Simplorer用于定制化高级建模及高性能开关电源仿真方法

杨利辉/高级应用工程师
ANSYS

内容提要

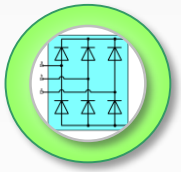
- **Simplorer用于定制化高级建模方法**
  - Simplorer建模平台概述
  - Simplorer基本库模型应用
  - Simplorer基本库模型定制化高级应用模型（以脉冲功率负载为例）
- **Simplorer用于高新能开关电源仿真**
  - 移相全桥电源变换器原理
  - Simplorer R18中实现移相全桥电源变换器方法
  - PExprt设计移相全桥变换器变压器
- **总结**

ANSYS平台价值: Modeling the System

Powerful Capabilities for Assembly and Reuse

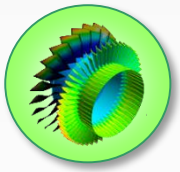
Simplorer

Language-Based Modeling



Multi-Domain Model Libraries

Co-simulation with 3D Physics



Reduced Order Model Creation

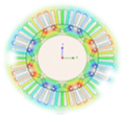
Embedded Software Integration

Functional Mockup Interface (FMI)

VHDL-AMS
C/C++
SPICE
SML
Modelica

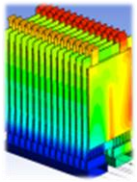
- Multi-Domain
- Analog
- Digital
- Power Systems
- Manufacturers
- App-Specific

ANSYS 3D Physics

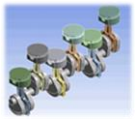


EM

Fluid

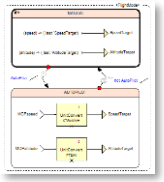


Thermal



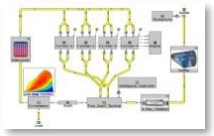
Mech

ANSYS SCADE



Simulink
C Code

3rd Party System Modeling tools (AMESim, Simulink, Dymola, GT Suite etc.)



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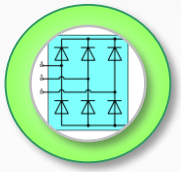

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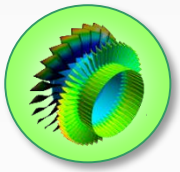

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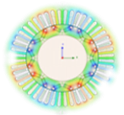

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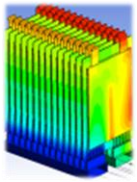

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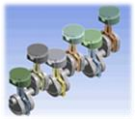

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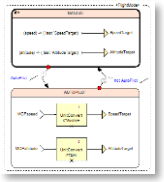

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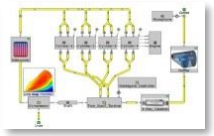
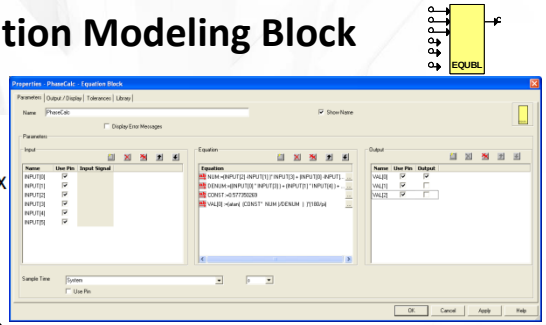
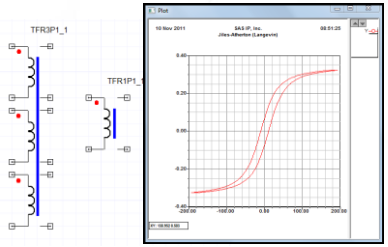


Simplorer's Integrated Environment

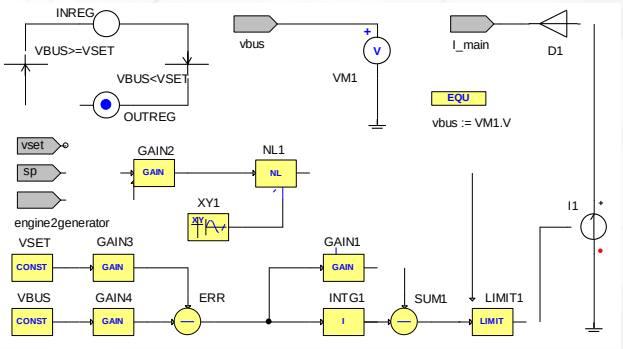
Equation Modeling Block

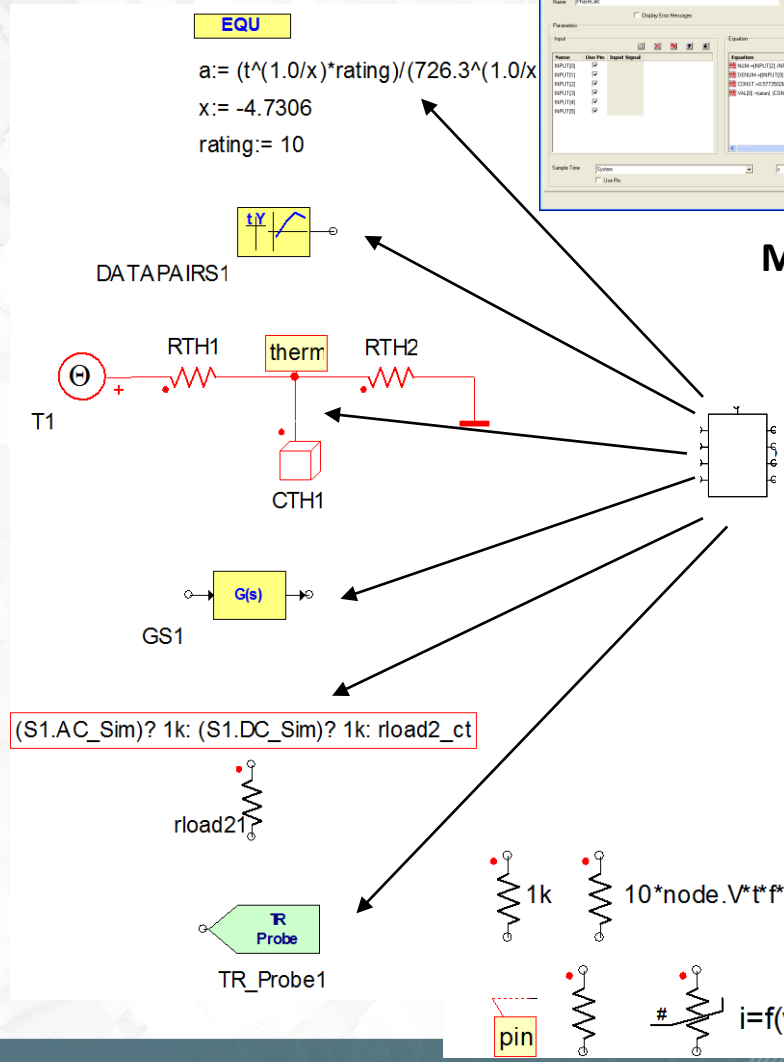


Magnetics

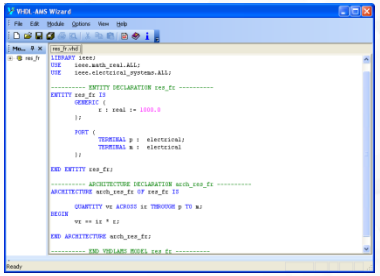


Circuit, Block, State

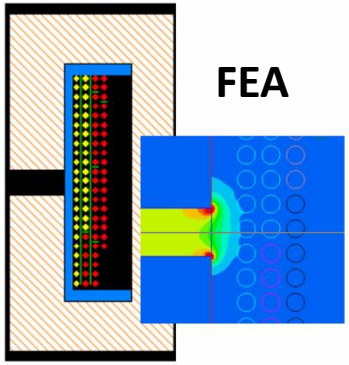




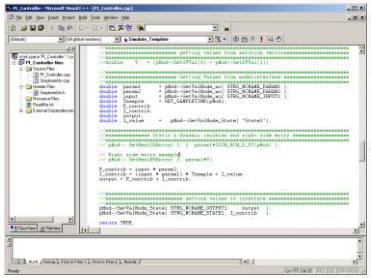
VHDL-AMS



FEA



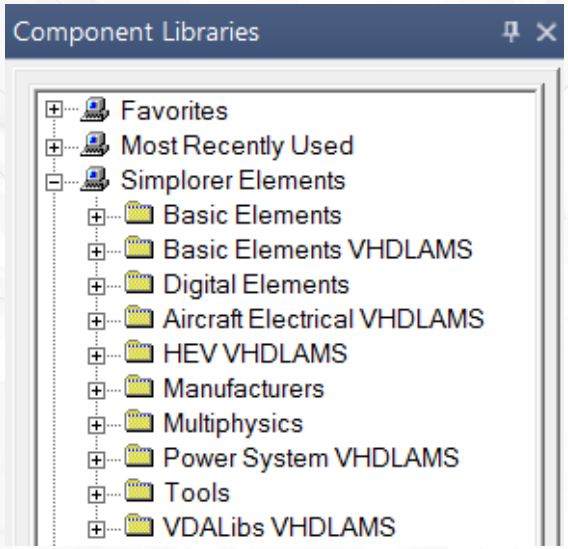
C code

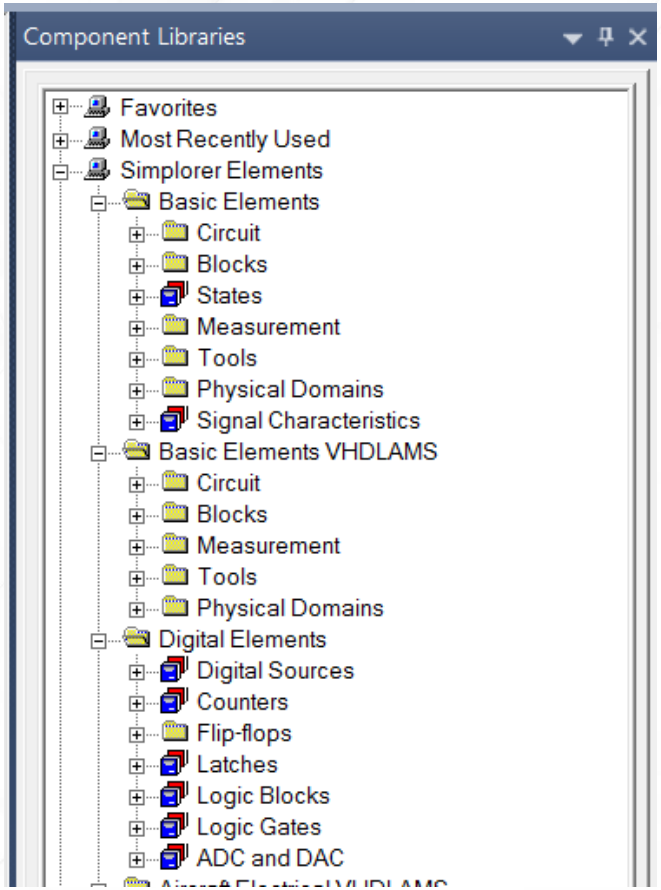


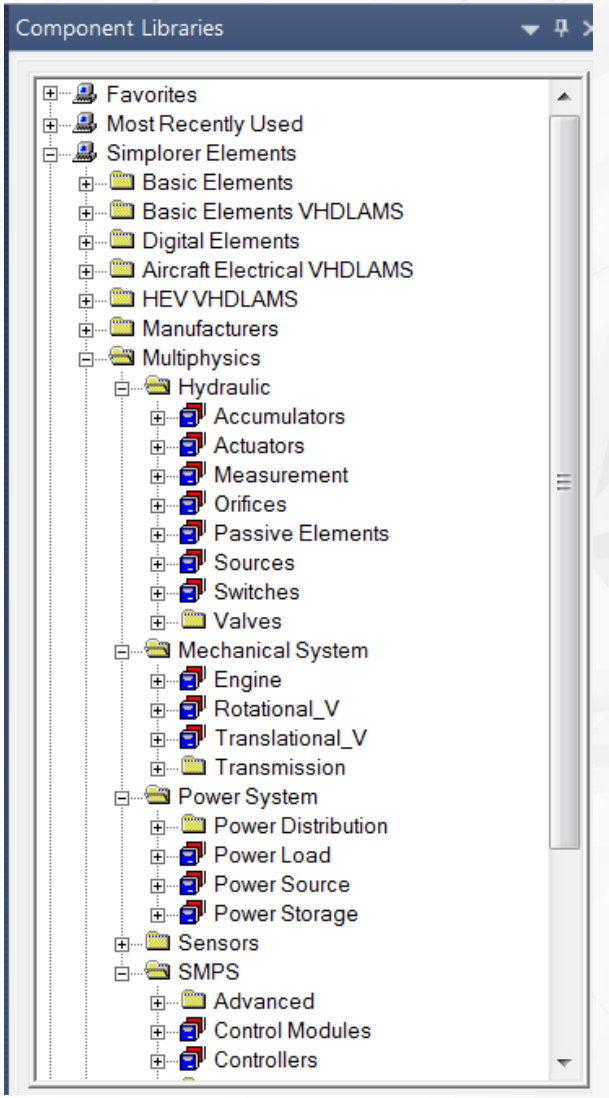
Spice Import

Co-Sim (ie Simulink)

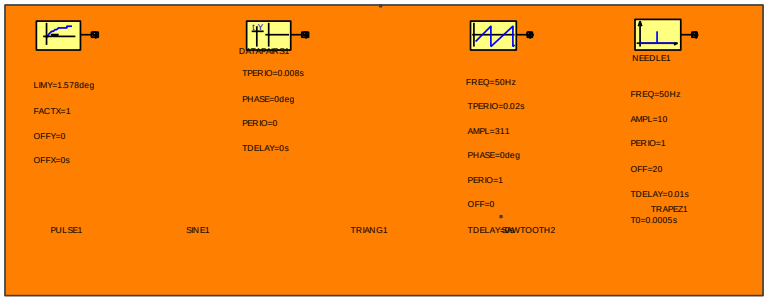
Simplorer基本库文件

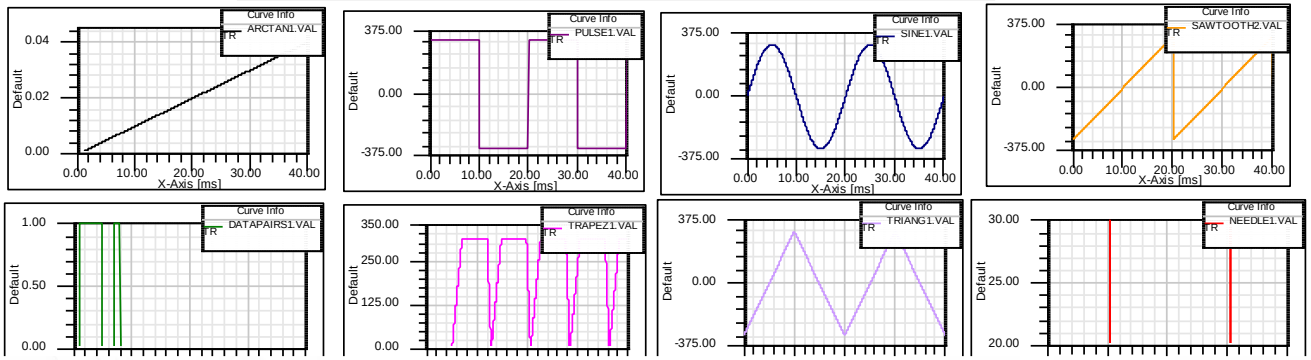






Simplorer基本库文件模型搭建的仿真电路





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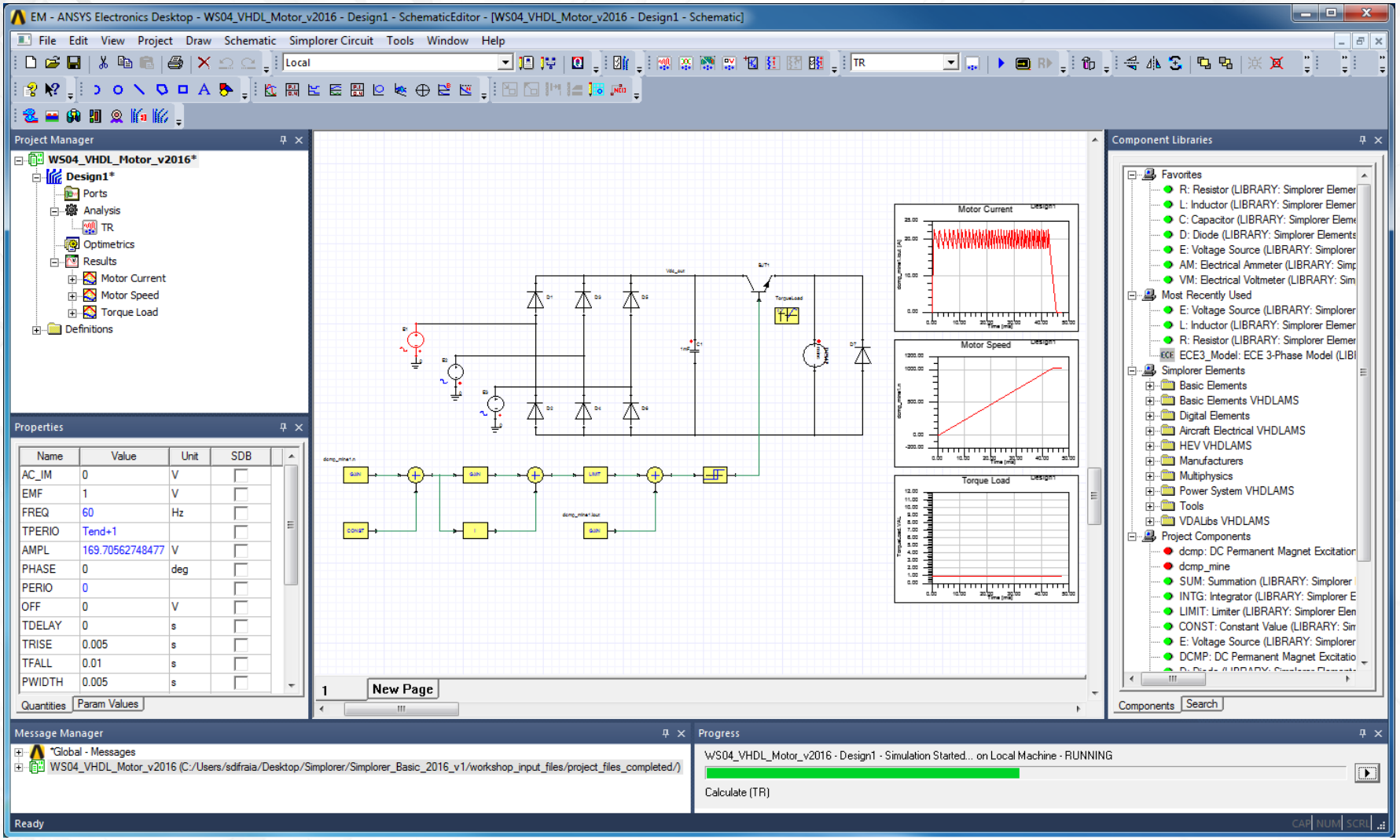
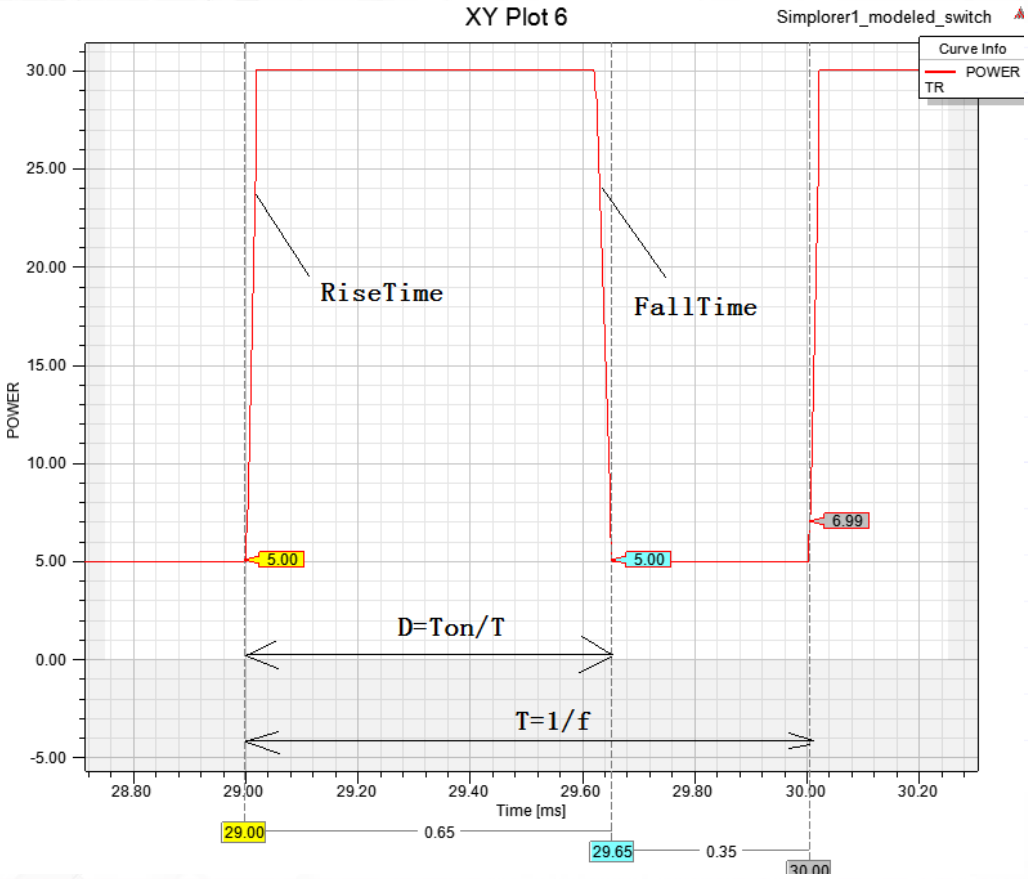


Simplorer基本库元件搭建复杂模型

脉冲功率负载模型：负载脉冲频率可调、脉冲占空比可调、脉冲上升沿时间和下降沿时间可调、脉冲值最大值和最小值可调、负载启动和关闭电压可调，并可由用户通过界面输入。



Simplorer基本库元件可以搭建复杂模型

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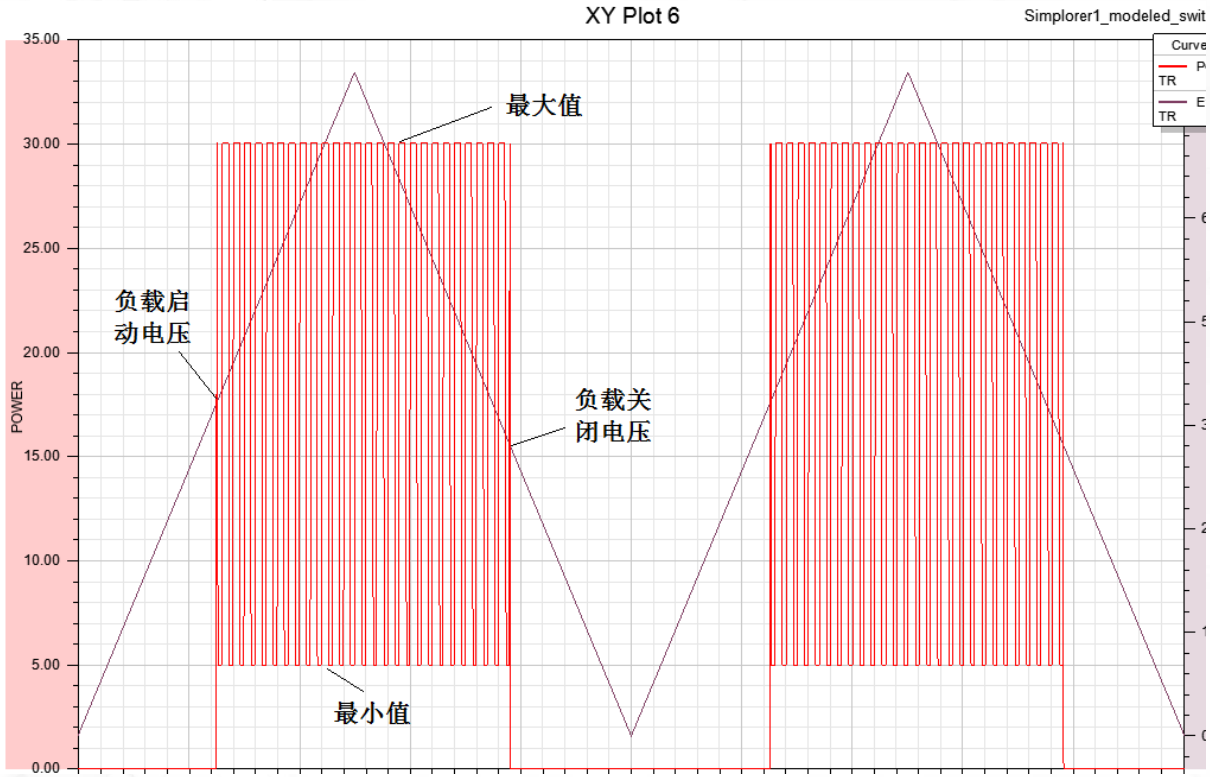
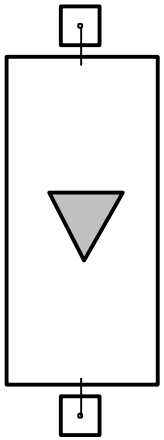


Simplorer基本库元件的基本器件模型

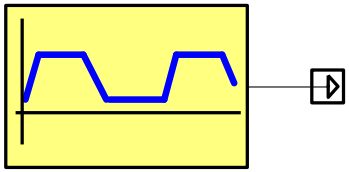
功率负载

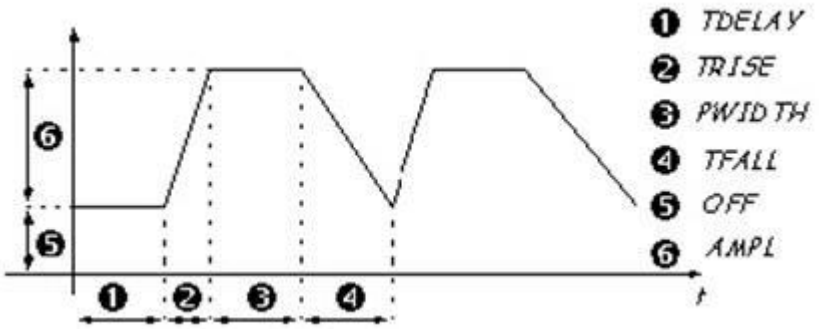
POWER_L1



梯形波发生器

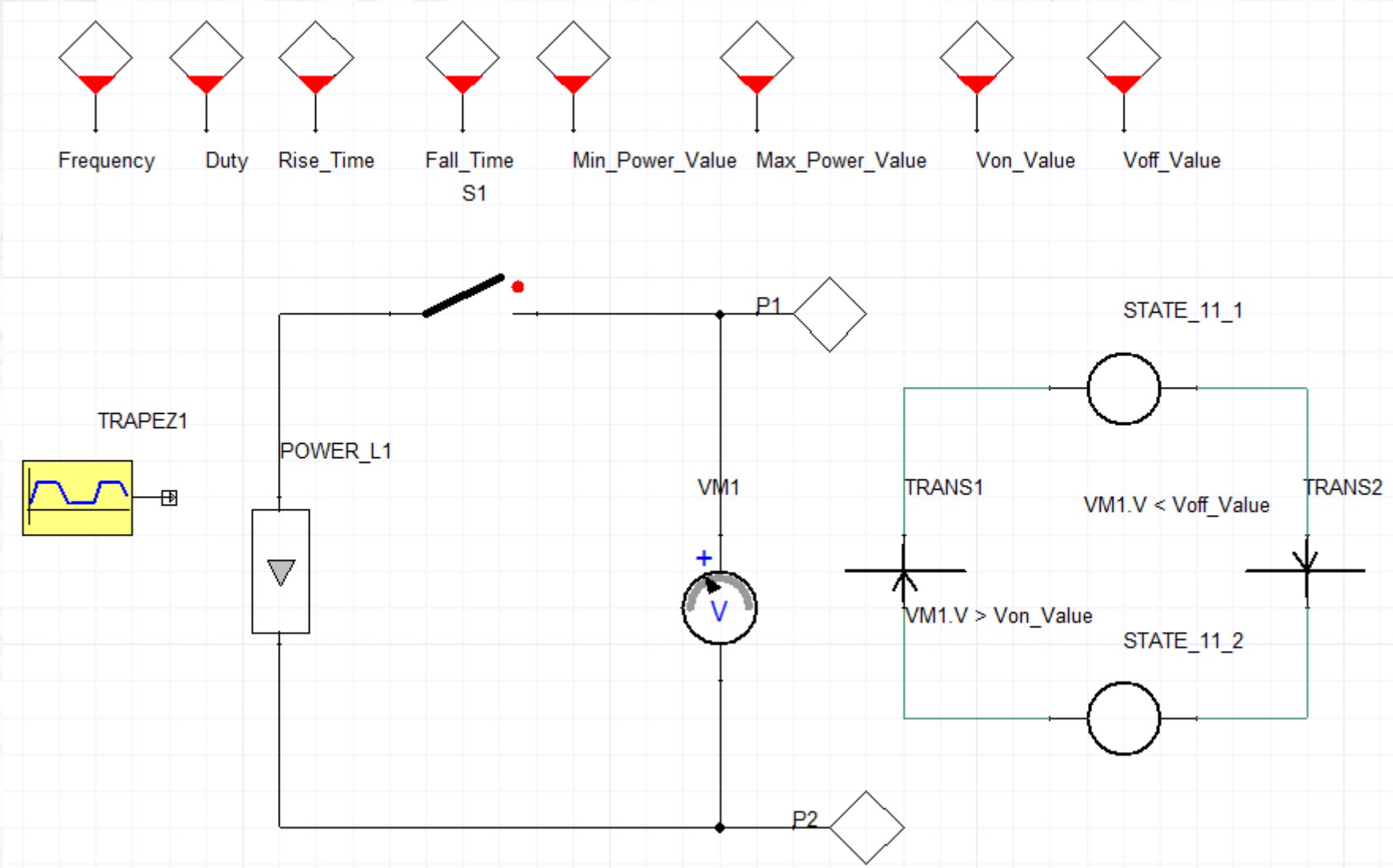
TRAPEZ1





脉冲功率负载实现方法：通过合适方式关联两个基本模型

Simplorer搭建脉冲功率负载子电路



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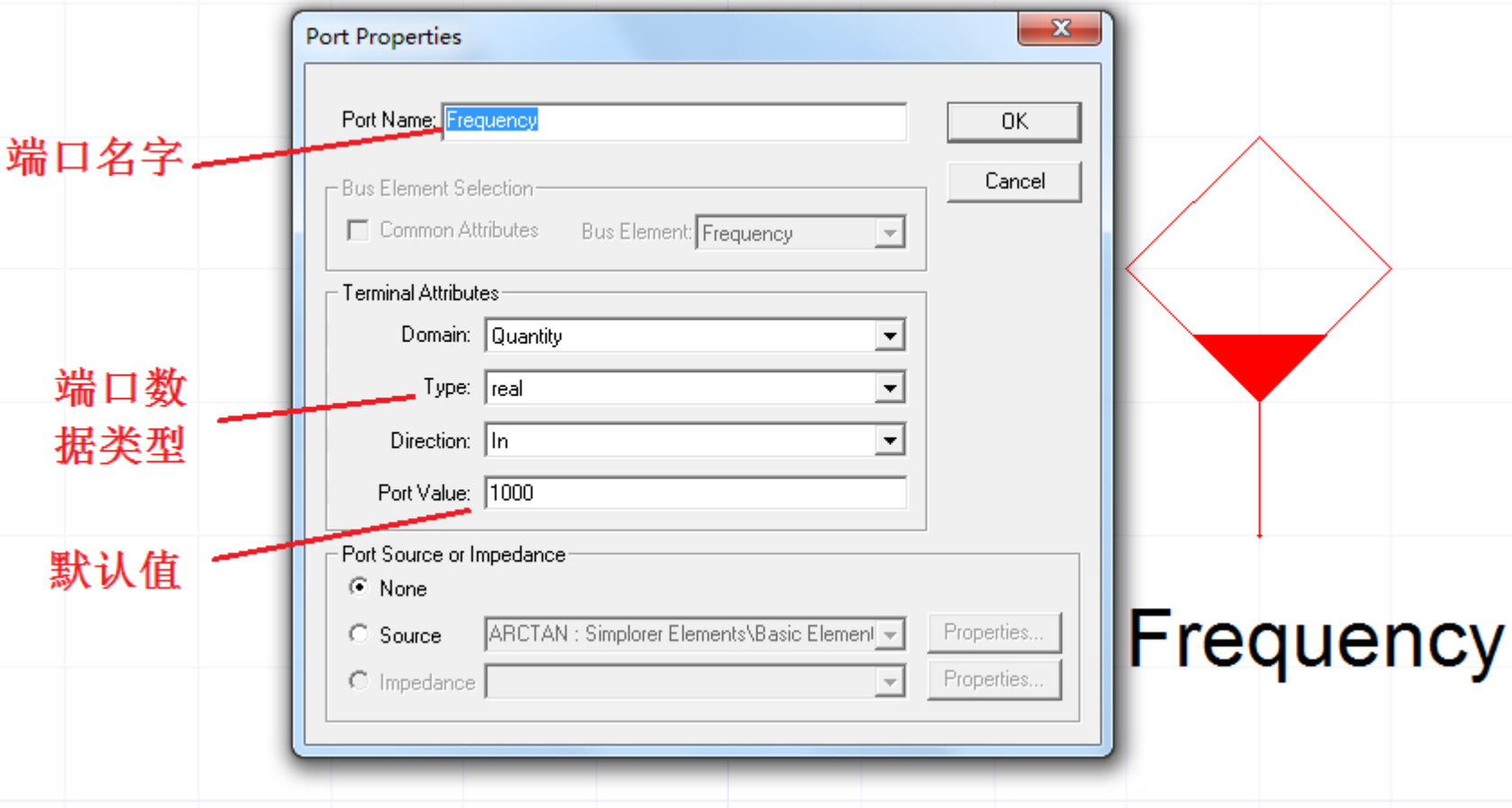
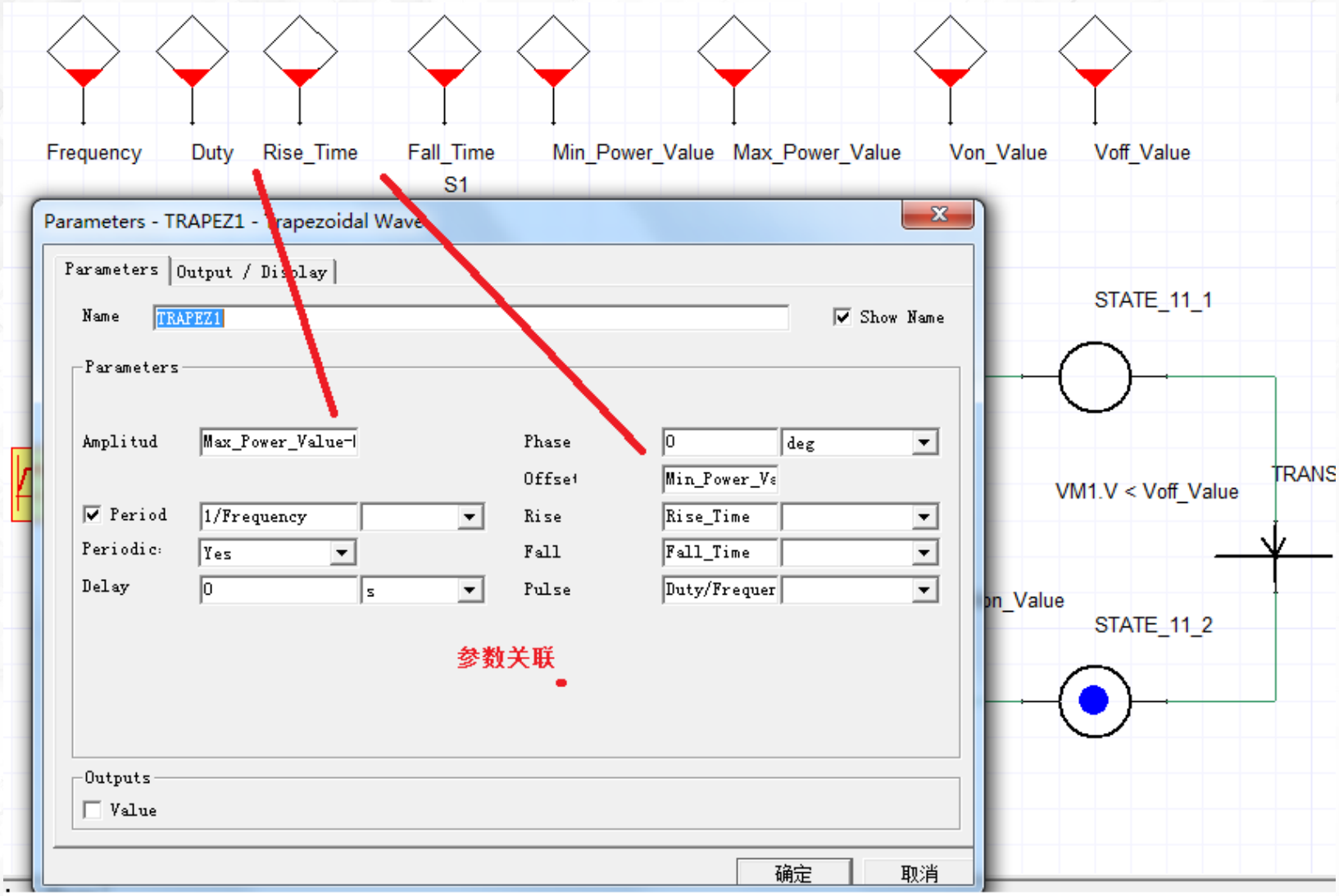


Simplorer基本器件参数和端口参数相关连



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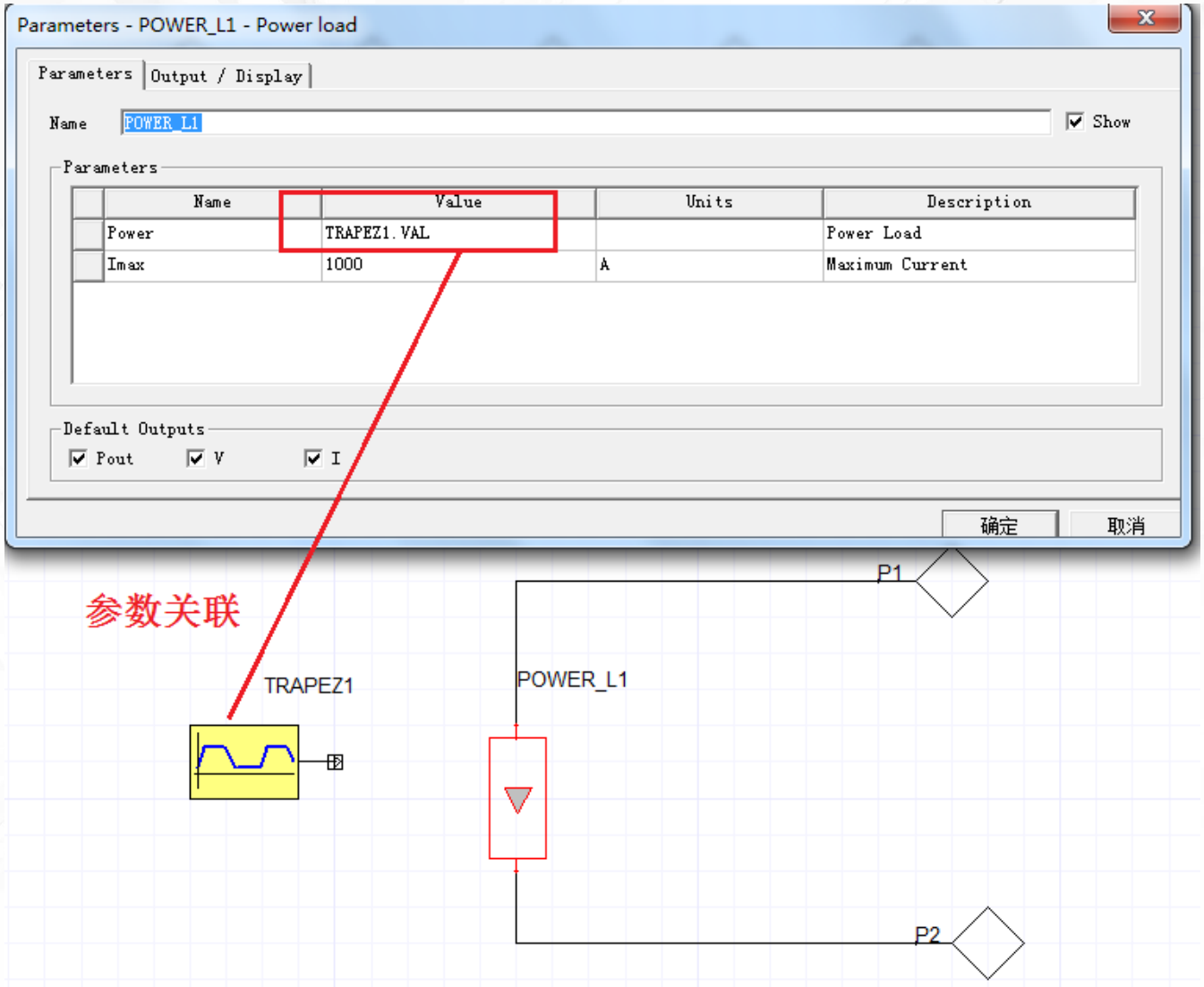
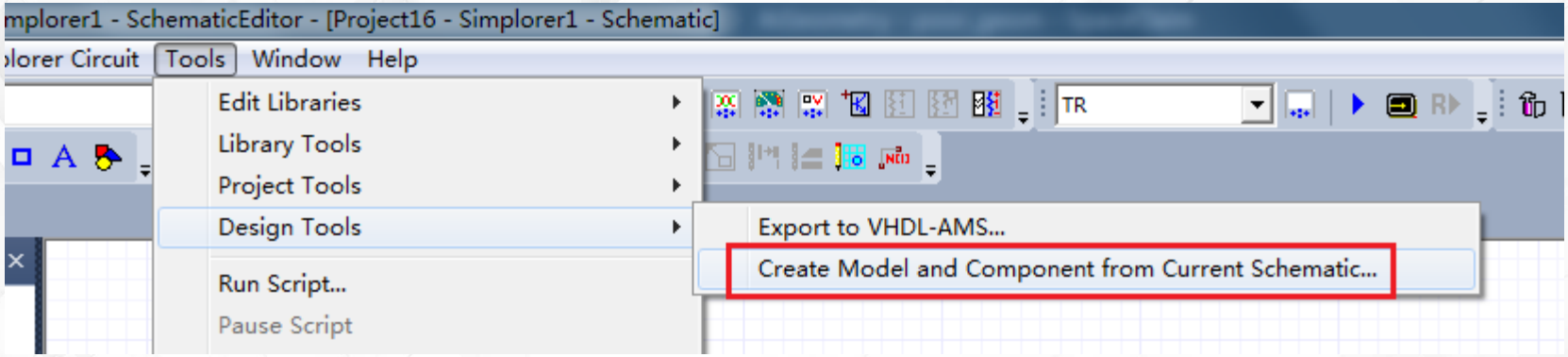
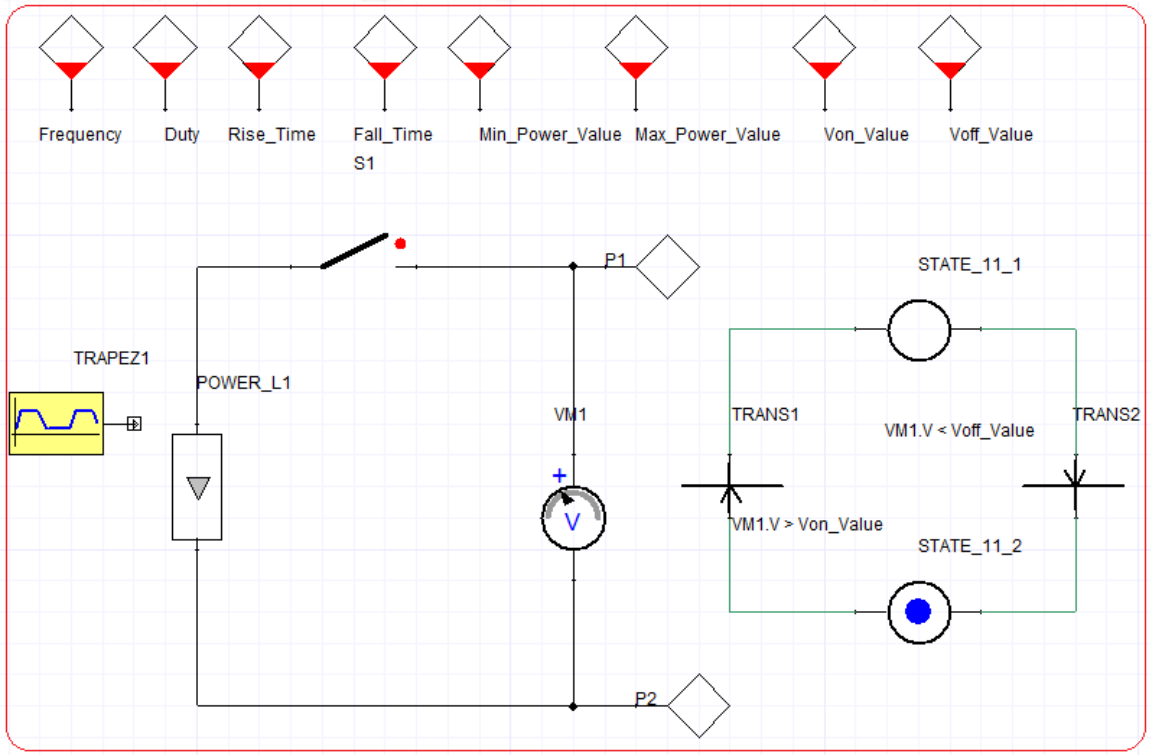


脉冲负载建模过程：模型打包建库

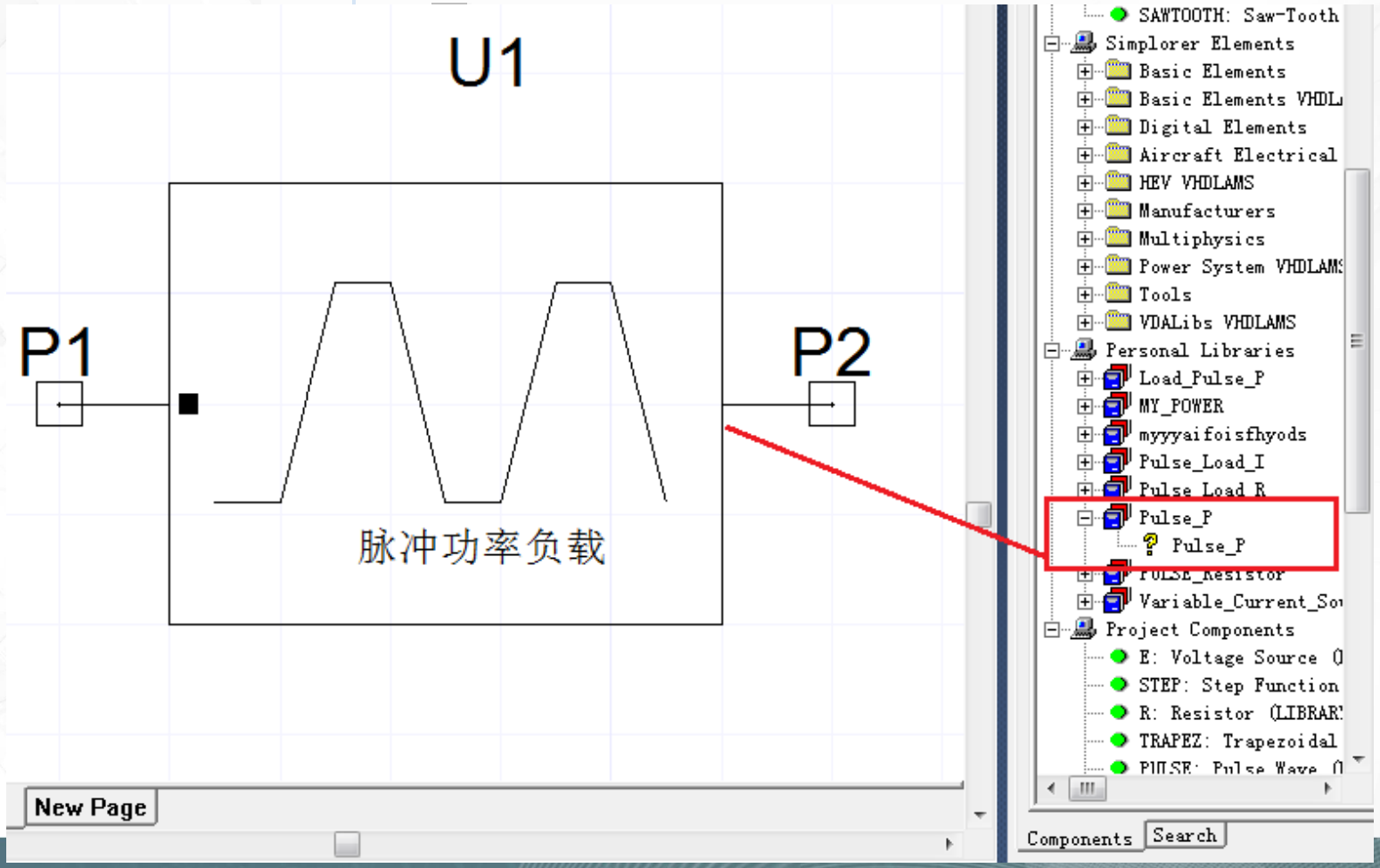




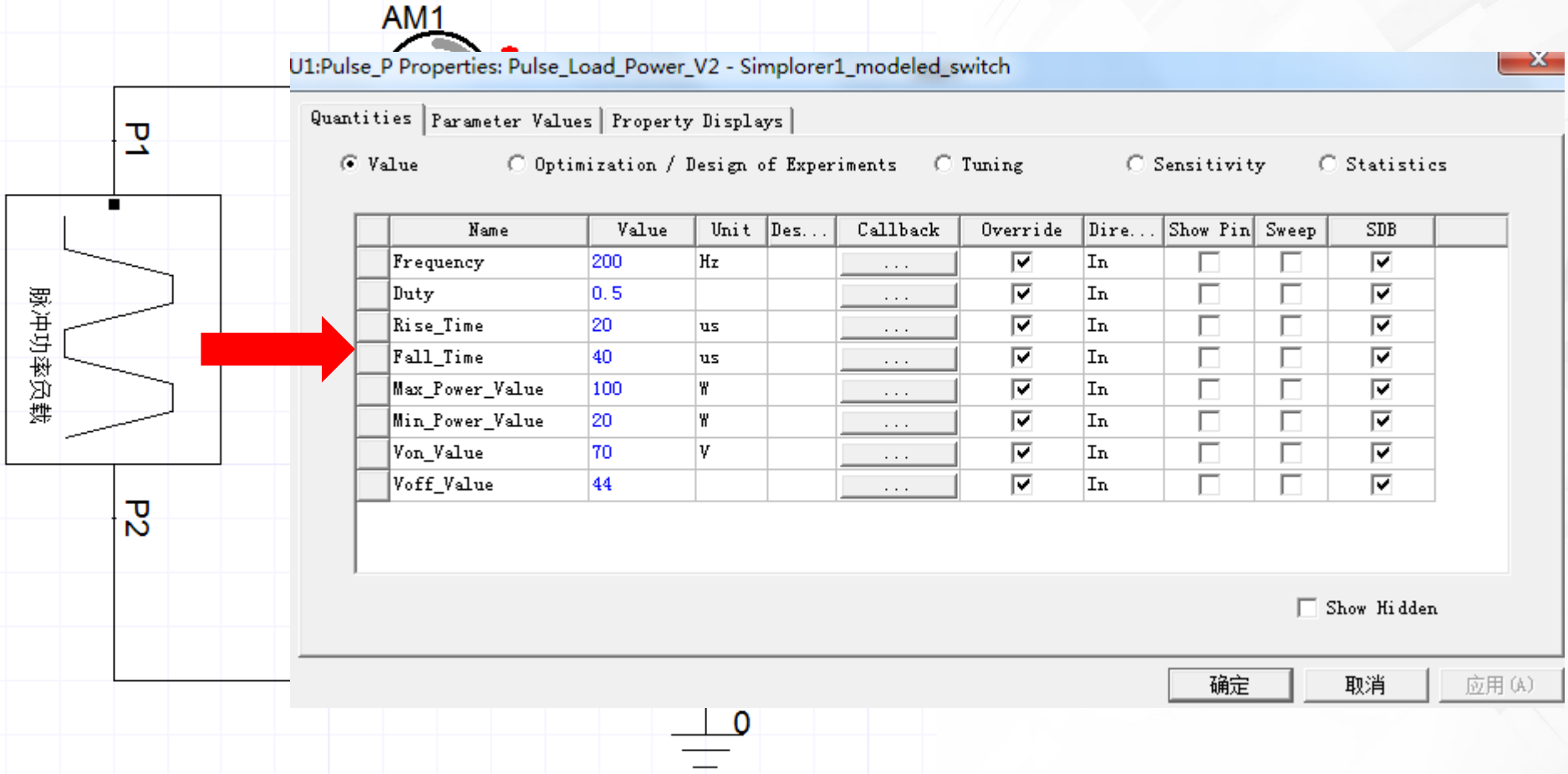
打包建模

脉冲负载建模过程：获取建模结果

建模结果为后缀分别为.aclb、.aslb、.asmd的文件，把这三个文件拷贝并粘贴在其PersonalLib中，用户则可以直接使用这些模型



脉冲负载模型测试：简单测试电路



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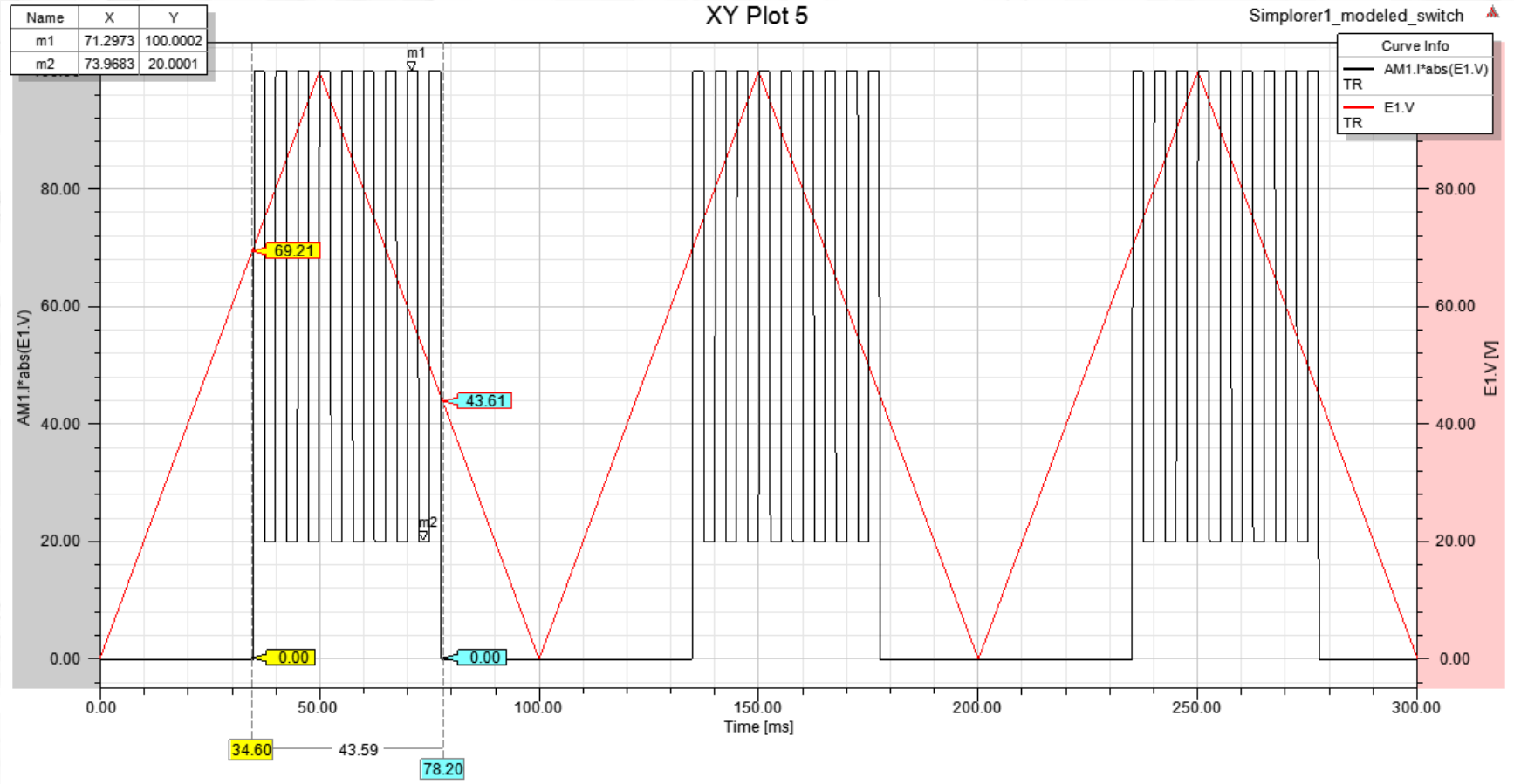

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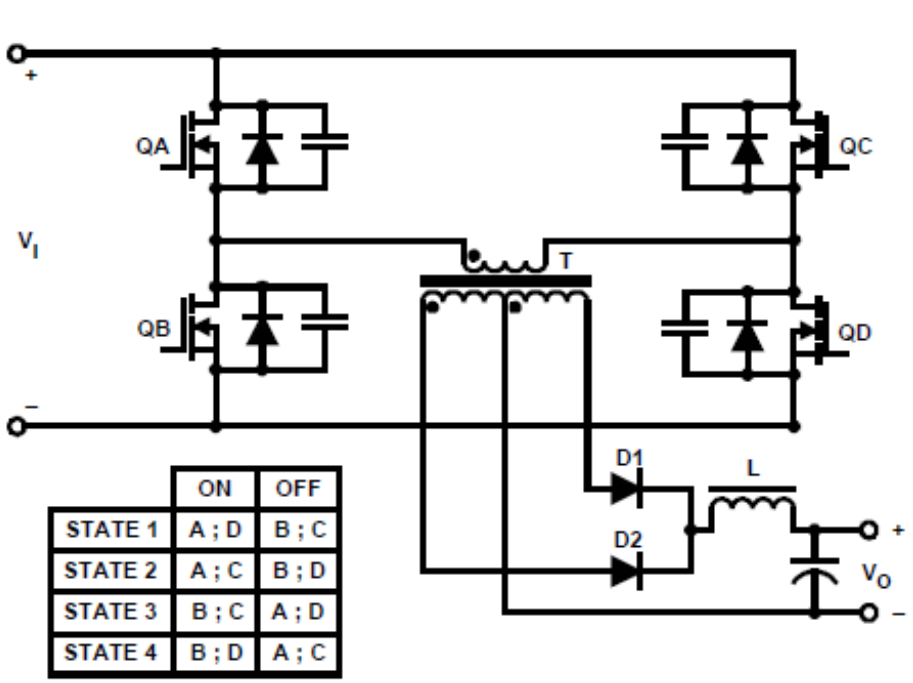
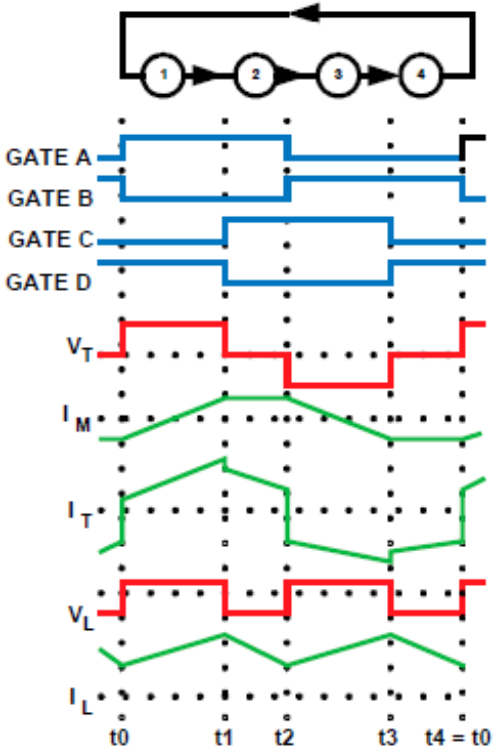
  - PExprt设计移相全桥变换器变压器
- 总结

移相全桥工作原理-通过电容电感的谐振实现开关管零电压开通



	ON	OFF
STATE 1	A ; D	B ; C
STATE 2	A ; C	B ; D
STATE 3	B ; C	A ; D
STATE 4	B ; D	A ; C



复杂的移相全桥变换器仿真设计对仿真软件和工程师设计水平要求高

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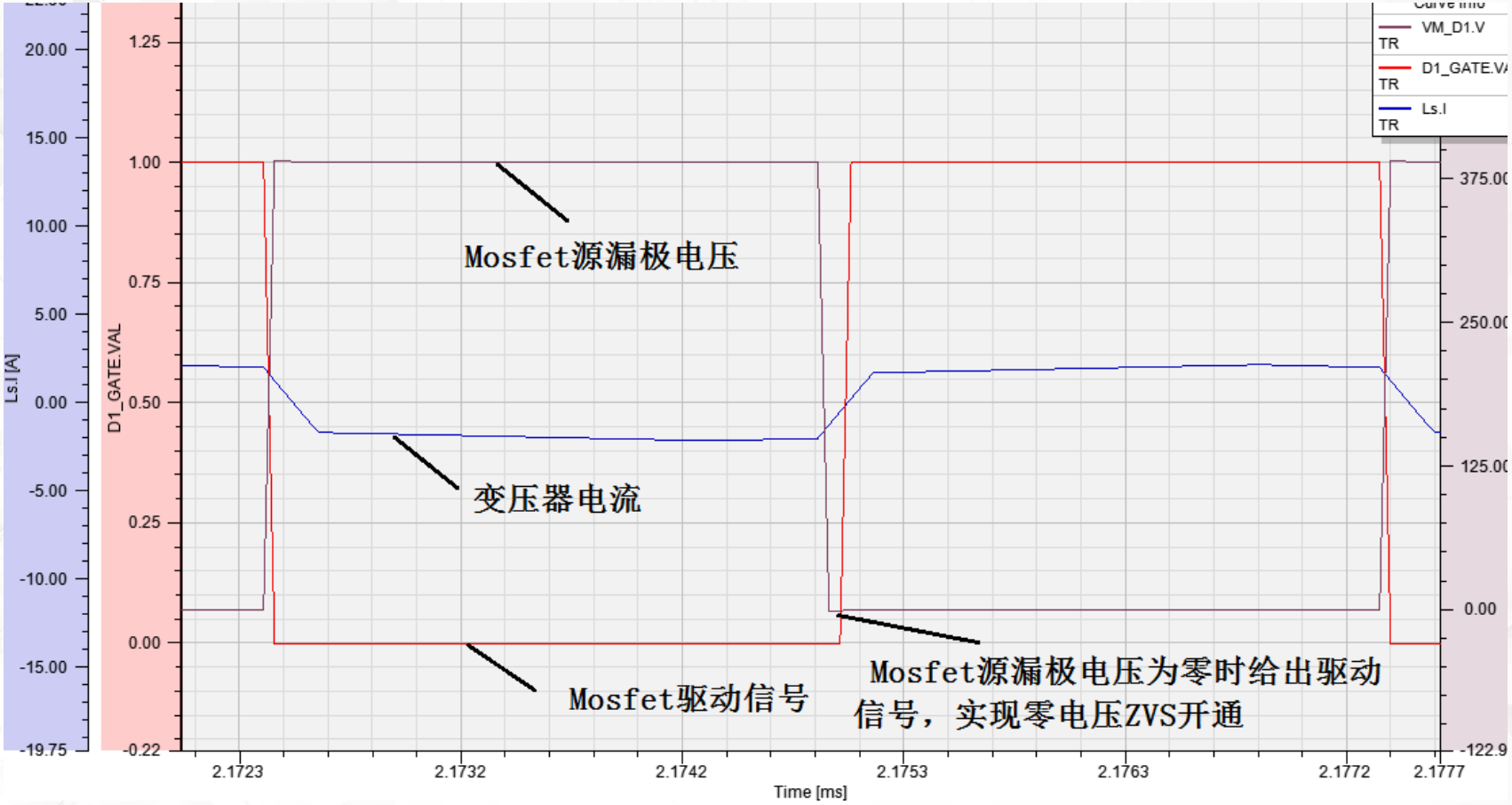

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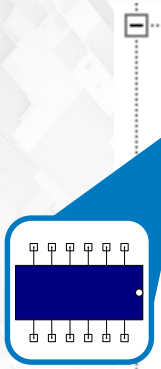
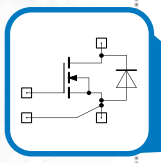
移相全桥工作变换器优点和难点

- 优点
  - 软开关（ZVS）
  - 开关频率高
  - 电源模块转换效率高
  - 低EMI/EMC问题
- 难点
  - 硬件设计，因为谐振的需要，对变压器的原边漏感需要精确设计
  - 对电源主控芯片性能要求高
  - 对工程师设计水平要求高，仿真保证设计成功

More Devices in Manufacturers Library R18



- Manufacturers
  - Magnetic
  - Power Management ICs
    - High and Low Side Drivers
    - High Side Switches
    - Linear Regulators
    - Load Share Controllers
    - Low Side Switches
    - Power Factor Correction
    - Protection
    - PWM Controllers
    - Switching Regulators
    - Three Phase Bridge Drivers
    - Zener
  - Power Semiconductors
    - Si
      - Diodes
      - IGBTs_Average
      - IGBTs_BasicDyn
      - MOSFETs_BasicDyn
    - SiC
      - Diodes
      - MOSFETs_Average
        - APTMC120AM20CT1AG: Microsemi - SiC - MOSFET Modules_Average
        - CAS300M17BM2: Cree - SiC - MOSFETs Modules_Average
      - MOSFETs_BasicDyn



New Power Management ICs from

Texas Instruments

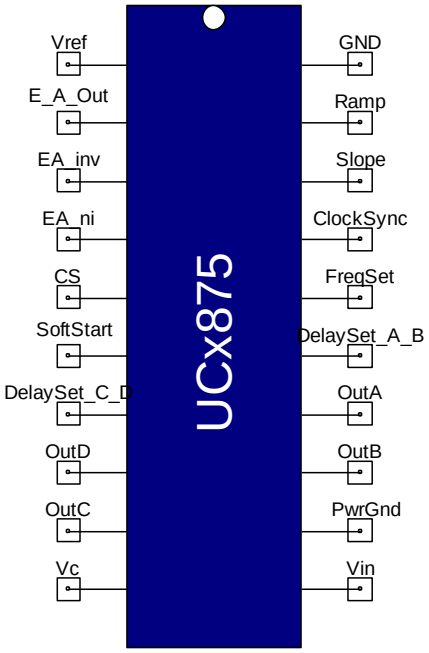
Linear Technology

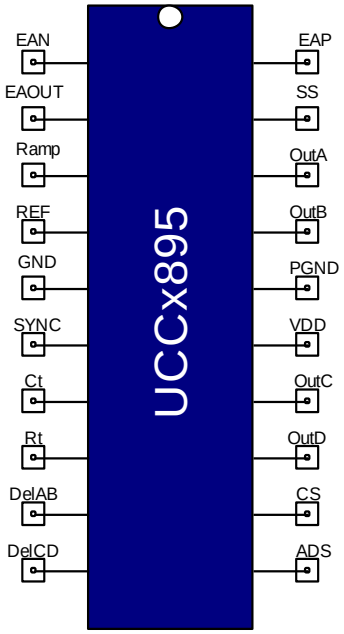
New SiC Average MOSFET devices from

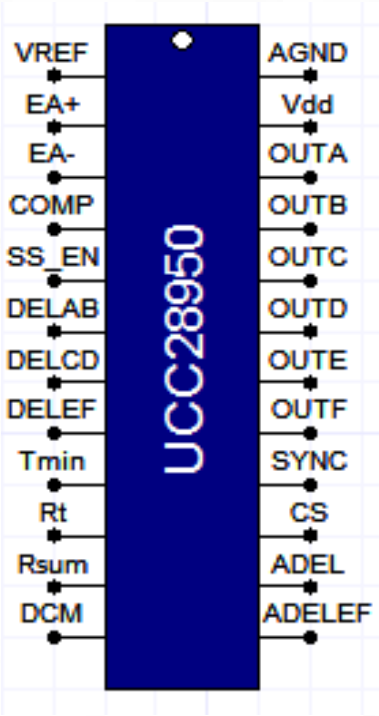
Microsemi

CREE

Simplorer R18中可实现移相全桥变换器的IC

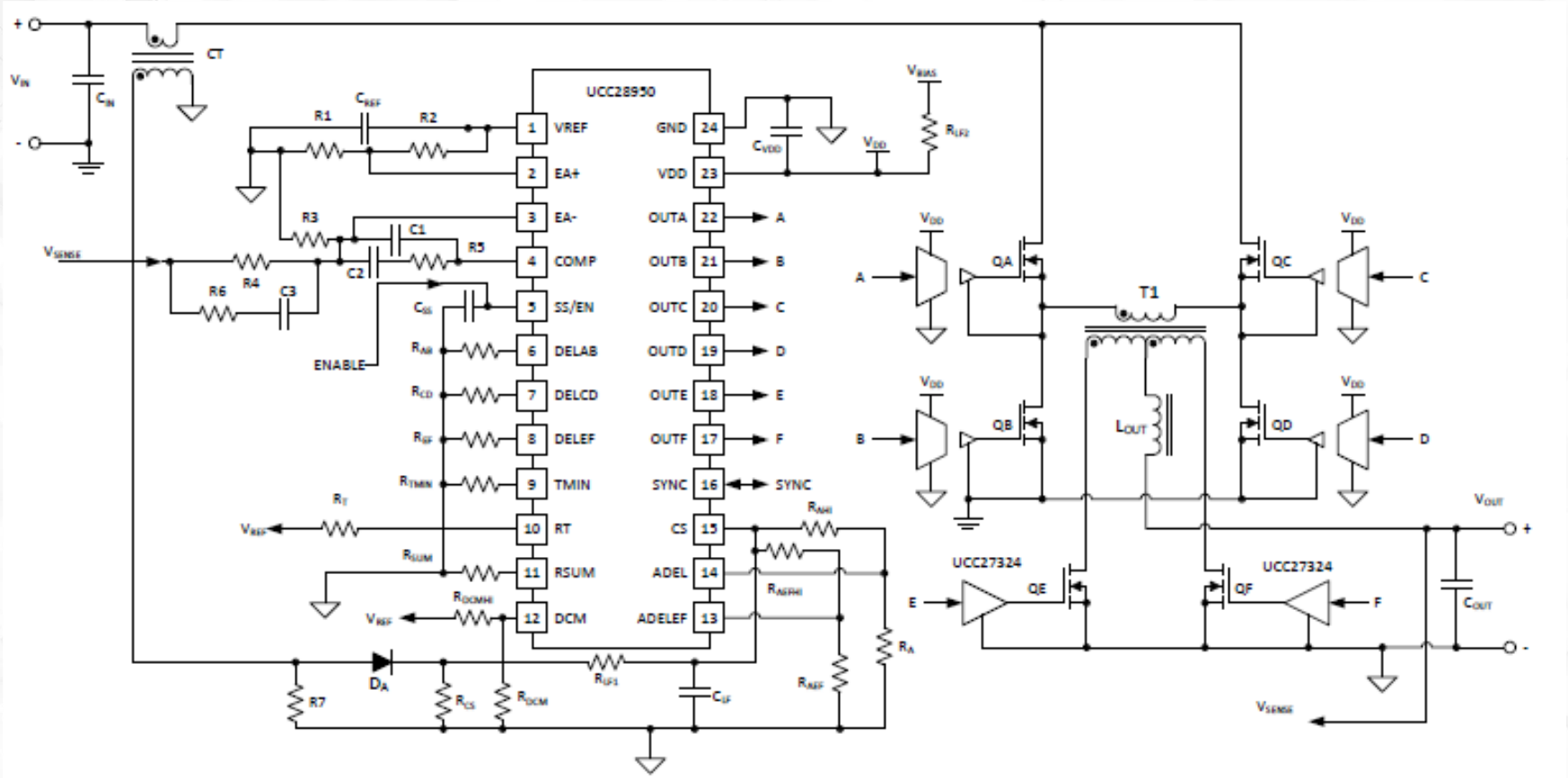




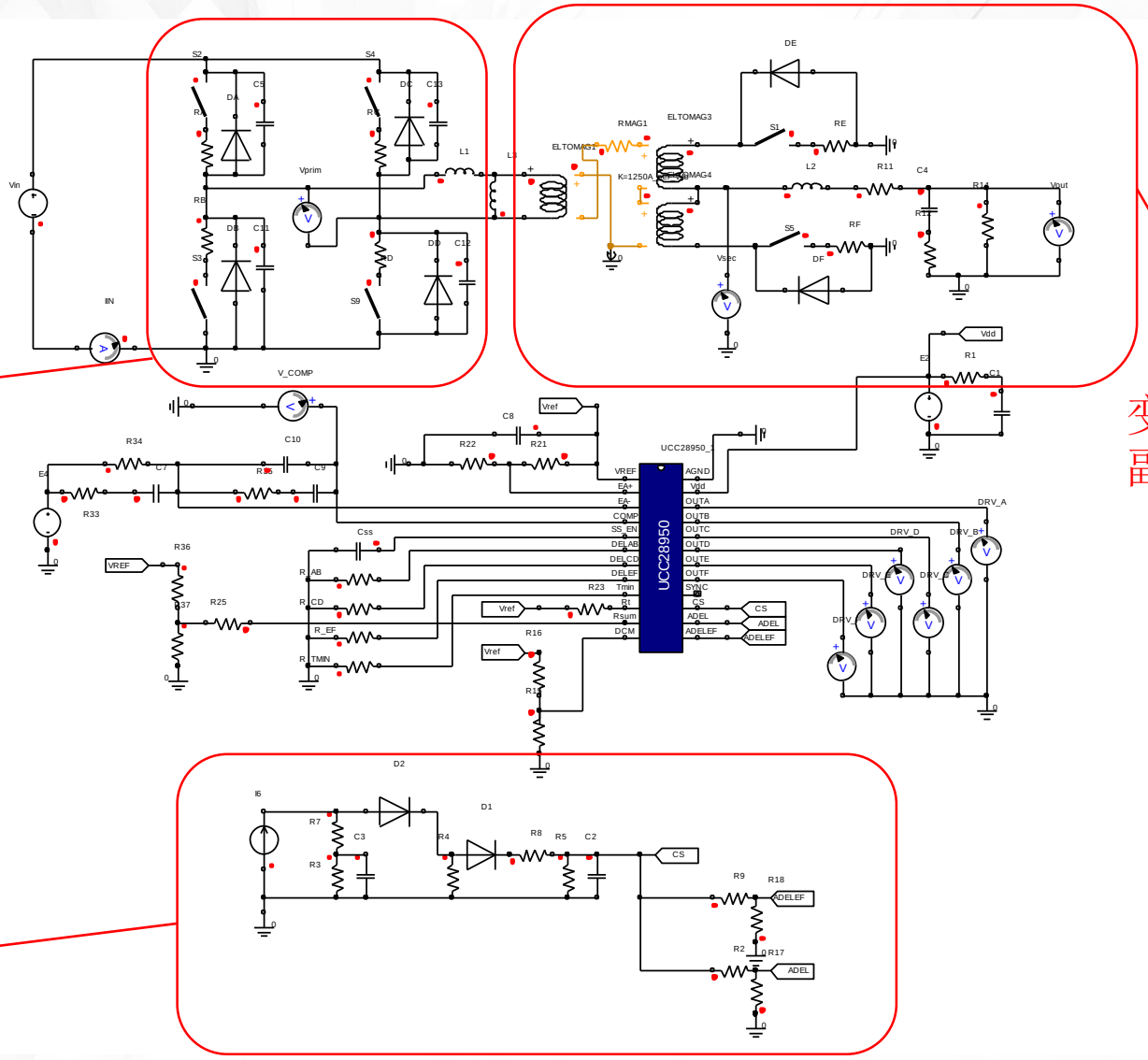


UCC28950是TI公司进一步改进的移相全桥控制IC,功能更为强大

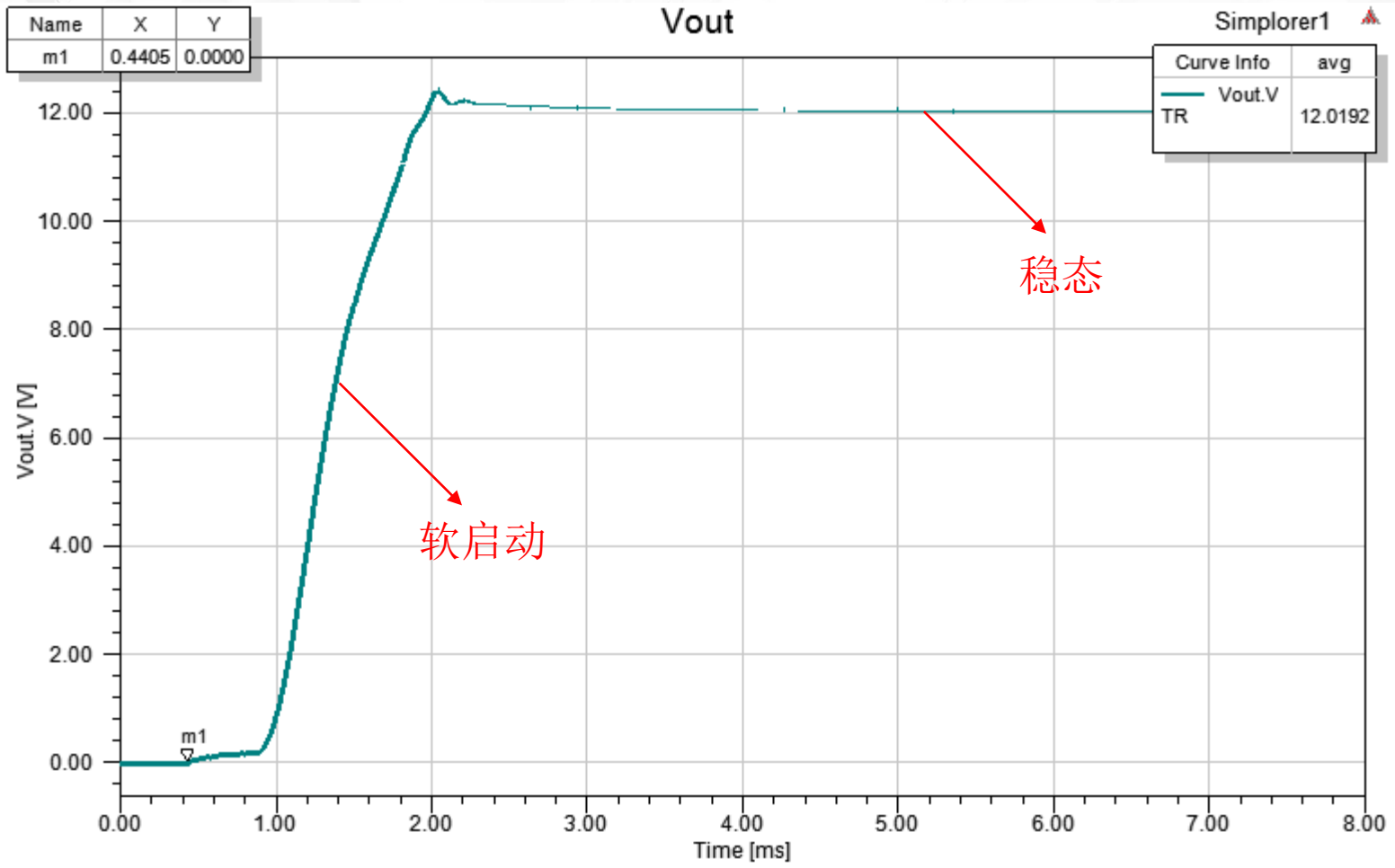
Ti 公司UCC28950移相全桥典型解决方案



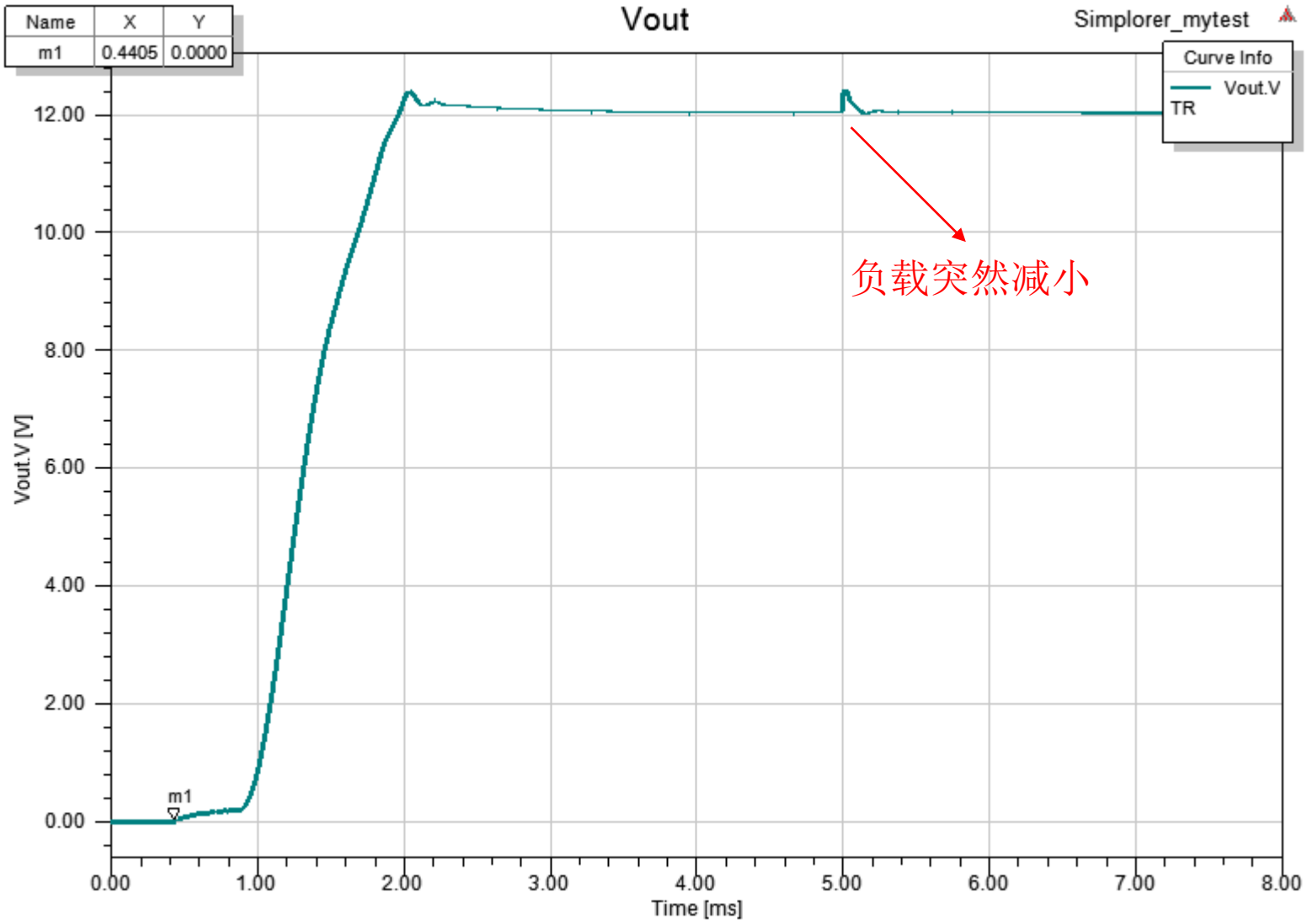
ANSYS公司UCC28950移相全桥解决方案



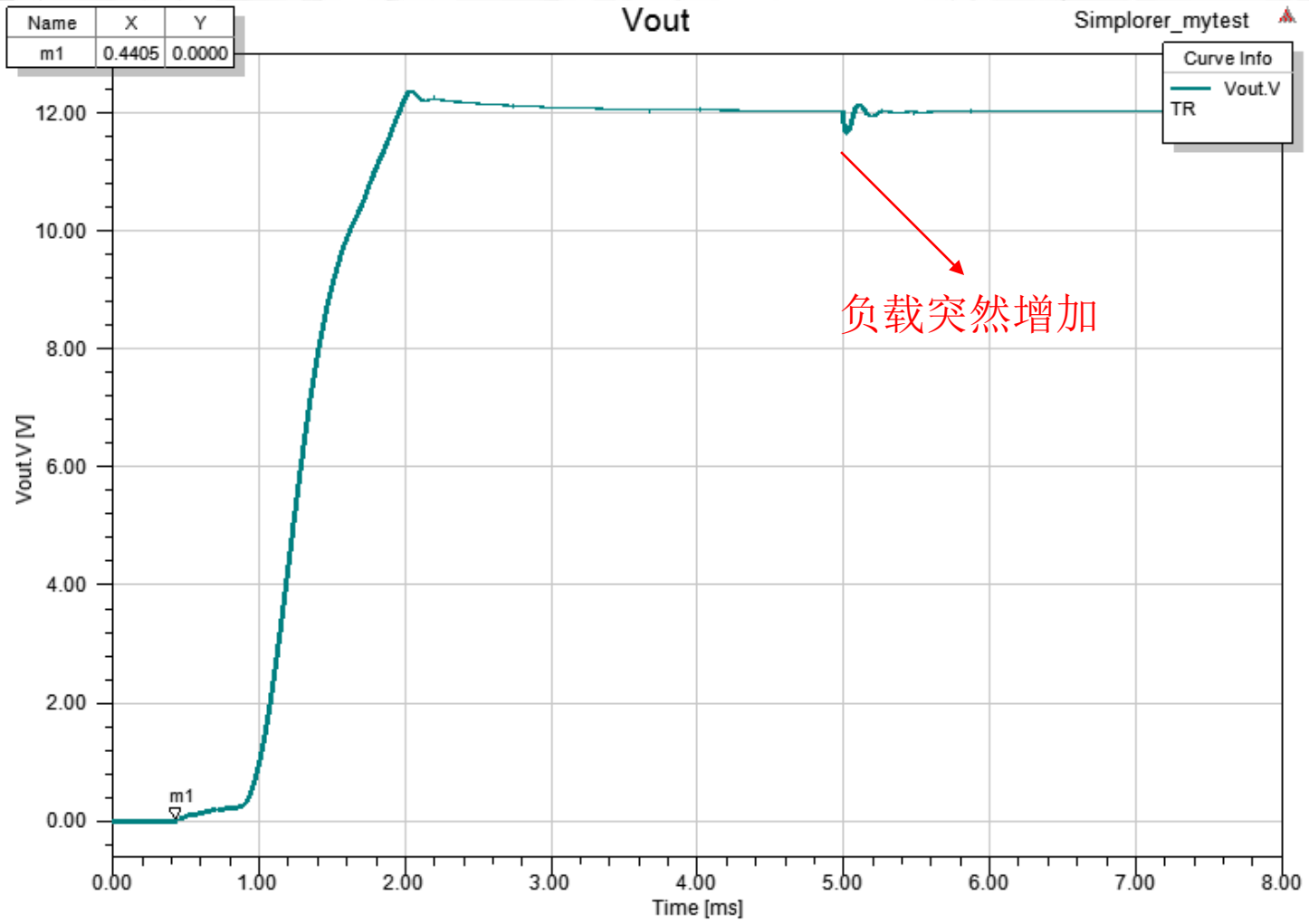
UCC28950移相全桥变换器输出电压



UCC28950移相全桥变换器输出电压



UCC28950移相全桥变换器输出电压



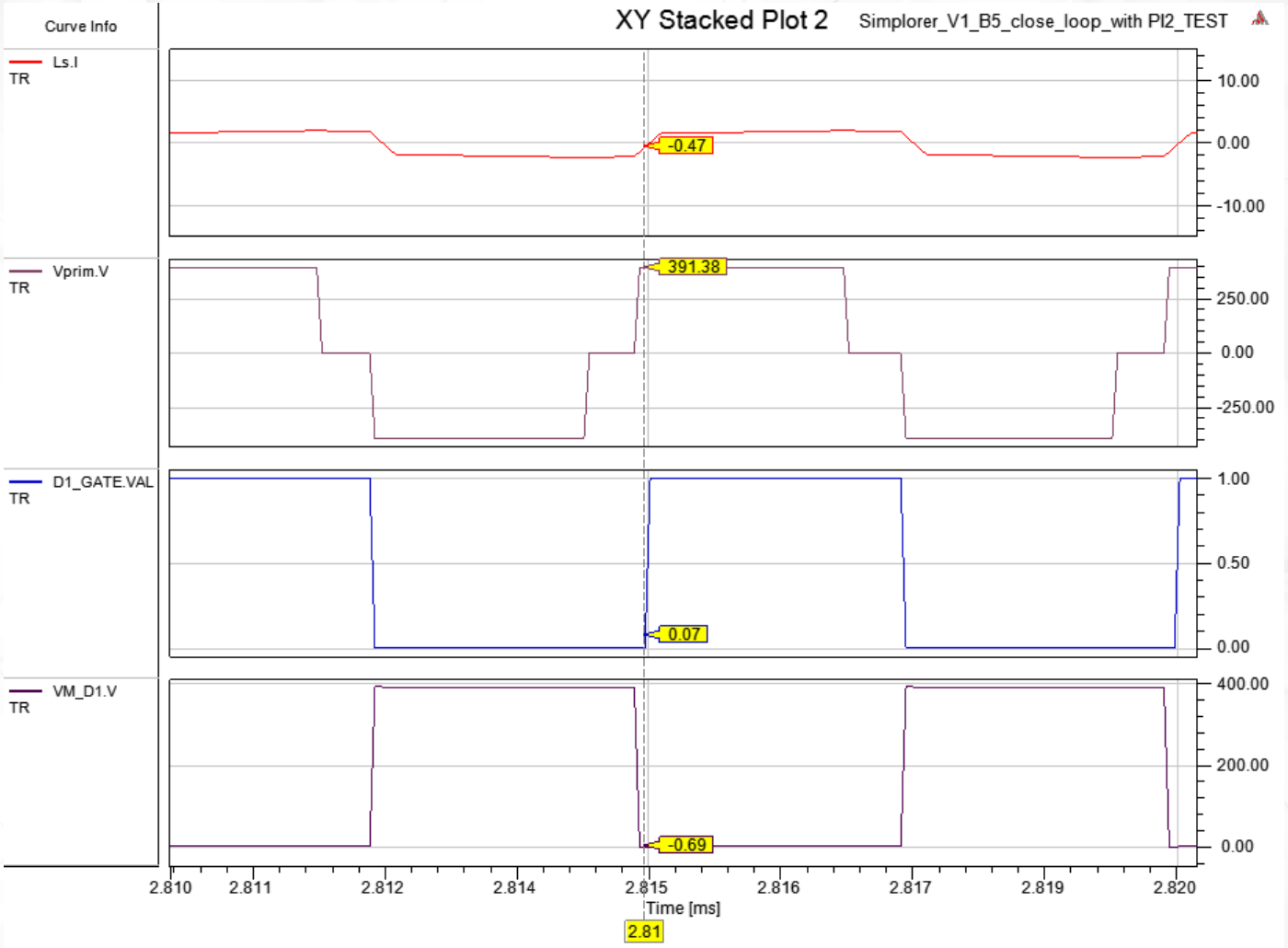
UCC28950移相全桥变换器关键信号波形

变压器原边电流

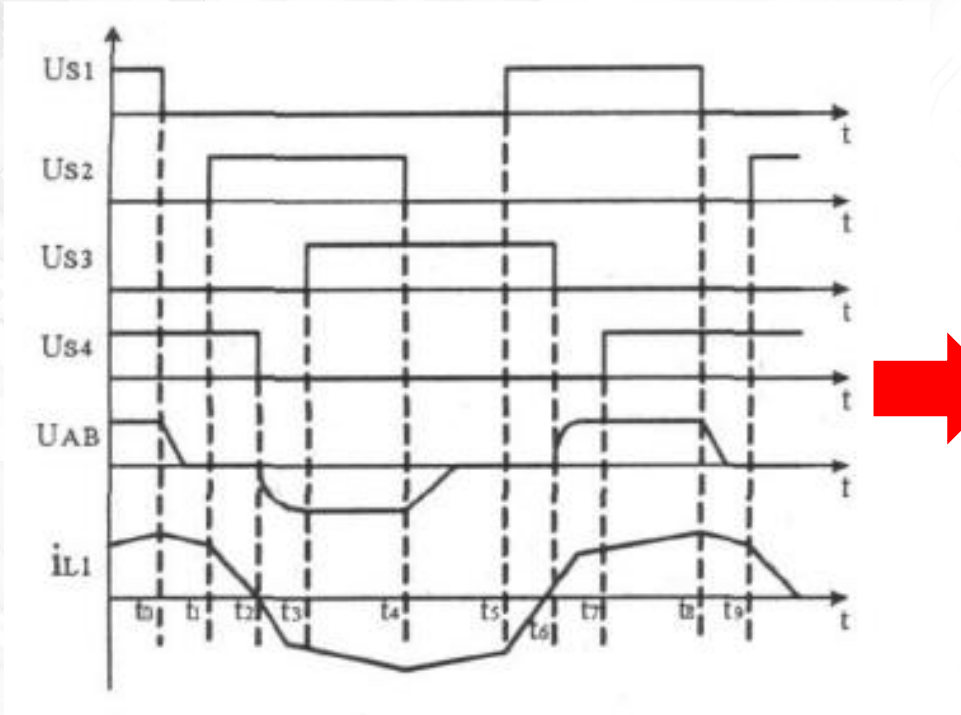
变压器原边电压

Mosfet1驱动信号

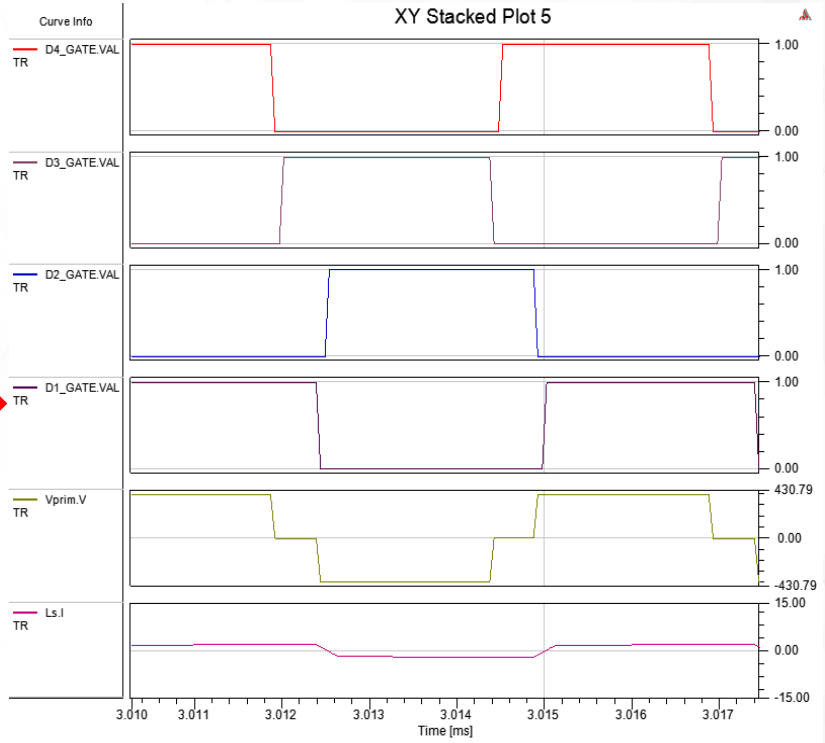
Mosfet1源漏电压



UCC28950移相全桥变换器关键信号波形

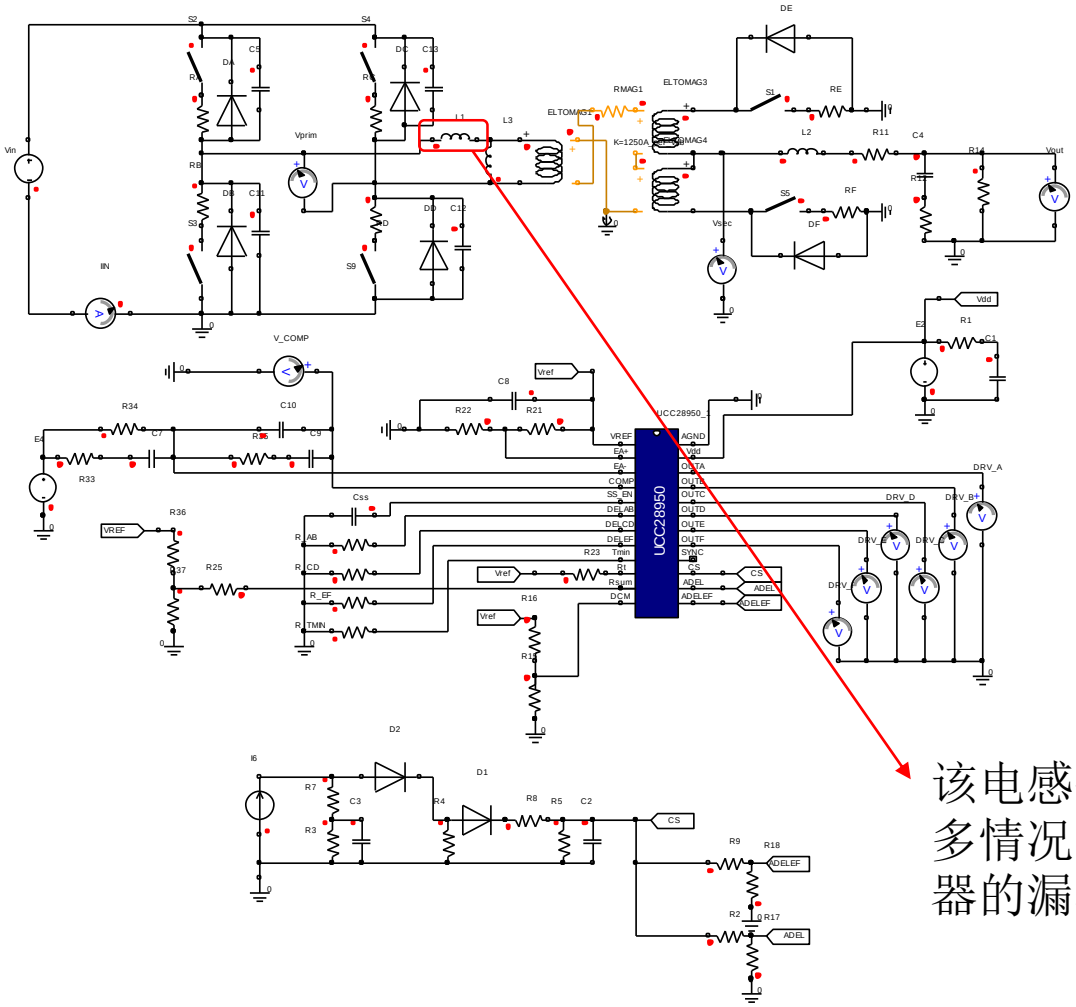


文献波形



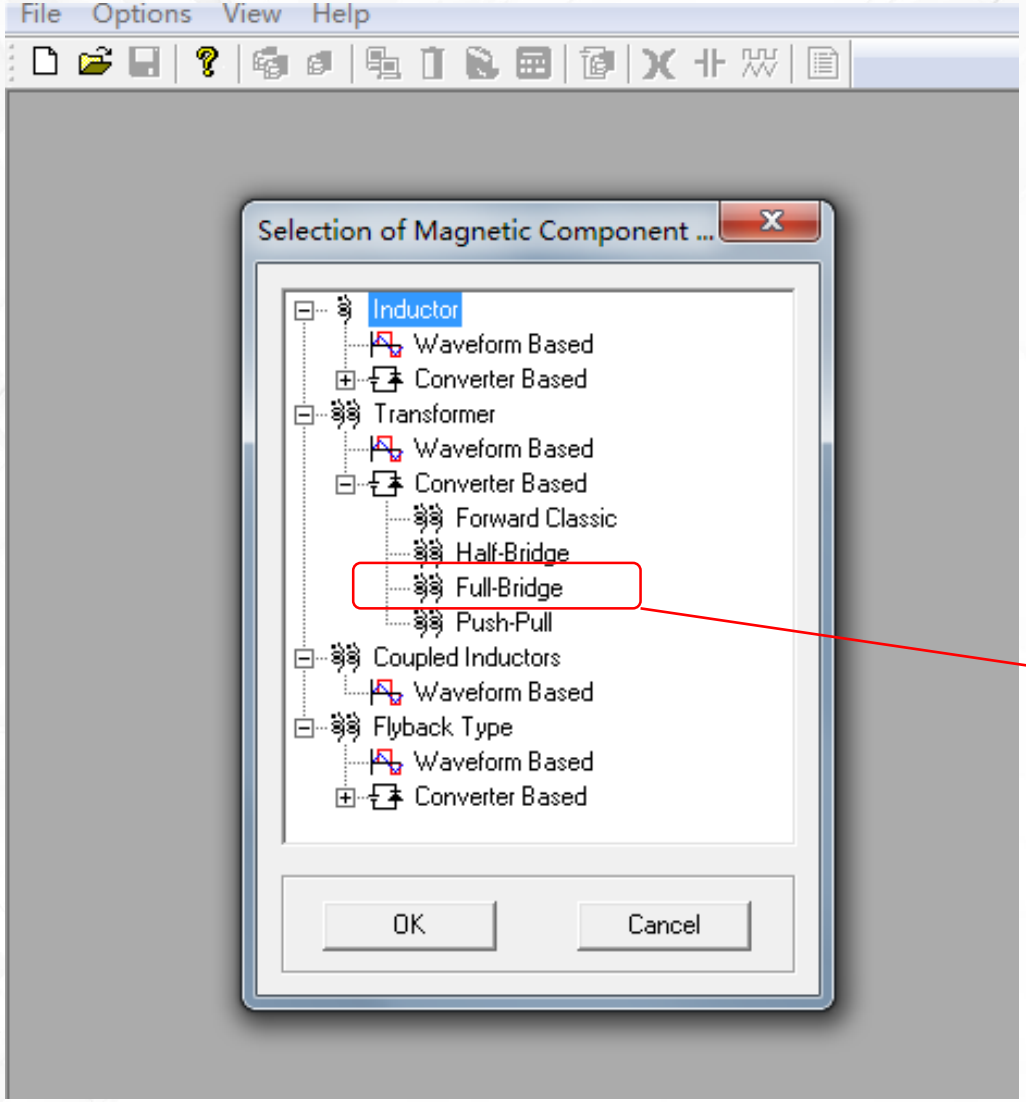
仿真波形

ANSYS UCC28950移相全桥变换器



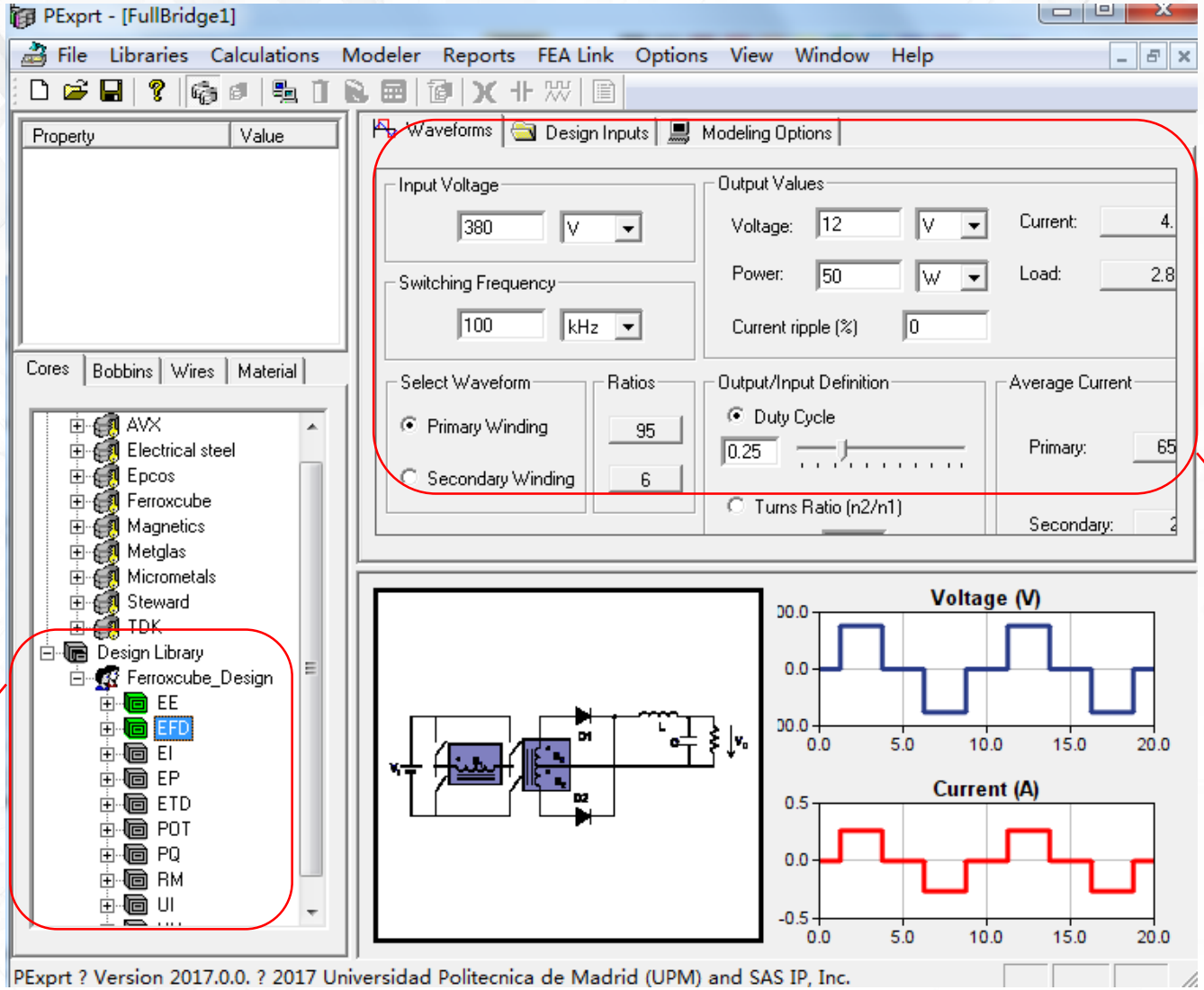
该电感值非常重要，很多情况下是直接用变压器的漏感

UCC28950移相全桥变换器变压器设计-PExprt



选定全桥变压器类型

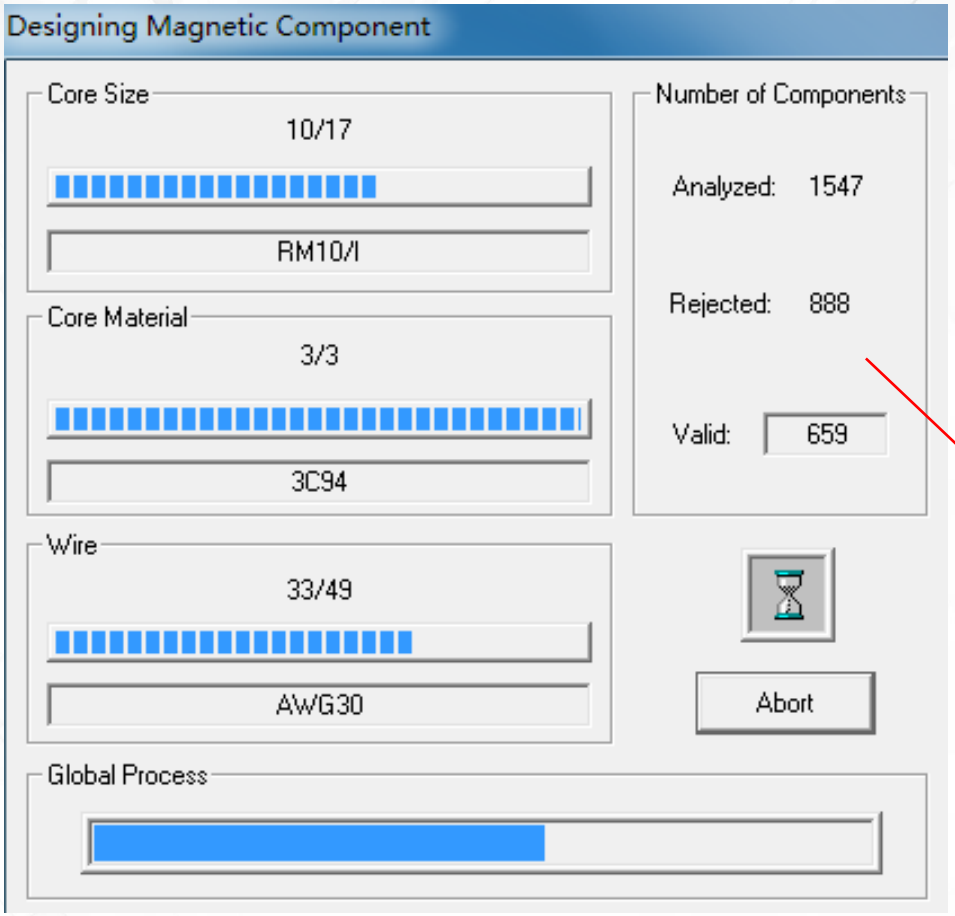
UCC28950移相全桥变换器变压器设计-PExprt



指定设计库

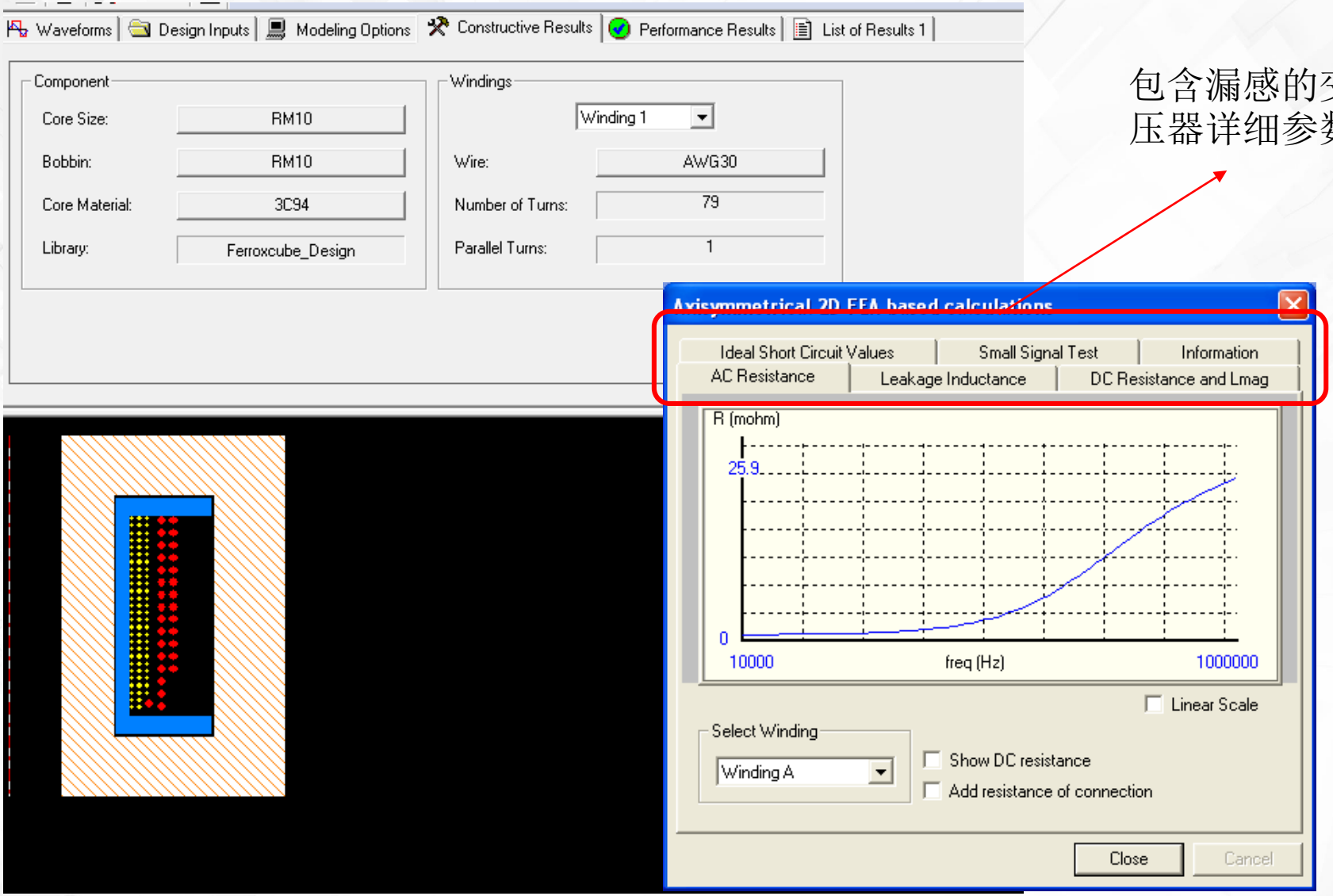
指定变换器电气参数

UCC28950移相全桥变换器变压器设计-PExprt



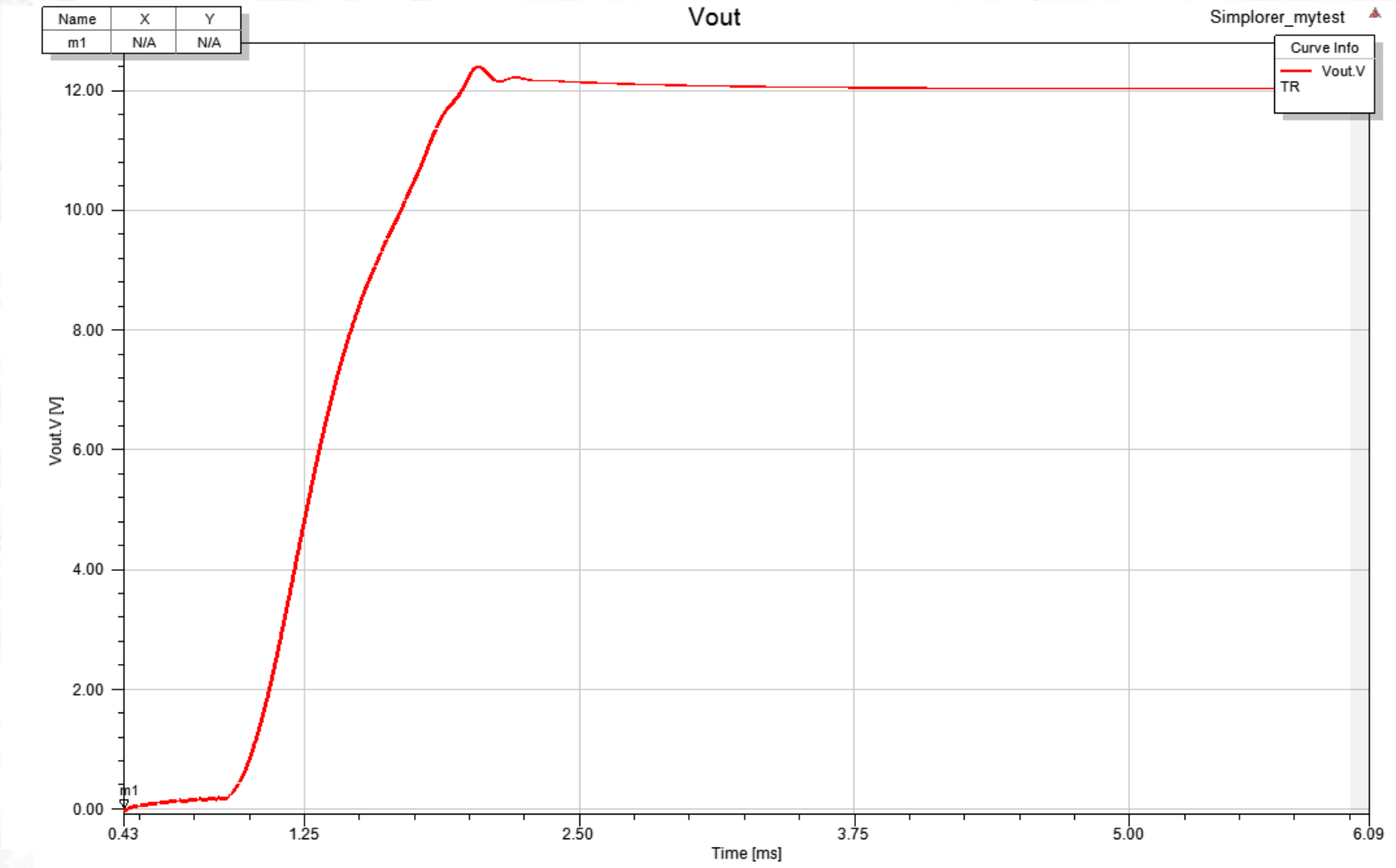
根据变换器电气参数自动设计

UCC28950移相全桥变换器变压器设计-PExprt



包含漏感的变压器详细参数

PExprt设计的变压器代替理想变压器



内容提要

- **Simplorer用于定制化高级建模方法**
  - Simplorer建模平台概述
  - Simplorer基本库模型应用
  - Simplorer基本库模型定制化高级应用模型（以脉冲功率负载为例）
- **Simplorer用于高新能开关电源仿真**
  - 移相全桥电源变换器原理
  - Simplorer R18中实现移相全桥电源变换器方法
  - PExprt设计移相全桥变换器变压器
- 总结

总结

- Simplorer基本模型库丰富
- 可利用Simplorer基本模型定制化高级模型，并可打包加入Personal Libraries重复使用
- Simplorer可以方便实现复杂移相全桥变换器的仿真设计
- PExprt可设计考虑原边漏感的移相全桥变换器，并集合Simplorer进行仿真分析

感谢聆听