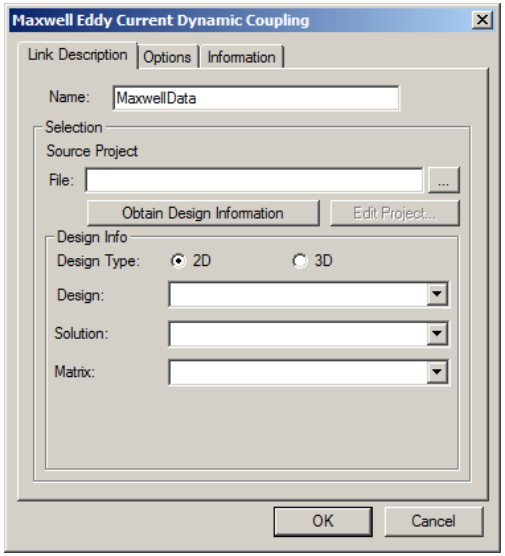
©2020 ANSYS, Inc. / Confidential

Maxwell Results – Matrix and Netlist

- Impedance Matrix results at solved frequencies

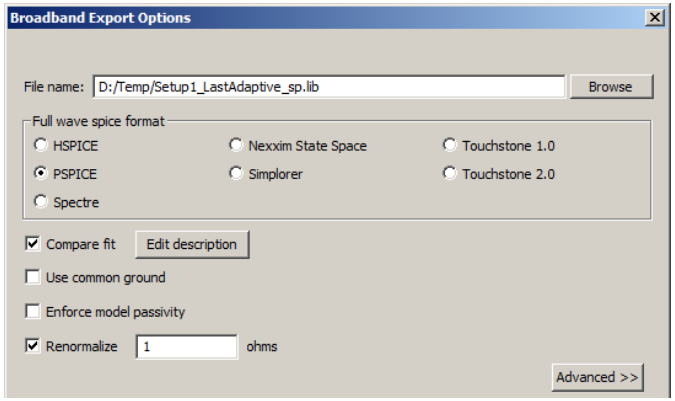


Maxwell to Simplorer



- 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 PSpice



©2020 ANSYS, Inc. / Confidential

Help

- Help contained exhaustive information about settings on each step. It is recommended to read help before starting to work with ACT since this presentation is giving only a short overview of ACT
- Accessed with “Help” button on any ACT panel

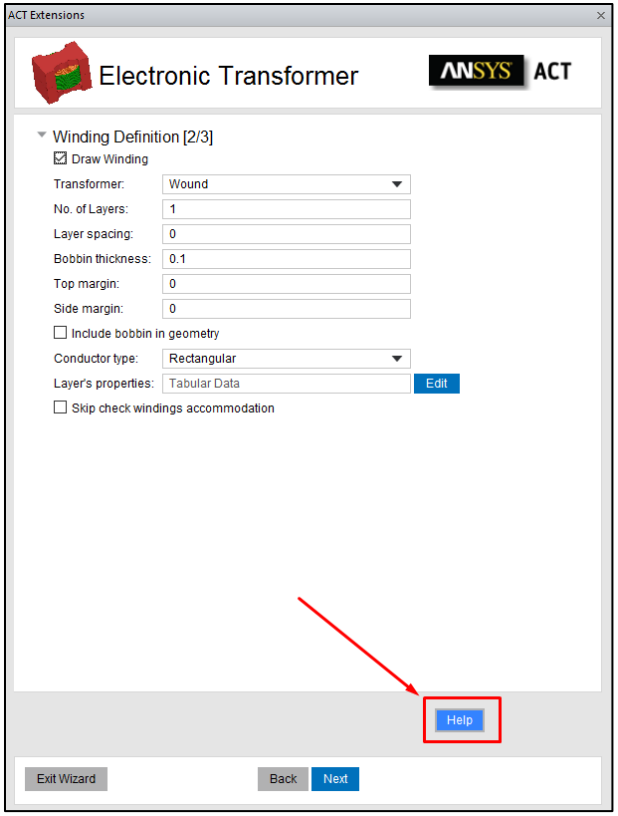


Table of Contents

©2020 ANSYS, Inc. / Confidential

Thank you

Join the ACT Group on LinkedIn:

"Customization ACTors for Engineering Simulation"

- Maksim Beliaev *maksim.beliaev@ansys.com*
- Mark Christini *mark.christini@ansys.com*

Copyright and Trademark Information

© 2018 ANSYS, Inc. All rights reserved. Unauthorized use, distribution or duplication is prohibited.