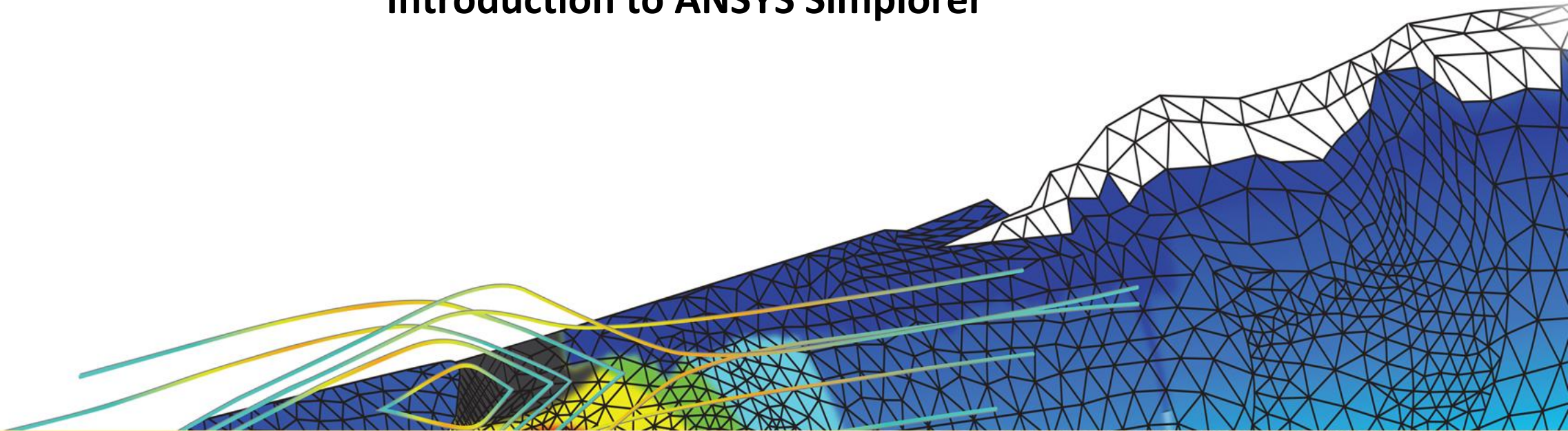




Module 01: Introduction and Basic Usage

Introduction to ANSYS Simplorer



ANSYS is the Simulation Leader

FOCUSED

This is all we do.

Leading product technologies in all physics areas
Largest development team focused on simulation



CAPABLE



PROVEN

Recognized as one of the world's **MOST INNOVATIVE AND FASTEST-GROWING COMPANIES***

TRUSTED

96 of the top 100

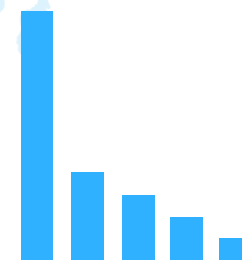
FORTUNE 500 Industrials
ISO 9001 and NQA-1 certified

INDEPENDENT

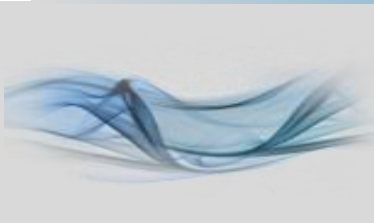
Long-term financial stability
CAD agnostic

LARGEST

3x The size of our nearest competitor



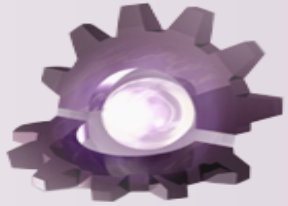
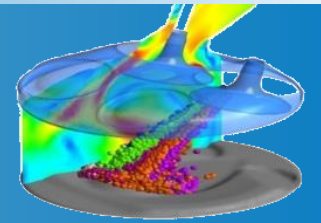
Breadth of Technologies



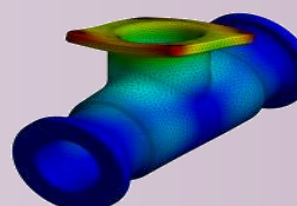
Fluid Mechanics:
From Single-Phase Flows



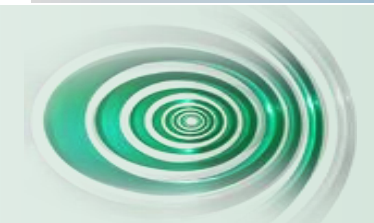
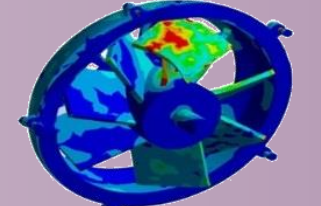
To Multiphase
Combustion



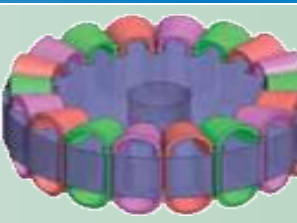
Structural Mechanics:
From Linear Statics



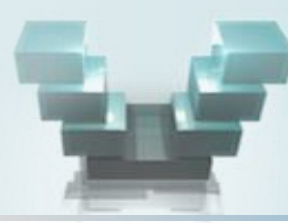
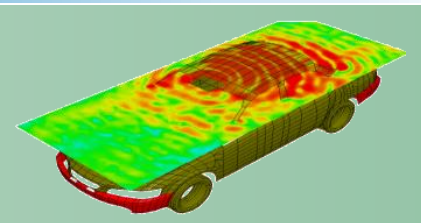
To High-Speed Impact



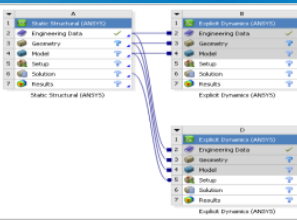
Electromagnetics: From
Low-Frequency Windings



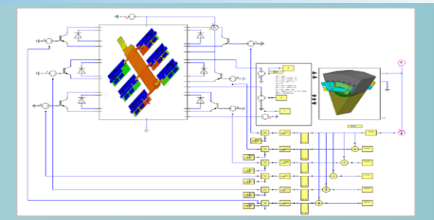
To High-Frequency
Field Analysis



Systems:
From Data Sharing



To Multi-Domain
System Analysis



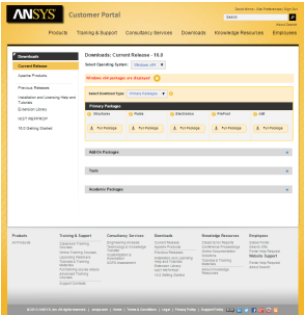
ANSYS Customer Portal

<https://support.ansys.com>



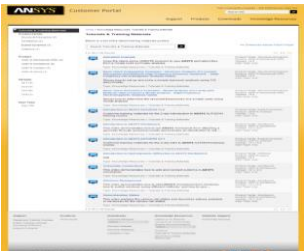
Submit and review service requests

If you cannot find the answer to your question within the ANSYS Customer Portal then you can submit a service request for technical assistance.



Download the latest software and updates

Download either ISO images or individual installer packages to access the latest software release.



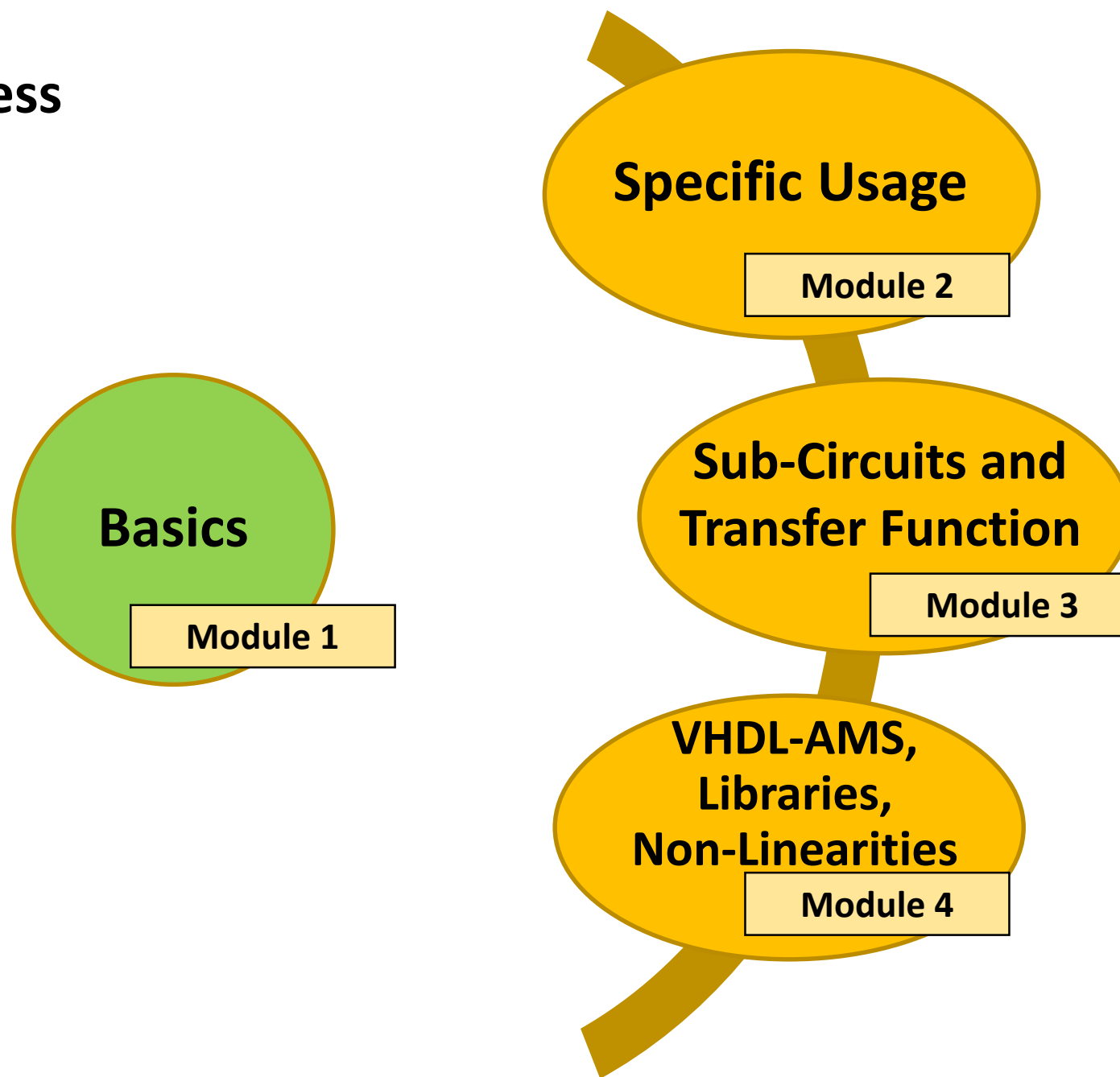
Download training and tutorial materials

Examples are available for both a broad range of ANSYS products and user's experience. Search the hundreds of examples available and improve your knowledge of ANSYS software.

Overview

- **Introduction to ANSYS Simplorer**
 - Components and their properties
 - Graphical user interface (GUI)
 - Add Component
 - Edit Component Properties
 - Set-up Simulations
 - Variables
 - View Results
 - View Component Examples
- **Workshop 1.1: Switching circuit + Parametric Analysis**

Overall Process



Introduction to ANSYS Simplorer

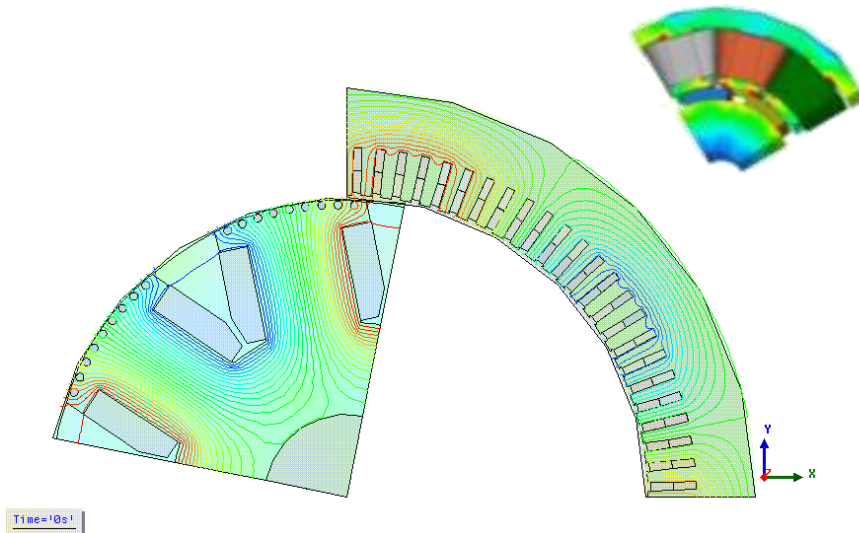
- **What is ANSYS Simplorer**

- ANSYS Simplorer is a circuit and system simulator capable to handle both mathematical representation of physical structures and mathematical representation of signals/controls
- Physical structures represent behaviours of different physical domains, not only Electrical but also Magnetics, Mechanical, Hydraulics, Thermal, etc.
- Purely mathematical representations of signals/controls can be control blocks, mathematical operations, state space system representation, state-machines logics, etc.
- Simplorer can run three types of analysis: **Transient** (time domain), **AC** (Frequency domain) and **DC** (steady state)
- Simplorer is an environment specifically designed for system analysis through co-simulations and couplings with several further software products like ANSYS Maxwell, ANSYS Icepack, ANSYS Fluent, ANSYS SIwave, Simulink®, etc.

Electromechanical Components and Systems

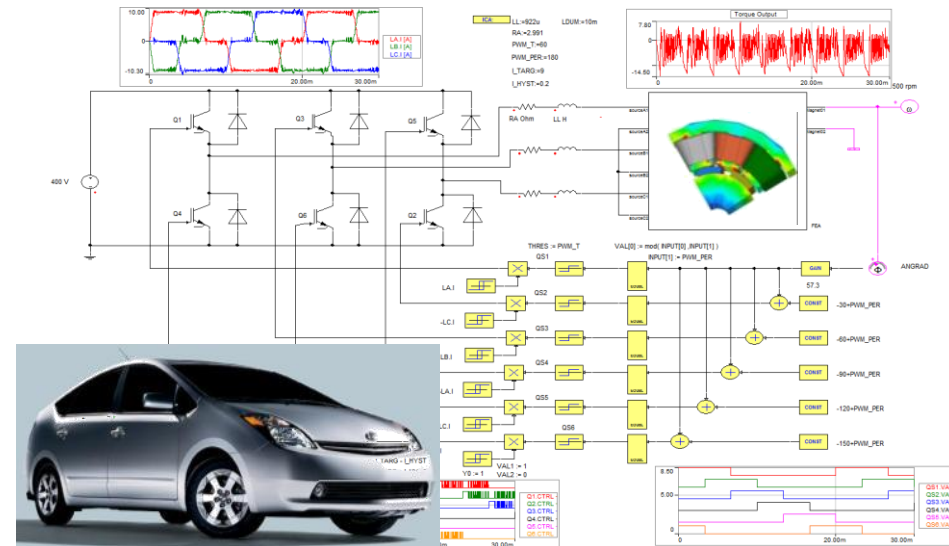
• Component Analysis

- Look at *component* alone
- Motors, actuators, coils, ...
- Usually by field simulation or analytical models (e.g. Maxwell)
- Distributed parameters – geometry, materials, boundaries, sources

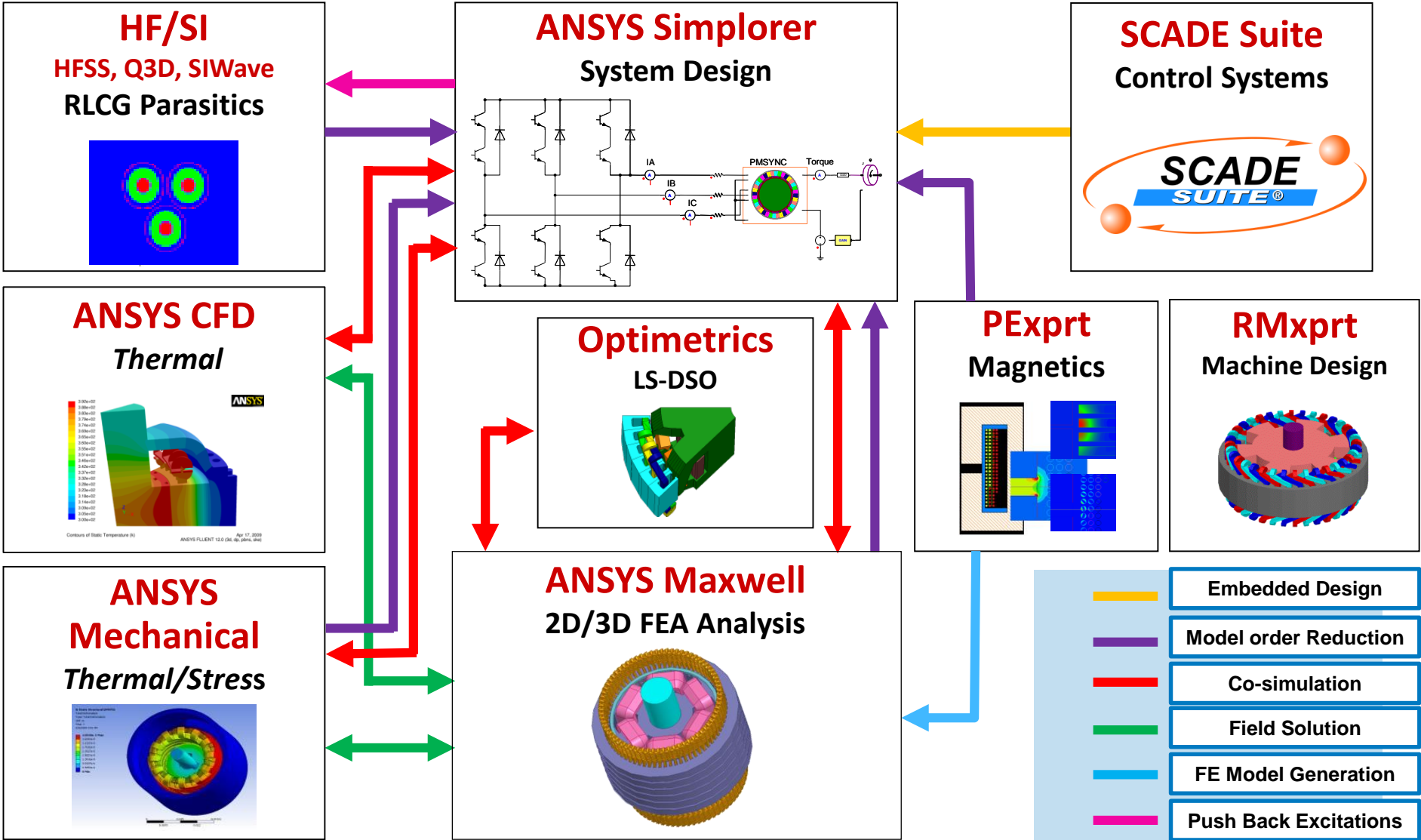


• System Analysis

- Look at *interactions* of components
- Drives, converters, motors, coils, resistors, ...
- Usually by system/circuit simulation or analytical models (*Simplorer*)
- Lumped parameters – behavioral component models

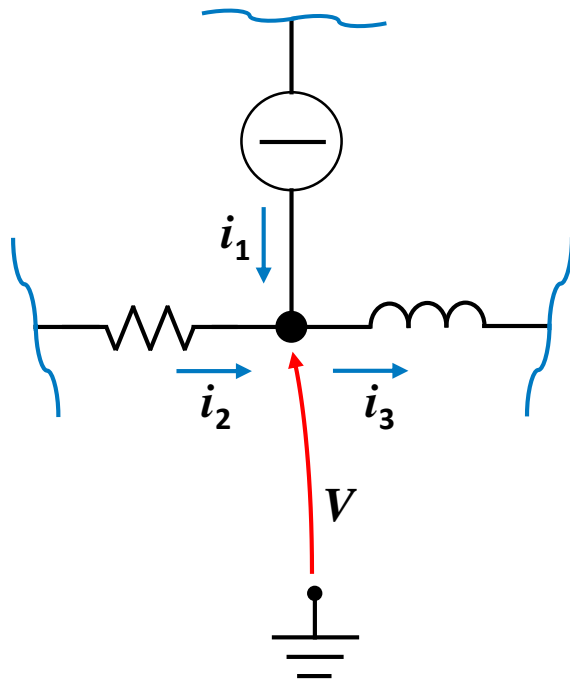


ANSYS Electromechanical System Solution

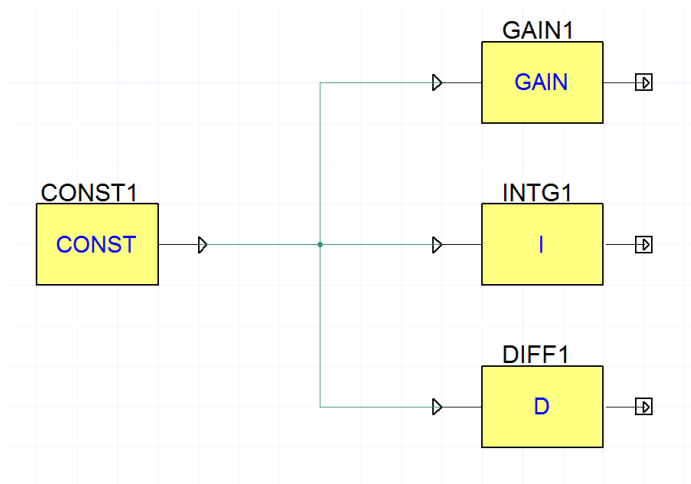


Conservative vs Non-Conservative Nodes

- A Conservative node can be defined as a node where the input power is identical to the output power (in other words there is no energy consumption inside the node)
- Looking at the figure below on the left, it is clear that the represented node is conservative, since $i_1 + i_2 = i_3$ and therefore the total power passing through the node is 0: $V*i_1 + V*i_2 - V*i_3 = V*(i_1 + i_2 - i_3) = 0$, where V is the node voltage with respect to the reference node (ground)

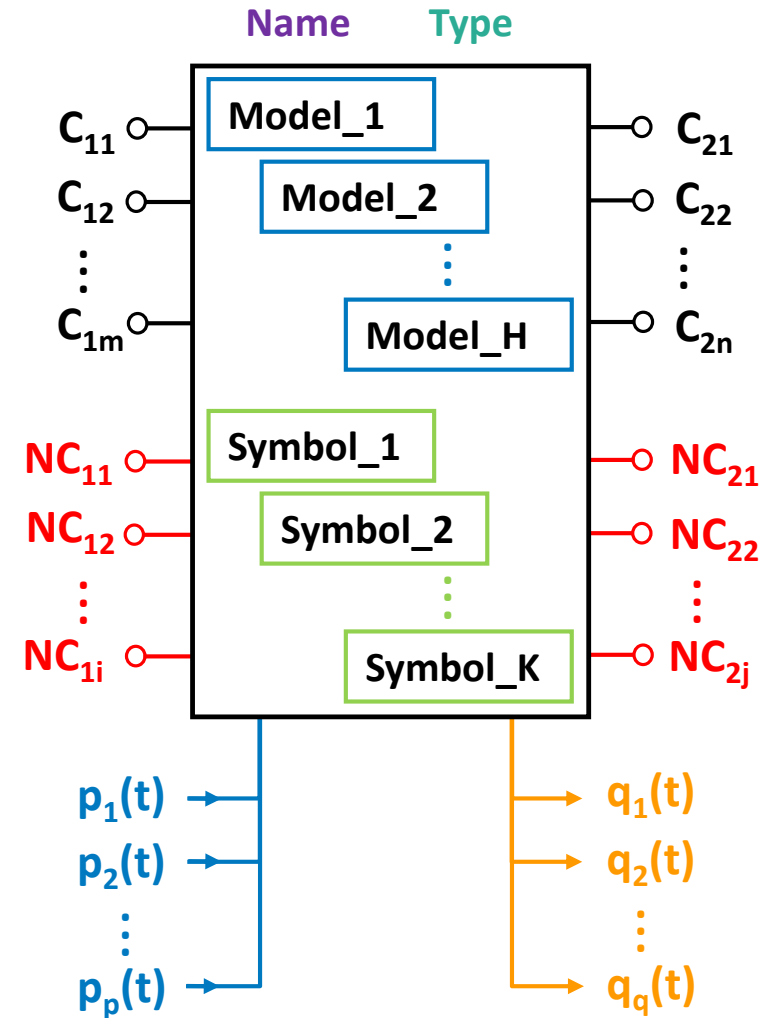


- A node not fulfilling the above requisite (figure below on the right) is called Non-Conservative

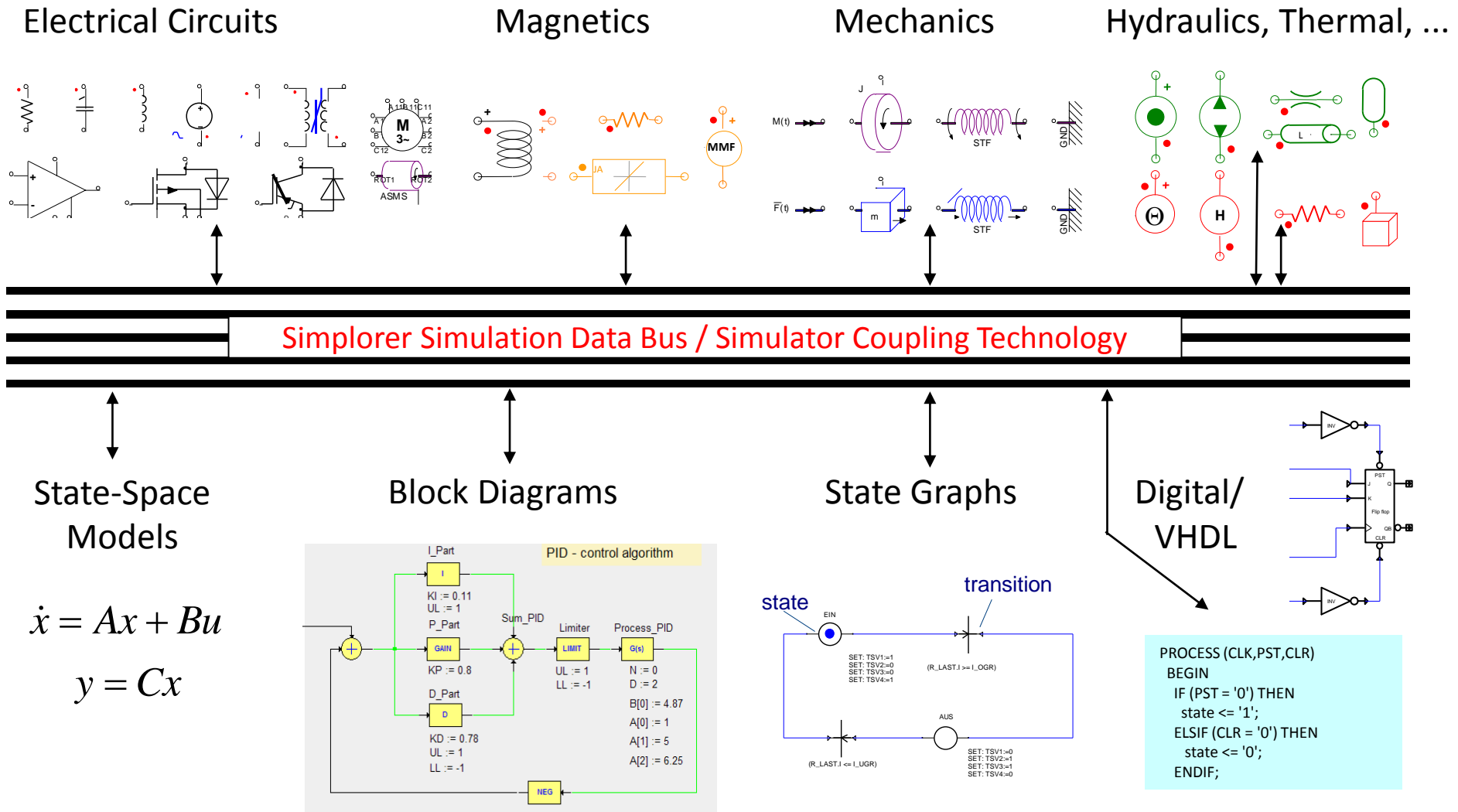


Components Structure in Simplorer

- A Component in Simplorer is a frame (or structure) having several properties:
- Is identified by a **Name** and a **Type**
- Contains one or more **Models** (behavior definitions), and models can be written also using different codes (SML, VHDL, C, etc.)
- Contains one or more **Symbols**, i.e. the graphical representations of component itself
- Can have multiple Terminals/Pins, which can be **Conservative** and/or **Non-Conservative** nodes (**Non-Conservative** nodes show always a direction: **in**, **out** or **in/out**)
- Furthermore, a component can have Terminals/Pins (behaving like Non-Conservative nodes) for input **Parameters** and for output **Quantities/Signals** (also time-dependent). An example can be a time-varying resistance value as input **Parameter** and the resistance power loss as output **Quantity**

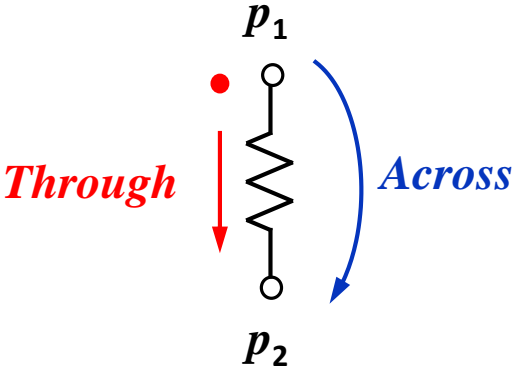


ANSYS Simplorer – Multidomain



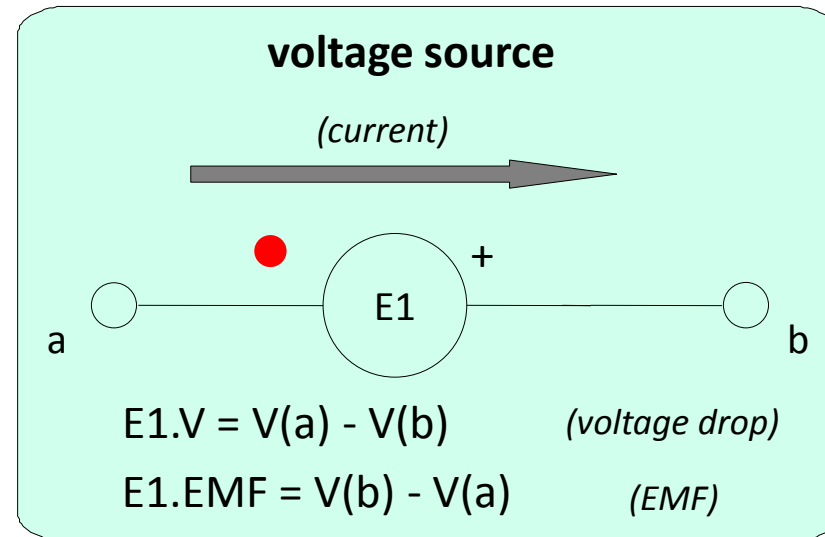
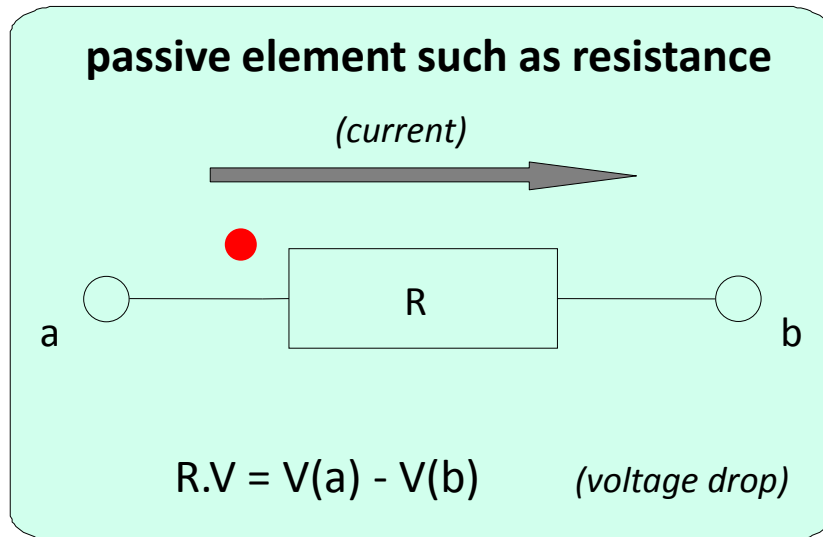
Domains

Components models can support *nature types* for several physical domains. *Nature types* are properties of conservative nodes (also referred to as **ports** or **terminals**) of models. At least one specific nature exists for each domain. An **Across** and a **Through** quantity is associated with each nature. The following table links the **Across** and **Through** quantities for each nature type:

Nature	Across	Through	Circuit
<i>Electrical</i>	Voltage [V]	Current [A]	
<i>Fluidic</i>	Pressure [Pa]	Flow Rate [m³/s]	
<i>Magnetic</i>	Magneto Motive force [A]	Magnetic Flux [Wb]	
<i>Translational</i>	Displacement [m]	Force [N]	
<i>Translational_v</i>	Velocity [m/s]	Force [N]	
<i>Rotational</i>	Angle [rad]	Torque [Nm]	
<i>Rotational_v</i>	Angular velocity [rad/s]	Torque [Nm]	
<i>Thermal</i>	Temperature [K]	Heat Flow [J/s]	

Across and Through Quantities: Conventions

- To measure **Across** and **Through** quantities a **red dot** on the model Symbol is used to describe the following convention (it is supposed here that the red dot is placed on **Pin a** side):
- **Across** quantities: Value is calculated by subtracting the value at **Pin b** from the value at **Pin a**
- **Through** quantities: Value is positive if the quantity flows into the model at the pin marked with the red dot



Note: when using voltage sources, it is best to select the **Spice compatible** box so that $E1.V = E1.EMF = V(b) - V(a)$

Graphical User Interface (GUI)

Menu bar
Tool Icon bar

Project Manager window and project tree

Properties window

Status bar

Schematic Capture Window

Component Library

Message Manager window

Progress window

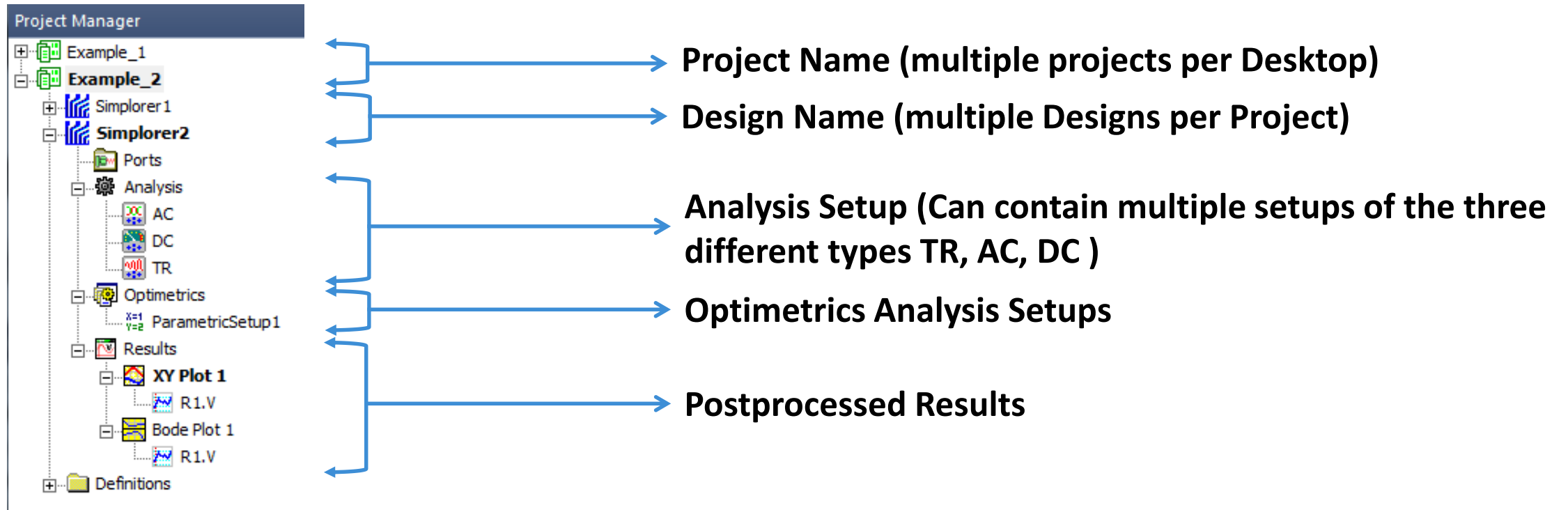
The screenshot displays the ANSYS Electronics Desktop GUI for a motor simulation project. The main window is the Schematic Capture Window, showing a circuit diagram of a motor. The Project Manager window on the left shows the project tree with folders for Ports, Analysis, Results, and Definitions. The Properties window below the Project Manager shows the parameters for the selected component, including Name, Value, Unit, and SDB. The Component Library on the right lists various components like Resistor, Inductor, Capacitor, Diode, Voltage Source, and Motor. The Message Manager window at the bottom left shows the simulation progress, and the Progress window at the bottom right shows the simulation status and progress bar.

Name	Value	Unit	SDB
AC_IM	0	V	
EMF	1	V	
FREQ	60	Hz	
TPERIO	Tend+1		
AMPL	169.70562748477	V	
PHASE	0	deg	
PERIO	0		
OFF	0	V	
TDELAY	0	s	
TRISE	0.005	s	
TFALL	0.01	s	
PWIDTH	0.005	s	


Graphical User Interface (GUI)

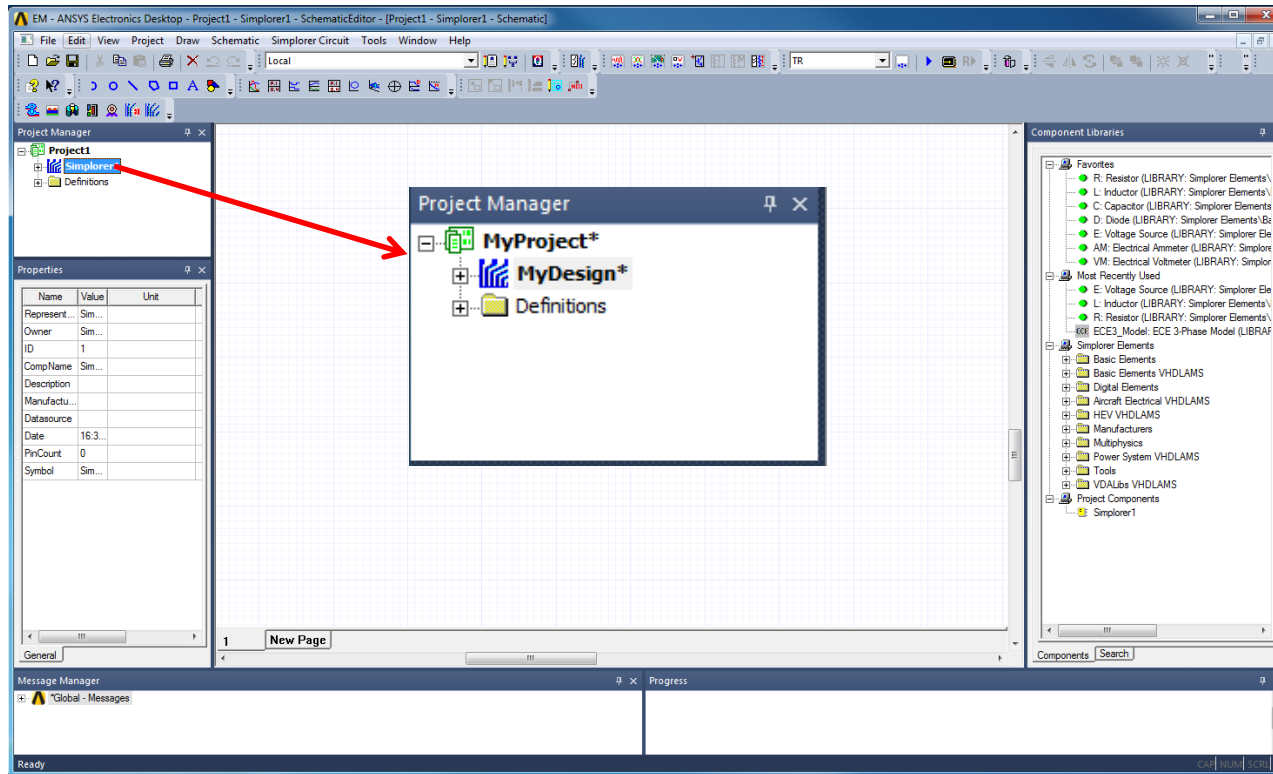
- **Project Manager Window**

- Project Manager Window contains all the details of Problem Setup done for any project



Adding a Simplorer Design

- Click the icon  to insert a Simplorer Design or use the menu item **Project** → **Insert Simplorer Design**
- Use **RMB** (Right Mouse Button) to rename the Project to “MyProject” and the Design “MyDesign”

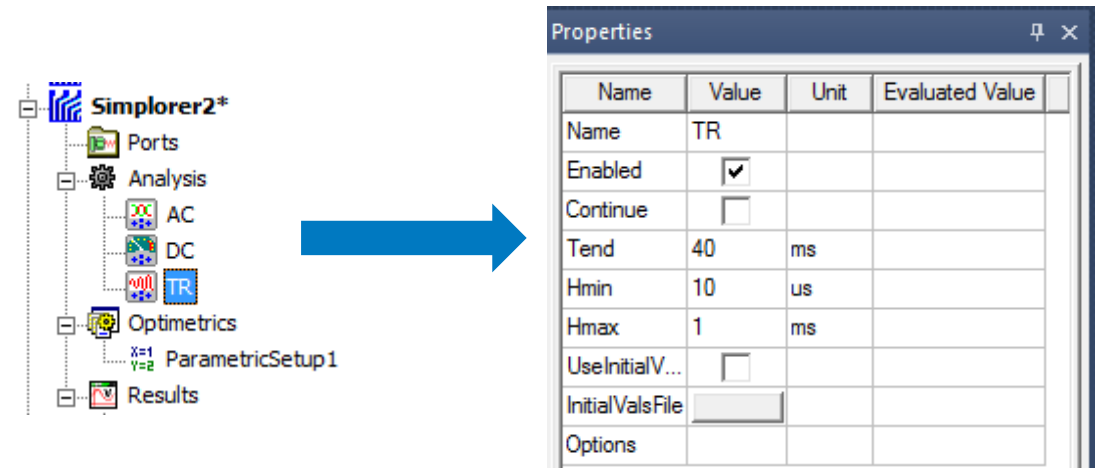
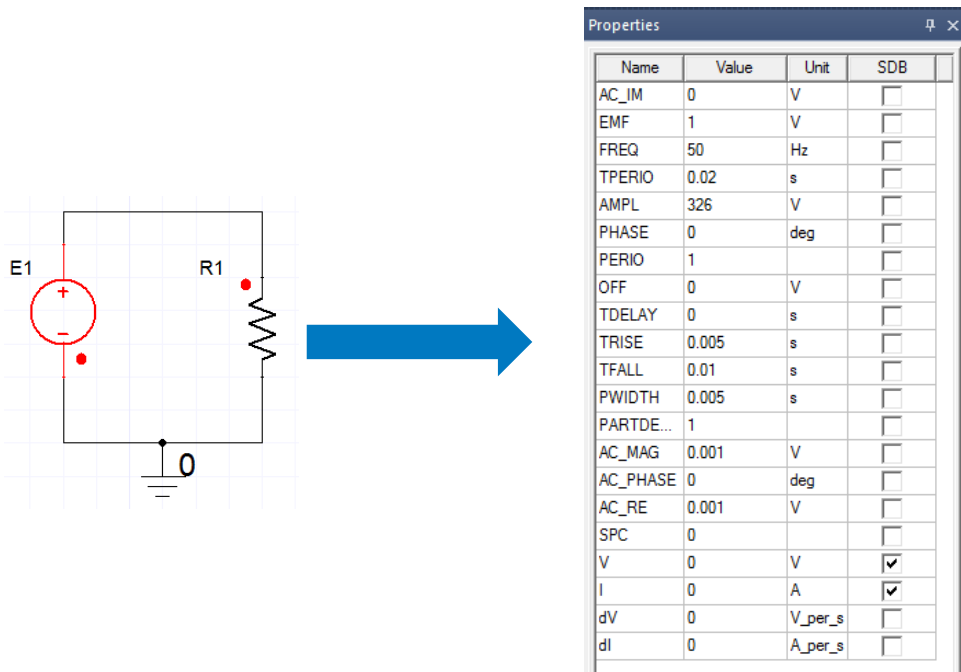


Note the “” will appear near Project and Design names meaning something has changed and user needs to save*

Graphical User Interface (GUI)

- **Properties Window**

- Note different properties menus can be invoked using RMB in different areas of the UI
- Shows all the properties of selected entities. To select an entity use LMB
- Selected entity can be any component placed in the schematic or any added setup entities selected from Project Manager window
- Display of Properties window will change based on selected entity



Graphical User Interface (GUI)

- **Toolbars**

- Most of the menu bar commands can be accessed from Toolbar as an icon
- Toolbar can be customized to add or remove any options by right clicking on Toolbar or selecting the menu item *Tools → Customize*

- **Message Window**

- Displays Error, Warning or Information messages resulting from an operation
- Messages can be Copy-Pasted to text file if required

- **Status Bar**

- Shows status of Simplorer window, prompts next course of action for any operation in the Schematic or information about any command on which mouse is placed

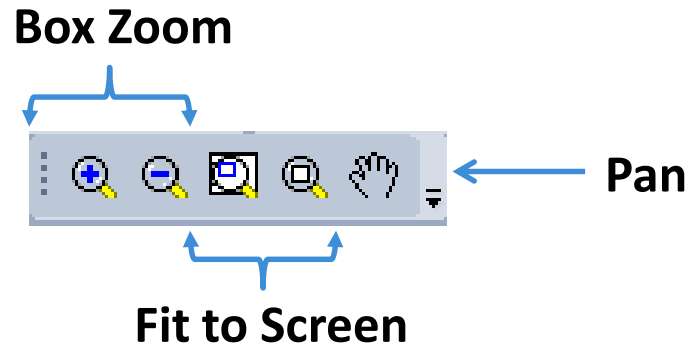
- **Progress Window**

- Shows progress of Analysis operation being carried out

Graphical User Interface (GUI)

- **Schematic Capture Window**

- Schematic Capture window enables users to view and interact with Components dynamically
- Components in Schematic Capture window can be manipulated either using Toolbar commands or Mouse-keyboard keys



- Mouse Commands and Short-keays for View and Selection Manipulation
 - **Zoom**: Right click and drag the mouse button with SHIFT+ALT pressed
 - **Pan**: Right click and drag the mouse button with SHIFT pressed
 - **Fit all**: Ctrl+D
 - **Select All**: Ctrl+A
 - **Rotate**: Ctrl+R

Simplorer File Structure

- **New File Structure in Simplorer for R17.0**

- **FileName.aedt** (Ansys Electronic Desk Top)

- This file contains all the information related to Simplorer project apart from results. The file is written in ASCII format.

- **FileName.aedtresults**





- This folder contains the solution related files. Users need to copy both *.aedt file and this folder in order to transfer the project with results

- **FileName.aedt.lock**

- This is a lock file created when file is open to avoid overwriting of file from multiple sessions

- **FileName.aedt.auto**

- Autosave file in order to recover lost data in case of unusual file closure. Created only when Autosave is turned ON

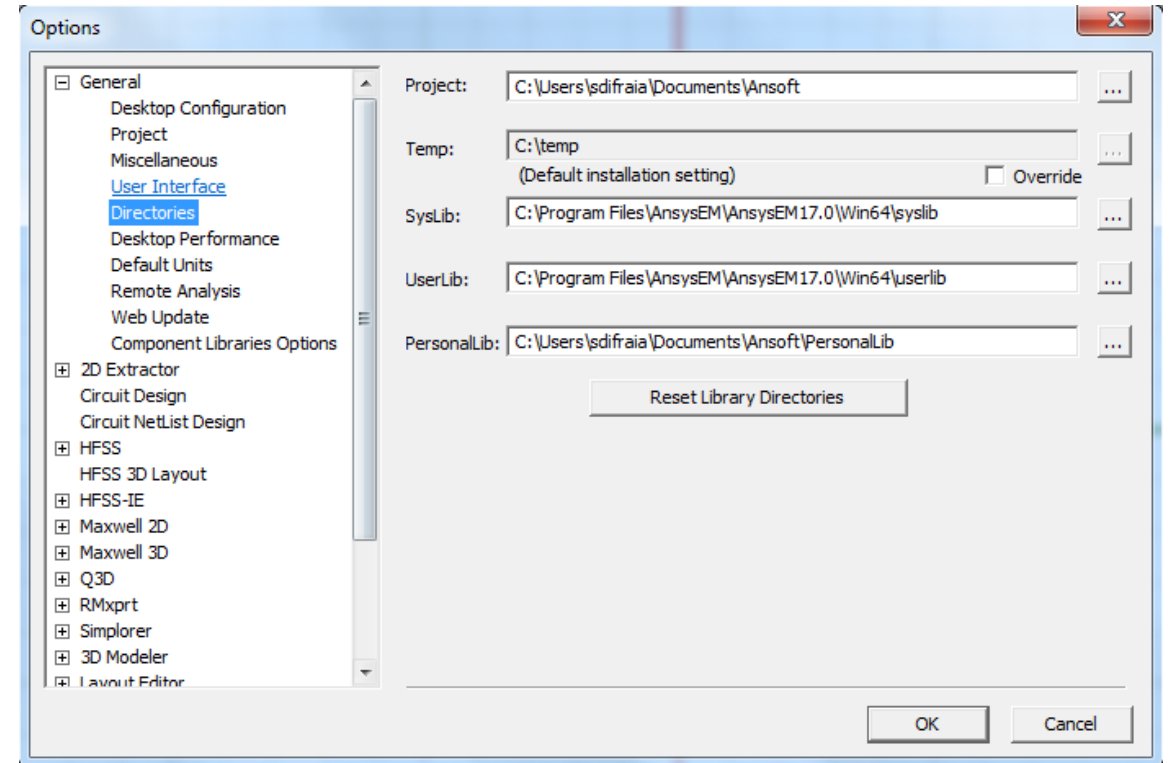
Name	Date	Type	Size
 example.aedtresults	22.02.2016 10:51	File folder	
 example.aedt	22.02.2016 10:50	Ansoft Electronics...	613 KB
 example.aedt.auto	22.02.2016 10:55	AUTO File	572 KB
 example.aedt.lock	22.02.2016 10:53	LOCK File	1 KB

Simplorer Folders

- Simplorer Folders

- Simplorer Folder locations can be set from the menu item *Tools → Options → General → Directories*

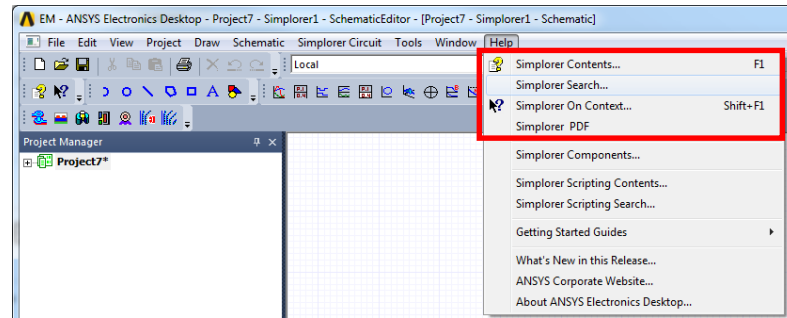
- **Project**: The default location where Simplorer project file is saved
 - **Temp**: Location for saving Temporary results files. Files will be deleted once project is saved
 - **SysLib**: Global level directory predefined by ANSYS and ships with new upgrades
 - **UserLib**: Can host user created material libraries or script files. Can be shared among all users at a company
 - **PersonalLib**: Can host user created material libraries or script files. Accessible only the user who creates it



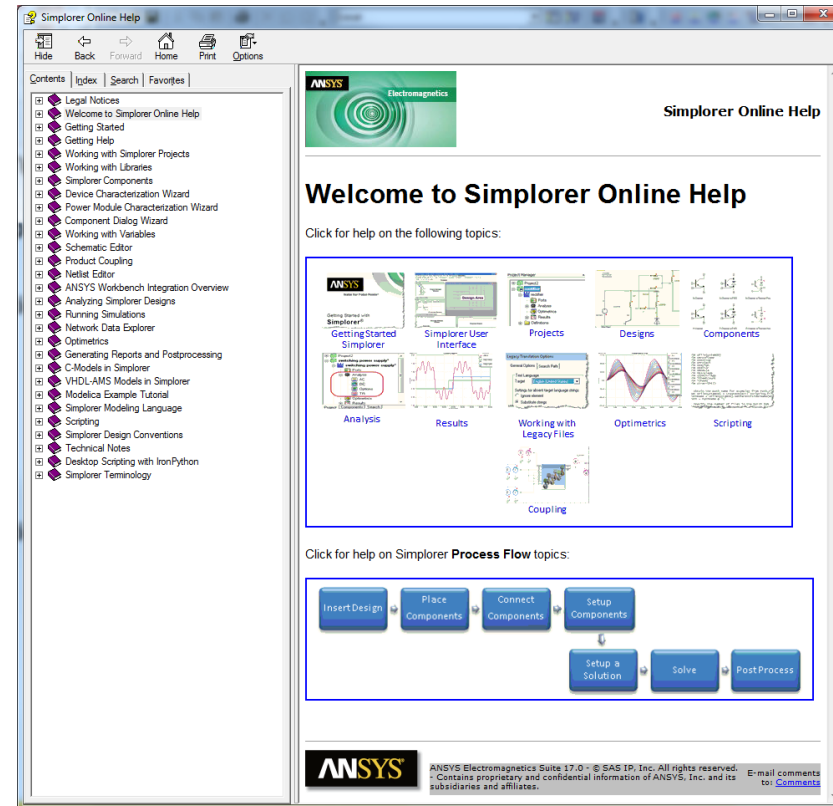
Simplorer Help

- Simplorer Help manual can be accessed from following locations:

– Option 1:



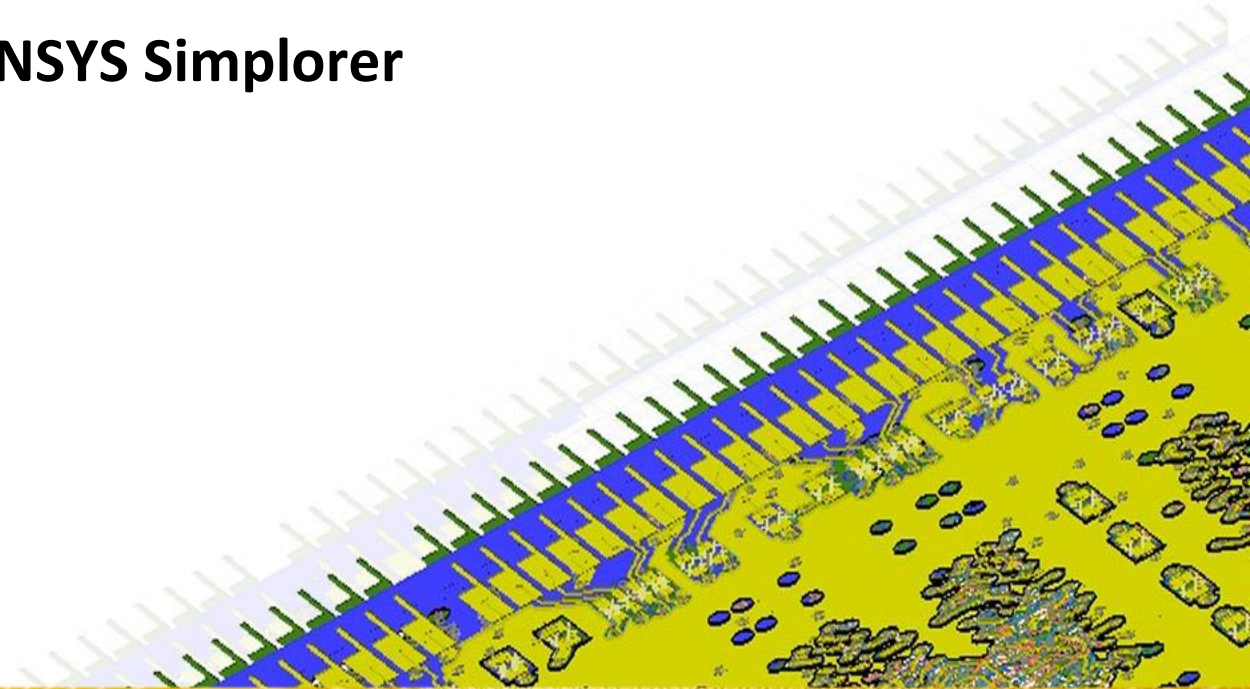
– Option 2: Use short cut key “F1”





Components

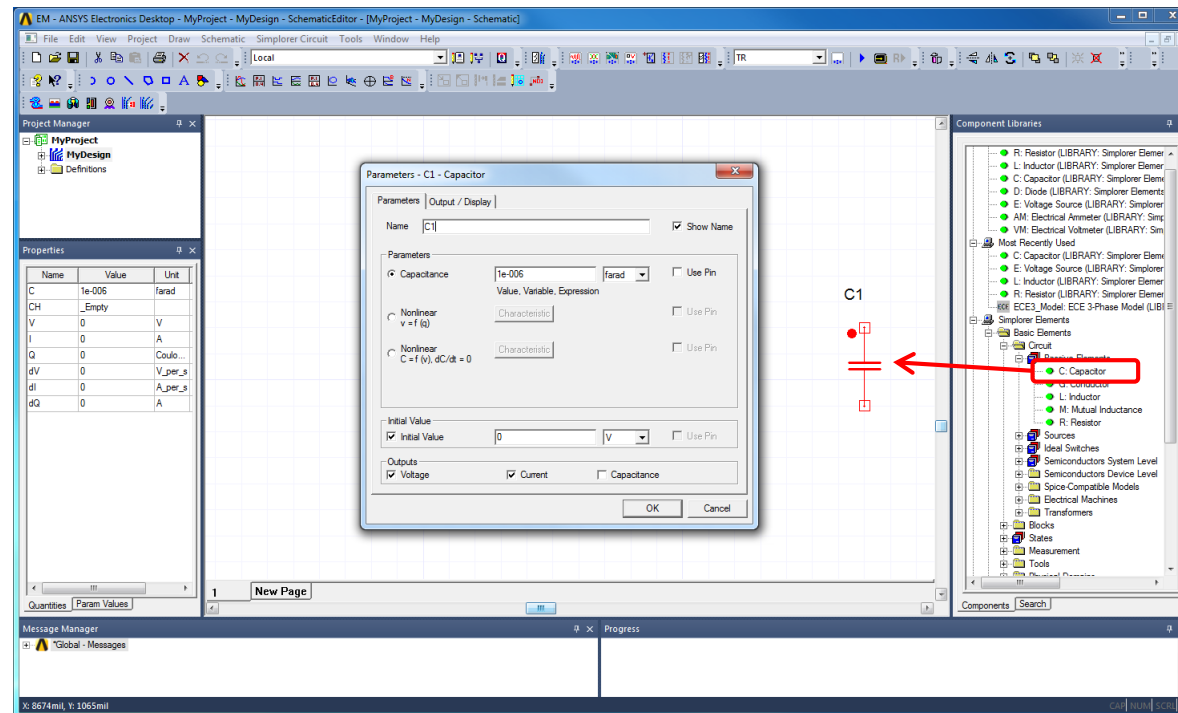
Introduction to ANSYS Simplorer



Adding Components

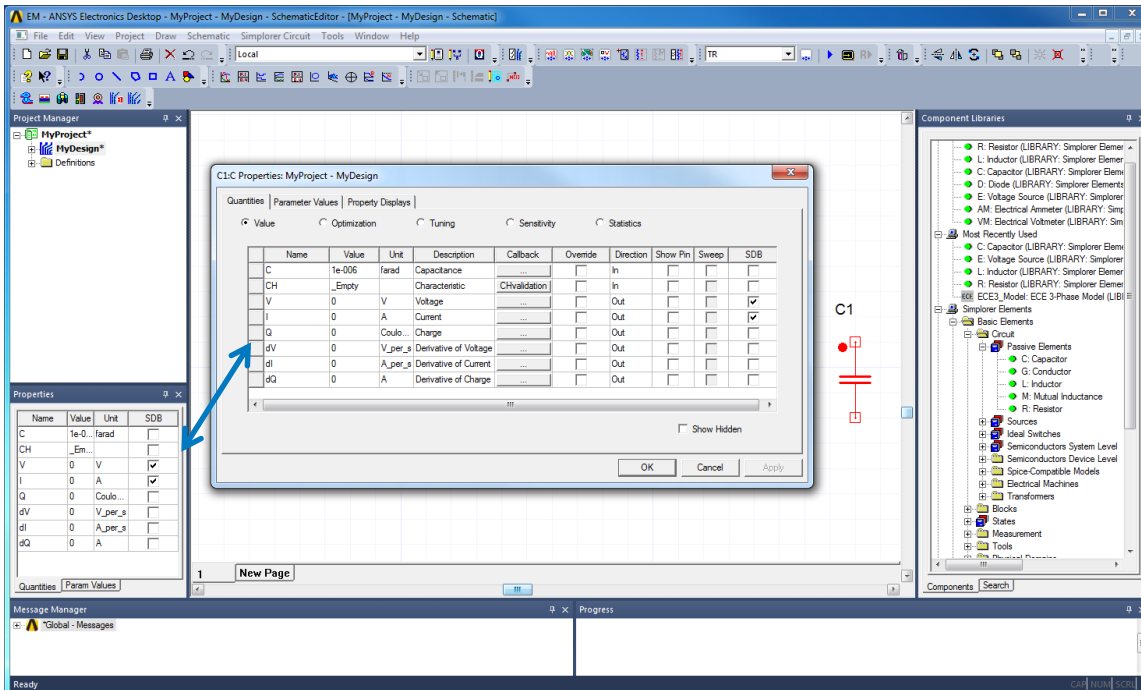
- Insert components via the “Component Library” window
 - Expand folders to select the desired component and then drag and drop it into the schematic window. By default multiple placement is active and pressing the **ESC** key is needed to exit the component insert mode. To modify the default settings go to **Tools** → **Options** → **General Options** → **Schematic Editor** → **Multiple placement** and uncheck the desired items
 - Once on schematic, double click on the part to bring up the related properties window

Note: for reactive components like e.g. Capacitors and Inductors the definition of suitable Initial Values is available

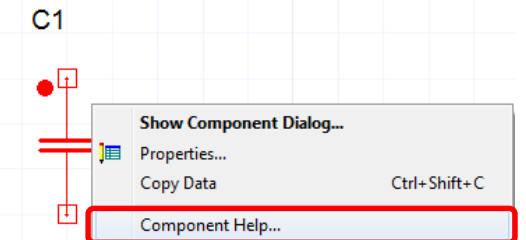


Adding Components

- A second type of property window is also available. This is selected by placing the mouse over the component already in the schematic, then **RMB** → **Properties**
- Note this is the same one that is found in the **Properties** window in the GUI
- Note the **Info** button under the **Parameter Values Tab** for Help or **RMB** over component to bring up menu for **Component Help**

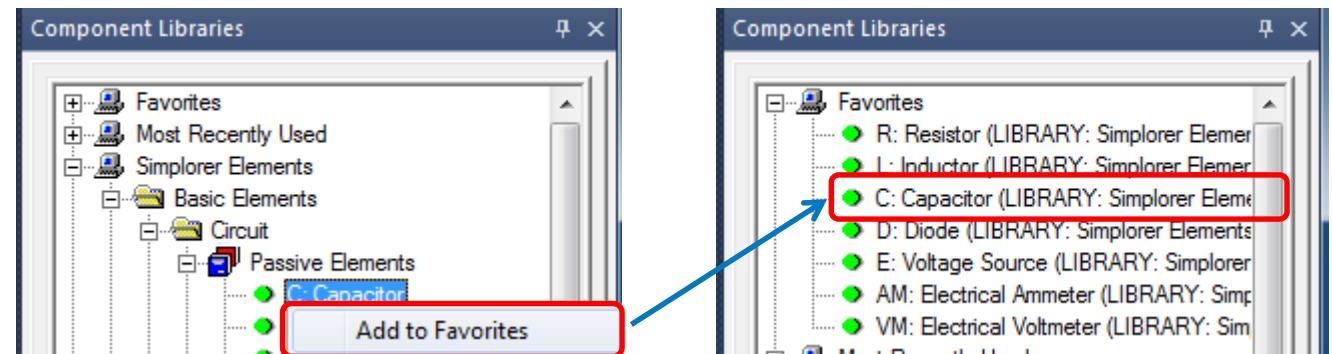
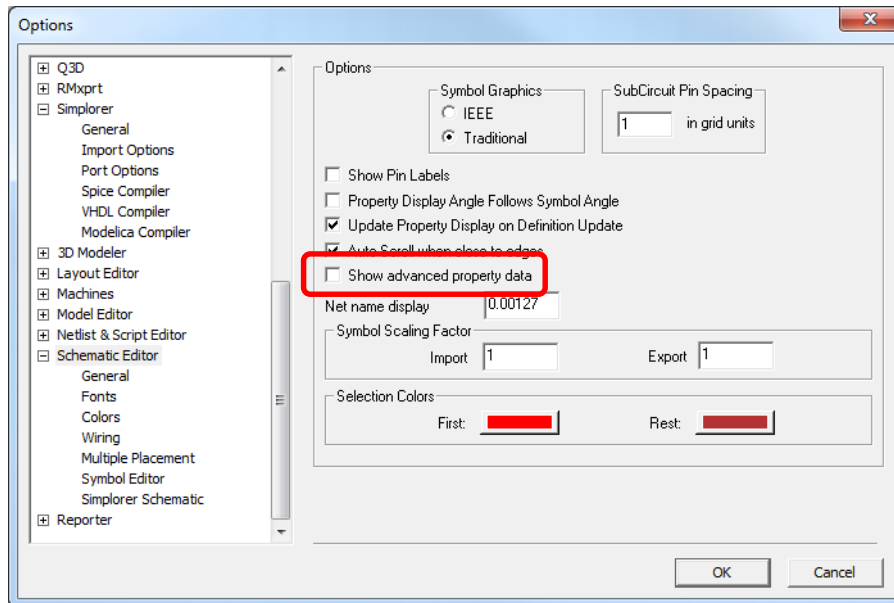


Parameter Values		
Value		
Name	Value	Unit
CH_FILE		
CH_ST...		
Instanc...	C1	
NLTYPE	CH	
Type	C	
CH_DA...	0	
UseIniti...	<input checked="" type="checkbox"/>	
CompDlg	C	
V0	0	V
Simulato...	C	
Status	Active	
Info	C	



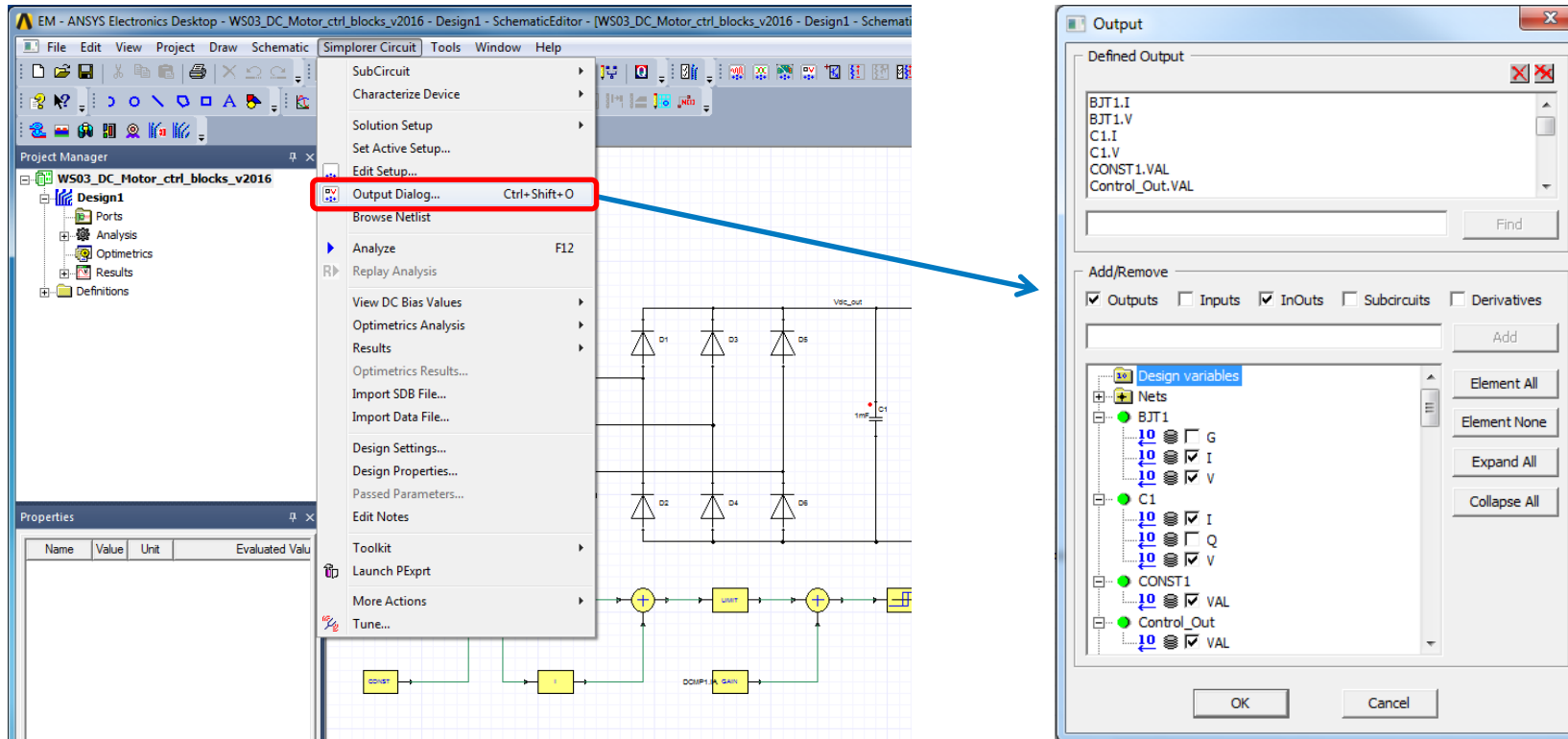
Adding Components

- To display more tab options, use menu *Tools* → *Options* → *General Options* → *Schematic Editor* and select **Show advanced property data**
- Components can be added to the **Favorites** section in the Component Manager window to be readily available in the future.
- This is done by selecting the component in the Component Manager, then *RMB* → *Add to Favorites*



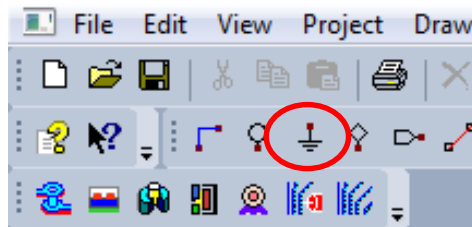
Define Outputs

- Once the schematic is finished, the user can define for each component the desired outputs to save to the database file and view after simulation.
- Select the menu item **Simplorer Circuit** → **Output Dialog** to bring up the dialog window which allows the user to choose desired signals
- Note: for each component the **Across** and **Through** quantities are saved as outputs per default

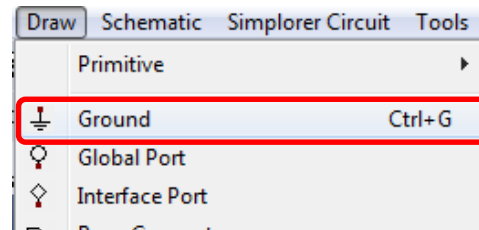


Ground Node

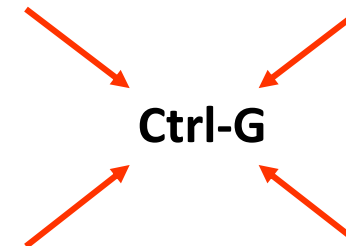
- A very important component is the **Ground** node, used as reference (0) node for the voltages
- Every Schematic must contain at least one **Ground** node
- There are several ways to insert the **Ground** node in a Schematic:
- Using the icon on the toolbars
- Selecting menu item **Draw** → **Ground**
- Using the key combination **Ctrl+G**



Toolbar

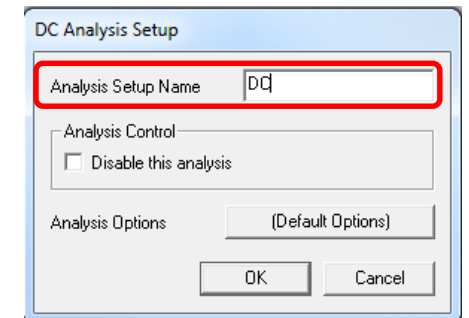
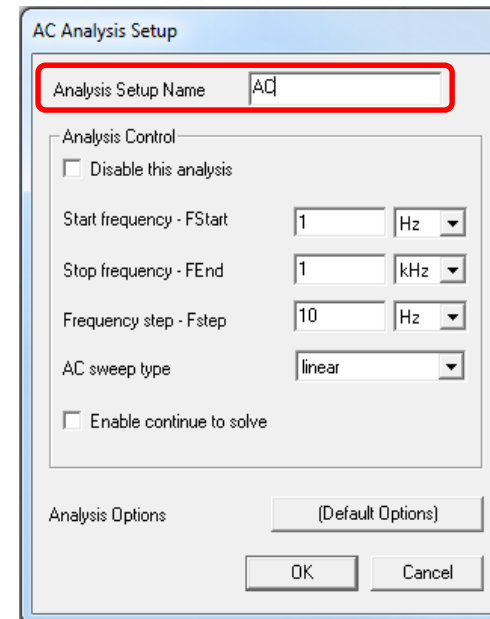
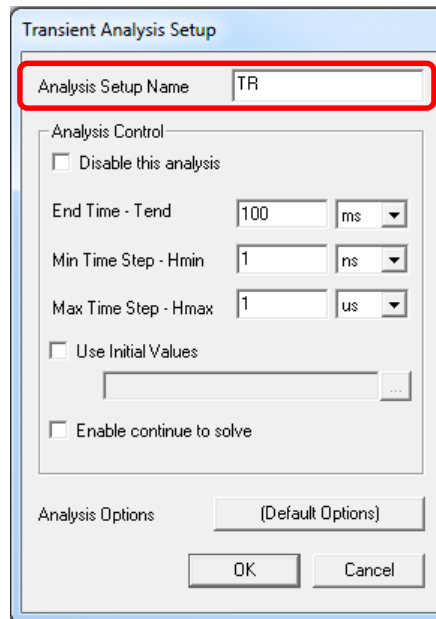
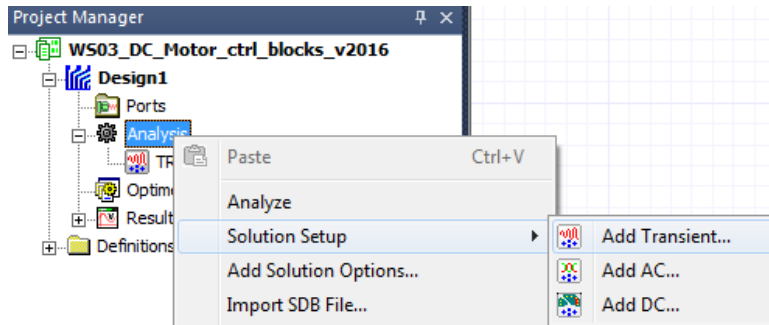
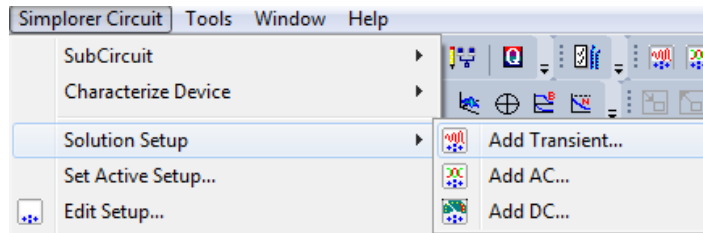


Draw Menu



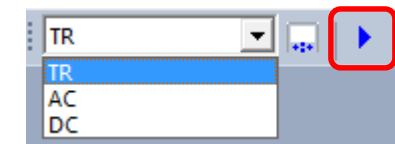
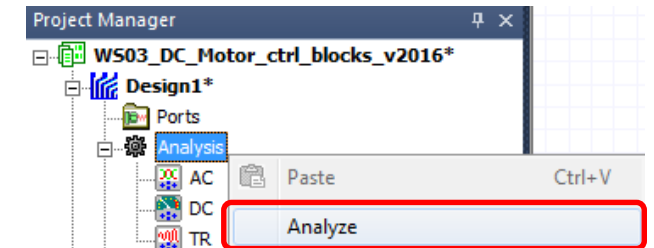
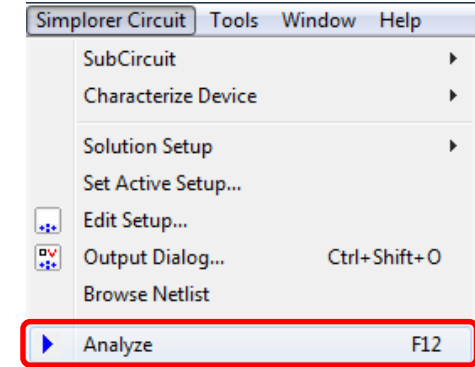
Set Up Simulation

- Simplorer offers the possibility to perform three different types of analysis: **Transient** (time domain), **AC** (frequency domain – sinusoidal signals) and **DC** (steady state constant)
- To add a Solution Setup select menu item **Simplorer Circuit** → **Solution setup** → **Add...** (Choose between **Transient, AC, DC**)
- It is also possible to place the mouse over “Analysis” in the Project Manager window and use the RMB to bring up the selections



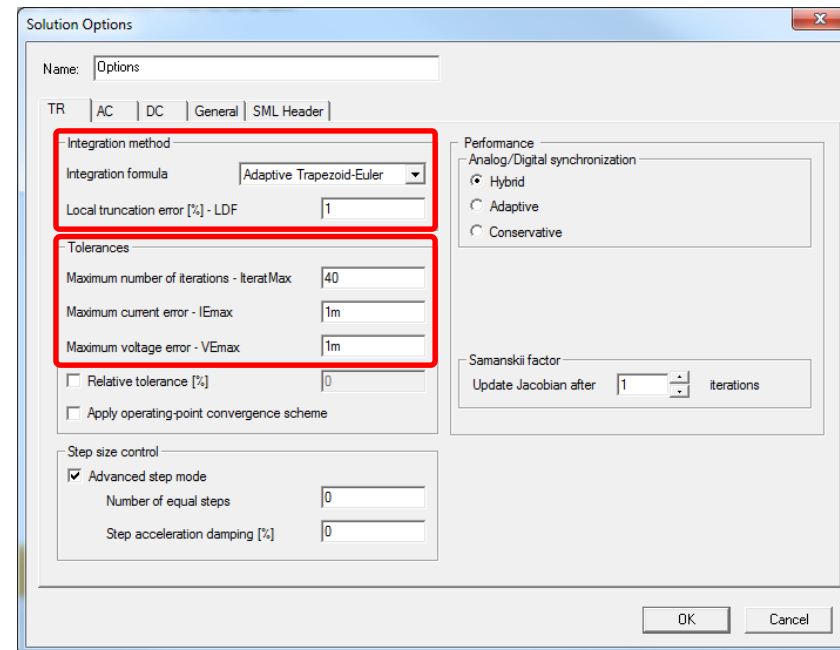
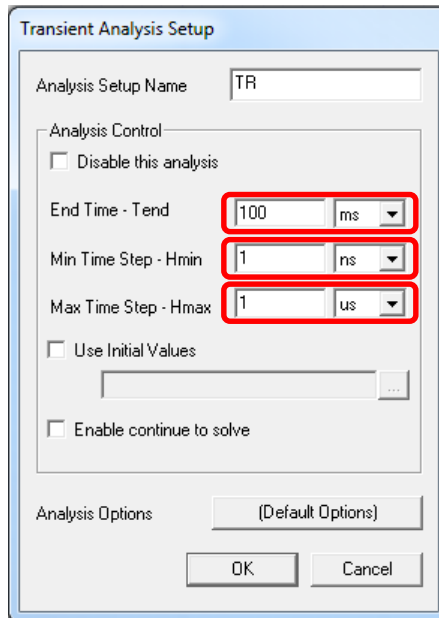
Simulate the Design

- To simulate the design, select the menu item *Simplorer Circuit* → *Analyze*
- It is also possible to use in the project manager window the *RMB over Analysis* → *Analyze*
- Or select desired Simulation at the top pull down menu, and click the icon representing a blue arrow



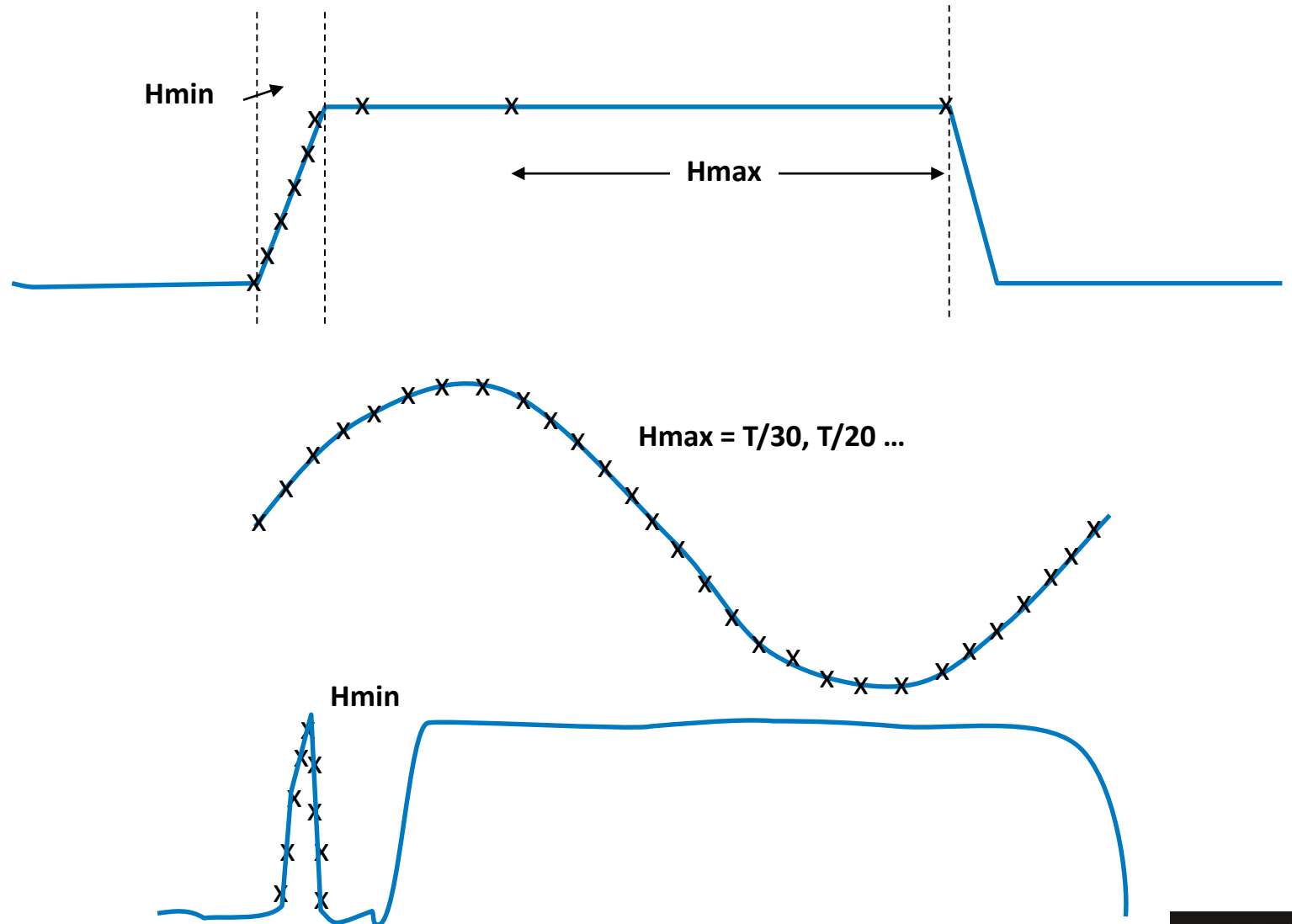
Transient Analysis (Time Domain)

- In the Transient Analysis Setup the most important parameters to be set are the Simulation Stop Time (**Tend**) and the minimum and maximum time steps (called **Hmin** and **Hmax**, respectively)
- Simplorer allows the solver to have a sort of flexibility in choosing the most suitable time step between **Hmin** and **Hmax**, optimizing the accuracy and the overall simulation time (see next slide)
- A further level of adjustment is shown in the highlighted sections in the “**Solution Options**” window if simulation convergence becomes an issue



Simulation Time Step (Hmin, Hmax)

- **Hmin** (Minimum time step) is set so the simulation can capture fast transients
- **Hmax** (Maximum time step) is set so the simulation can take the largest steps possible during times where the waveforms are not changing much. This helps to speed up Simulation
- Note also the **Hmax** can be set to force steps that yield higher fidelity waveforms
- Note also can set **Hmin = Hmax** for fixed time step operation



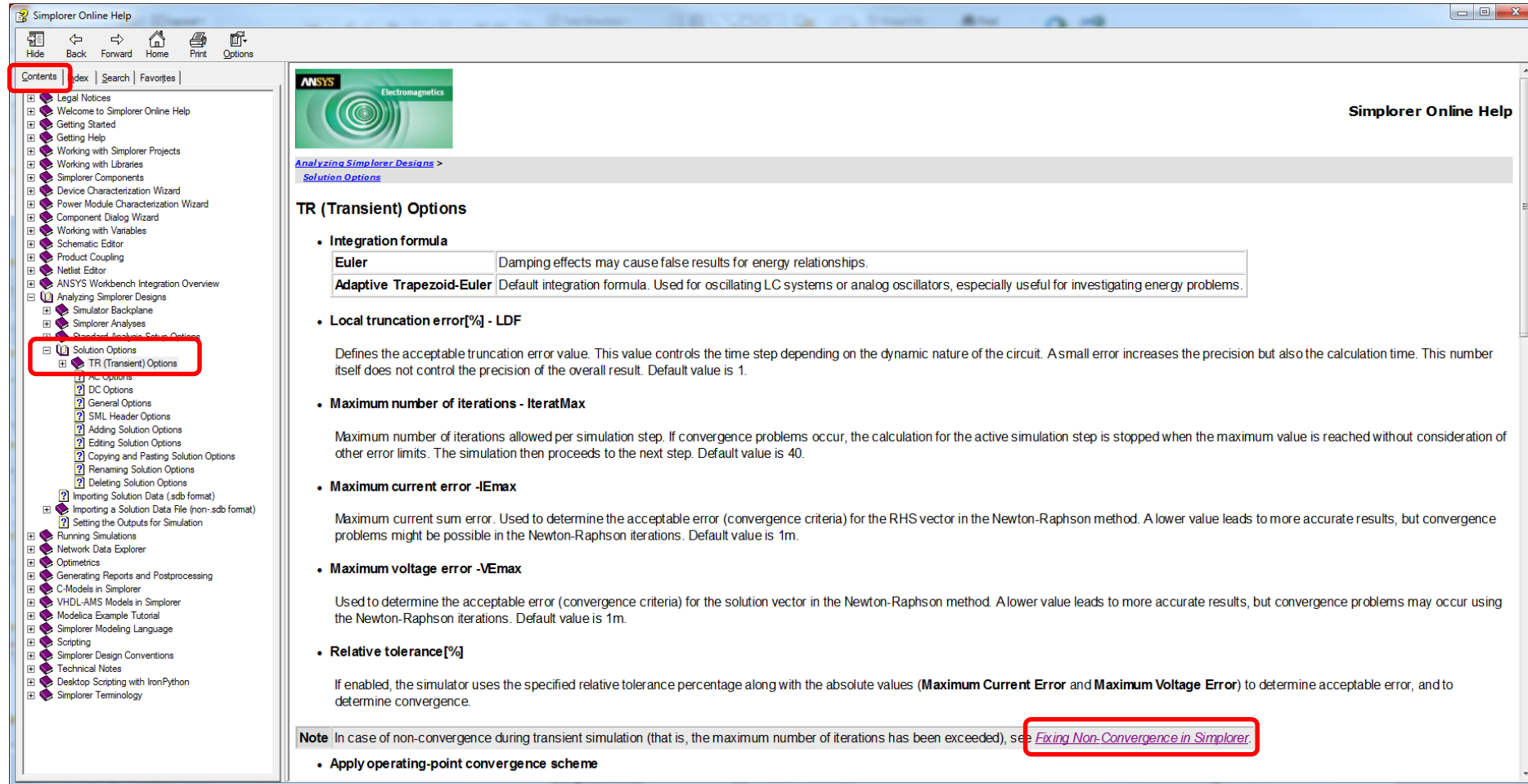
Simulation Time Step (Hmin, Hmax)

- Proper choice of minimum and maximum step size is important; the table below shows some basic guidance

Model Properties	Recommended
What is the smallest time constant (τ_{\min}) of the circuit or of the block diagram?	$H_{\min} < \tau_{\min} / 10$
What is the largest time constant (τ_{\max}) of the circuit or of the block diagram?	$H_{\max} < \tau_{\max} / 10$
Which is the smallest cycle (T_{\min}) of oscillations that can be expected (natural frequencies of the system or oscillating time functions)?	$H_{\min} < T_{\min} / 20$
Which is the largest cycle (T_{\max}) of oscillations that can be expected (natural frequencies of the system or oscillating time functions)?	$H_{\max} < T_{\max} / 20$
What is the smallest controlling sampling time (TS_{\min})?	$H_{\min} < TS_{\min} / 5$ $H_{\max} = TS_{\min}$
What is the fastest transient occurrence (TU_{\min} – edge changes of time functions)?	$H_{\min} < TU_{\min} / 20$
What is the time interval to be simulated (T_{end})	$H_{\max} < T_{\text{end}} / 50$

Simulation Parameters

- Detailed information on simulation options can be found in the [Help](#) section shown below. Note additional section on convergence



Variables and Parametric analysis

- Variables

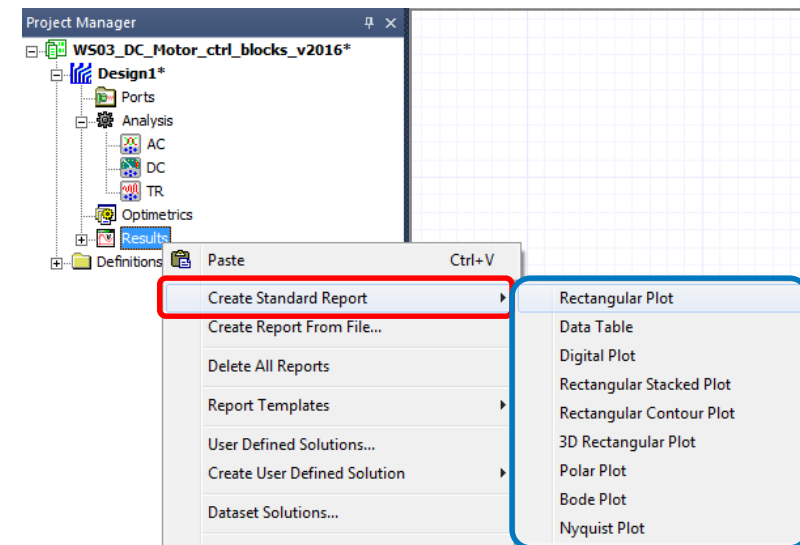
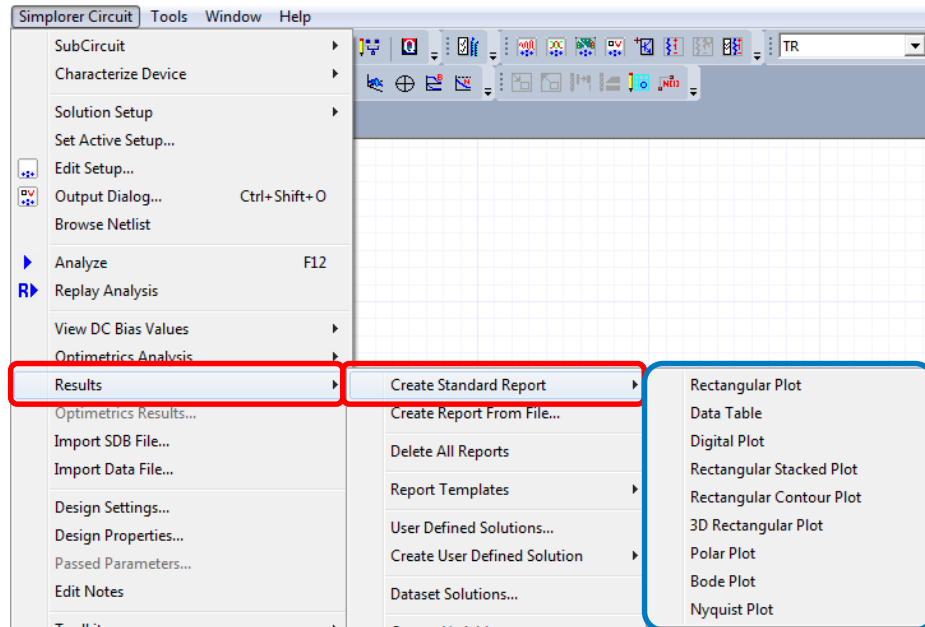
- All the Component properties and in general most of the settings can be parametrized through suitable variables
- Variables can be either **Local** (Design) or **Global** (Project)
- Local variables are valid only inside the Design where they have been defined
- Global variables begin always with the **\$** symbol and are shared through all the Designs belonging to the same Project

- Parametric analysis

- The **Optimetrics** module offers the possibility to sweep variables values and run a set of (even numerous) different simulations
- Parametric analysis is often used for model performances optimization or to study the influence of different parameters on devices performances
- Parametric analysis can be added through **RMB on Optimetrics → Add → Parametric**

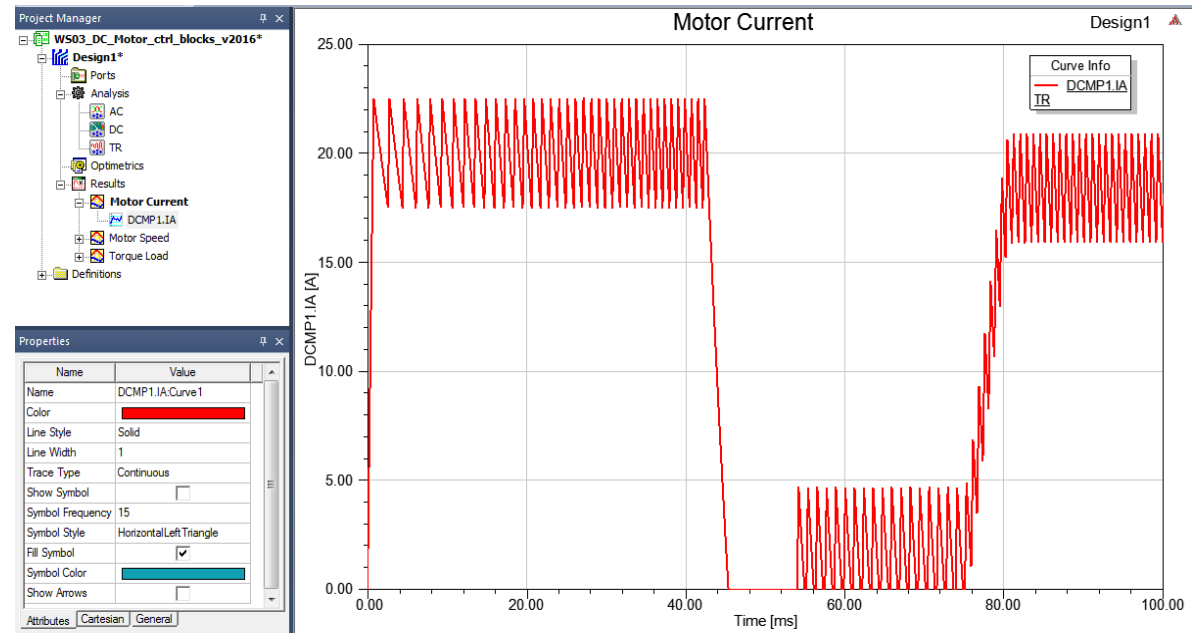
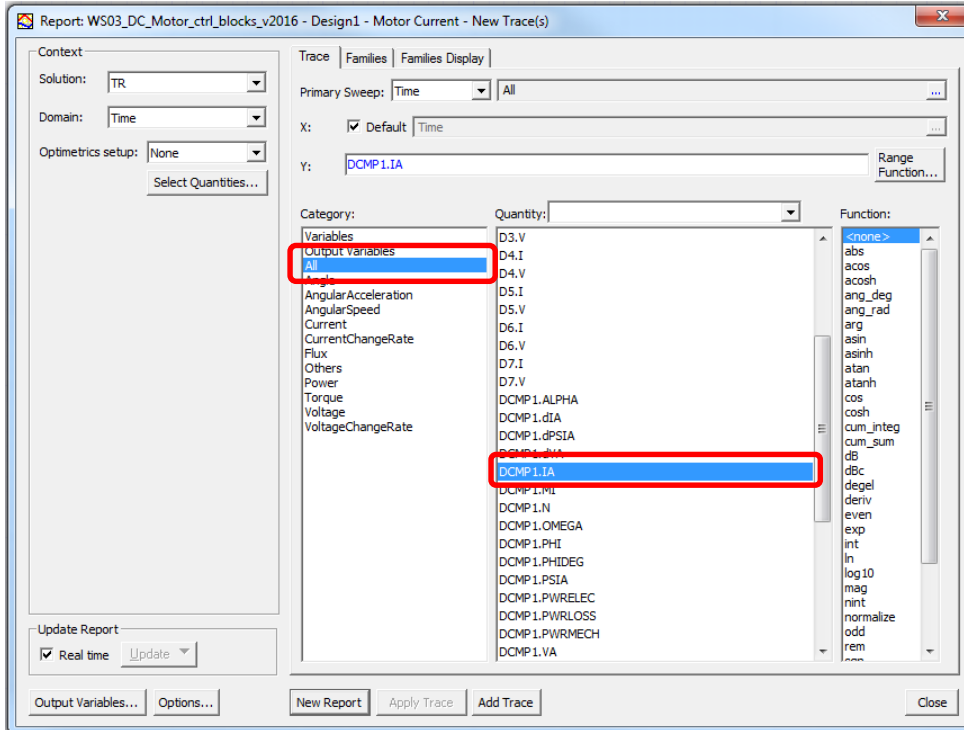
Post-Processing – Part 1

- To view the results, select the menu item *Simplorer Circuit* → *Results* → *Create Standard Report* or use the *RMB over Results* → *Create Standard Report* in the project manager window to create several types of plots.



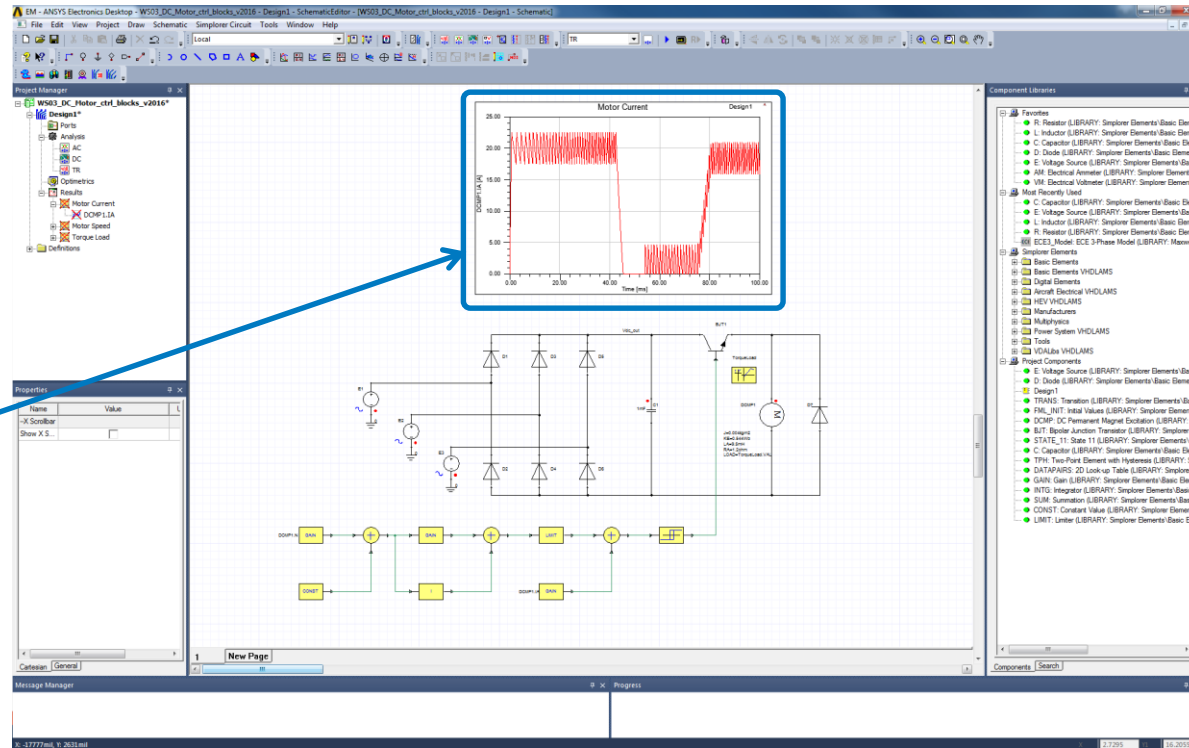
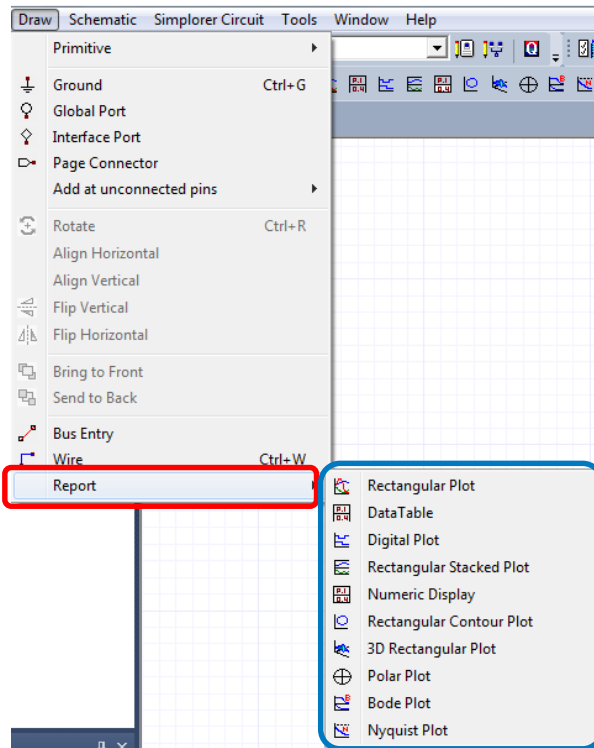
View Results (Reports)

- Once chosen the Plot type, it is possible to select the desired quantities to be shown and then click on New Report
- Depending on the Analysis type, the default quantity on the X-axis can be **Time** (Transient and DC) or **Frequency** (AC)



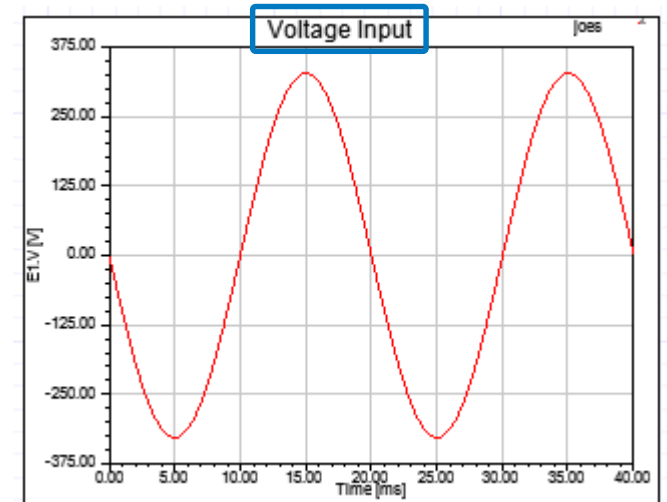
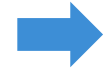
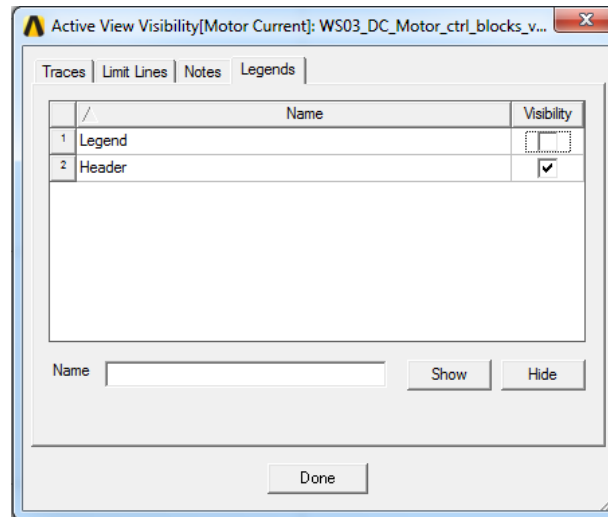
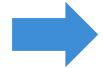
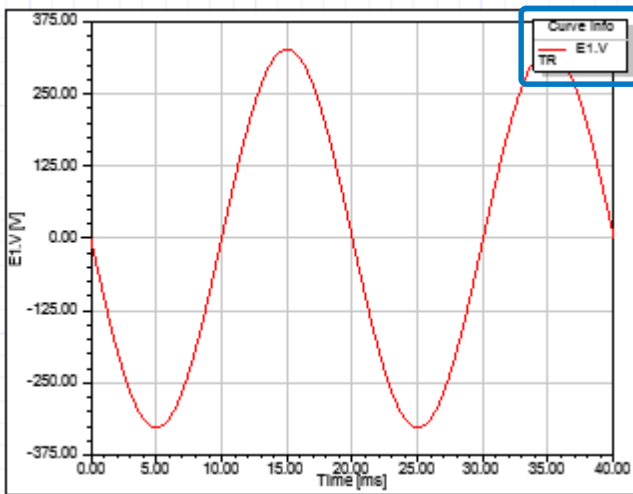
View Plots Directly on Schematic

- Plots can also be placed directly on the Schematic by selecting the menu item **Draw** → **Report** → **Report type** and placing it in the schematic
- The window with the selection of quantities pops-up automatically
- The Plot dimensions can be changed dynamically using the mouse



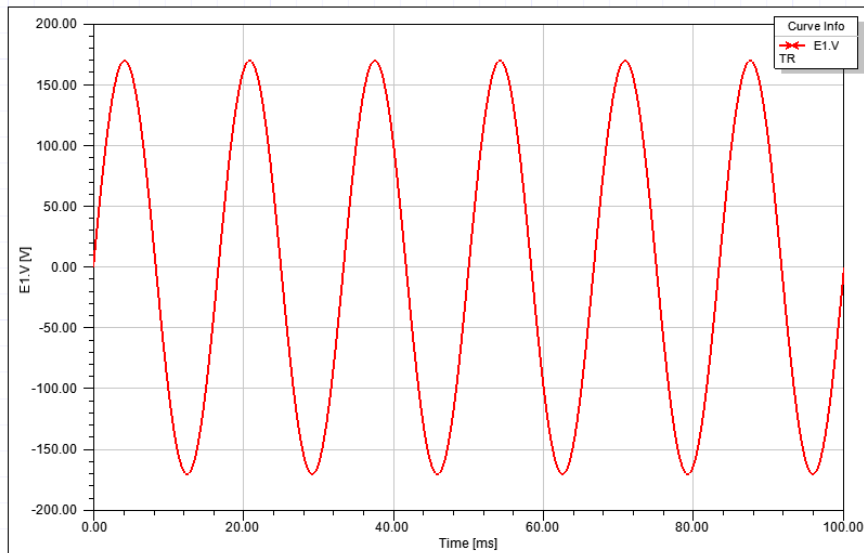
Adjusting Plot View

- The way plots are displayed can change depending on preference. Note here we show the display of the Header title instead of Legend:
- Select the menu item **View** → **Active view Visibility** and then select the **Legends Tab**
- **Legend:** ☐ Unchecked
- **Header:** ☒ Checked



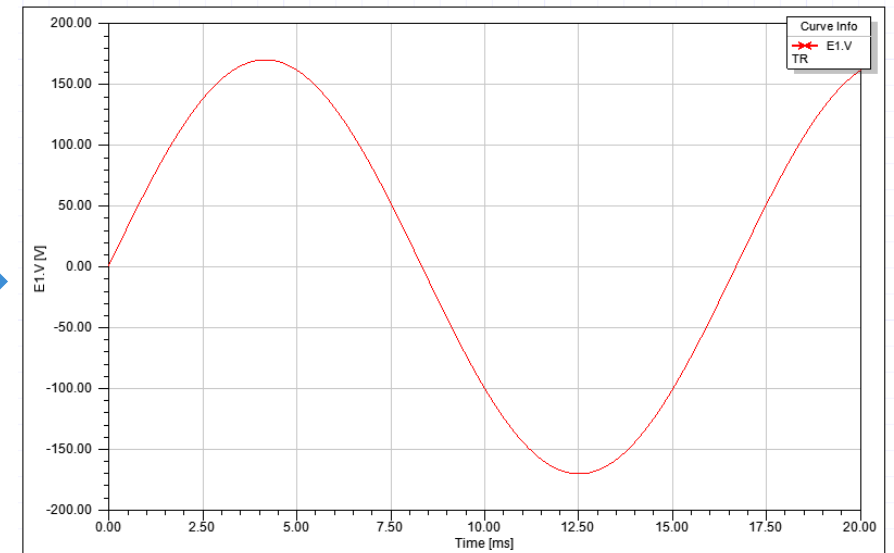
Adjusting Plot View

- Note the Plot View can be Edited in the Project Manager window or on the schematic by selecting the Plot and **RMB** → **Edit in place**
- For example to change the x-axis, select the axis, then in the Properties window select the **Scaling Tab** and specify the range



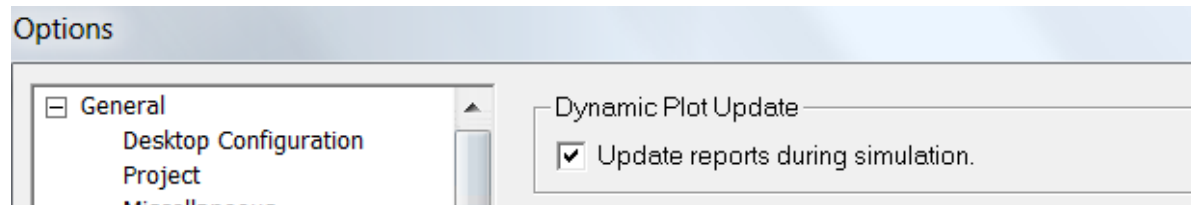
Name	Value	Unit
Axis Scaling	Linear	
Specify Min	<input type="checkbox"/>	
Min	0	ms
Specify Max	<input checked="" type="checkbox"/>	
Max	20	ms
Specify Sp...	<input type="checkbox"/>	
Spacing	2.5	ms
Minor Tick...	5	
-Manual ...		
Auto Units	<input checked="" type="checkbox"/>	
Units	ms	

Axis **Scaling** Cartesian General



Viewing Results (Walking Waveforms)

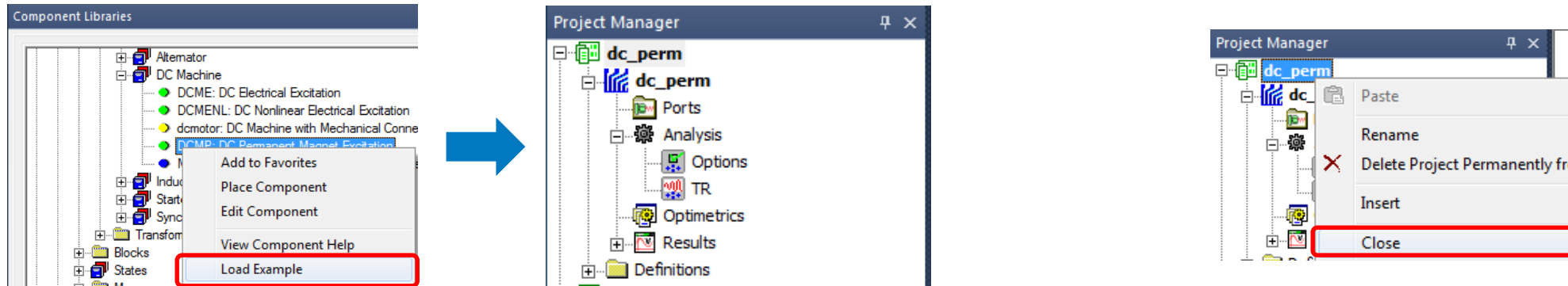
- Several ways to set up the viewing of results in the plots:
 - Show results only after simulation is done - speeds up simulation: select the menu item **Tools** → **Options** → **General Options** → **Simplorer**
 - Update reports during simulation: ☐ Unchecked



- Have the waveforms displayed as the simulation runs - may slow down simulation: select the menu item **Tools** → **Options** → **General Options** → **Simplorer**
 - Update reports during simulation: ☒ Checked
- Update the plots during the simulation to view what is happening: select the menu item **Simplorer Circuit** → **Results** → **Update All Reports**

Component Examples

- Notes on installed examples
 - *RMB over component of interest* → *Load Example* (this will load the example as a new project)
 - It is recommended to *Save* this project to a local directory with a different name
 - Care should be taken when removing projects
 - if *delete* is chosen, it will remove the project from the hard drive
 - If simply want to remove a project from the project manager, use *close* instead so it will not be deleted from the hard drive completely



Summary

What have we learned in this session?

- **Simplorer GUI**
- **Add Component**
- **Edit Component Properties**
- **Set-up Simulations**
- **View Results**
- **View Component Examples**

Workshop 1.1 – Switching circuit + Parametric analysis

