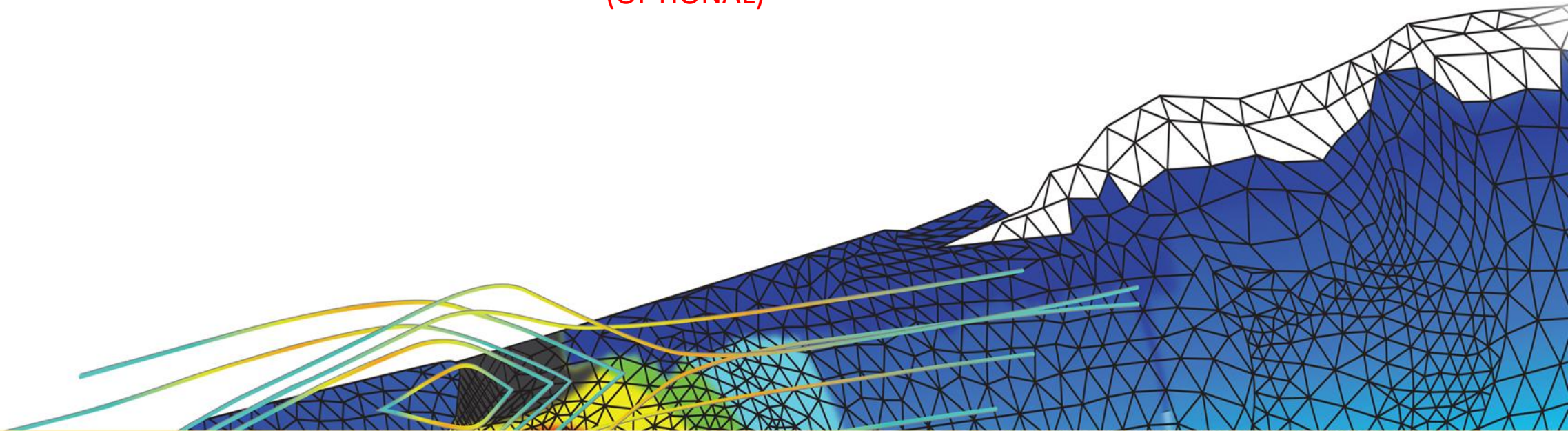




## Impedance Target Definition

(OPTIONAL)



# Opening Circuit Analysis Project

## Starting ANSYS Electronics Desktop

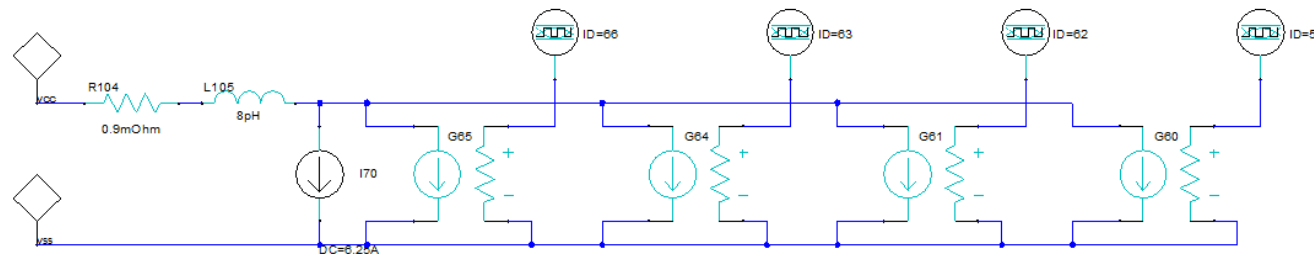
- To launch SIwave, click the Microsoft **Start Button** > **ALL Programs** > **ANSYS Electromagnetics** > **ANSYS Electromagnetics Suite 18.0**
- Select the **ANSYS Electronics Desktop 2017.0** executable.

## Open an Electronics Desktop Project

- Select the **File** > **Open** menu item
  - Browse to the file: **PI\_advanced\_circuit.aedt**
  - Click the **Open** button

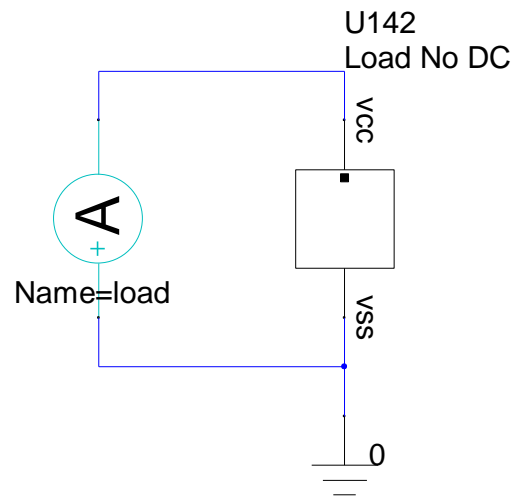
# Load Circuit

- Double click on the Load design in the Project Manager to open the schematic
- The load for this example consists of:
- Small RL circuit representing ball grid array
- DC current source representing average current draw of 6.25 A
- Dynamic current sources of  $\pm 78.1$  mA at four different periods/rise times:
  - 40/10 ns
  - 20/5 ns
  - 10/2.5 ns
  - 5/1.25 ns
- As an alternative this load circuit could come from a SPICE model of the current draw on the power supply or an Apache Chip-Power-Model (CPM)

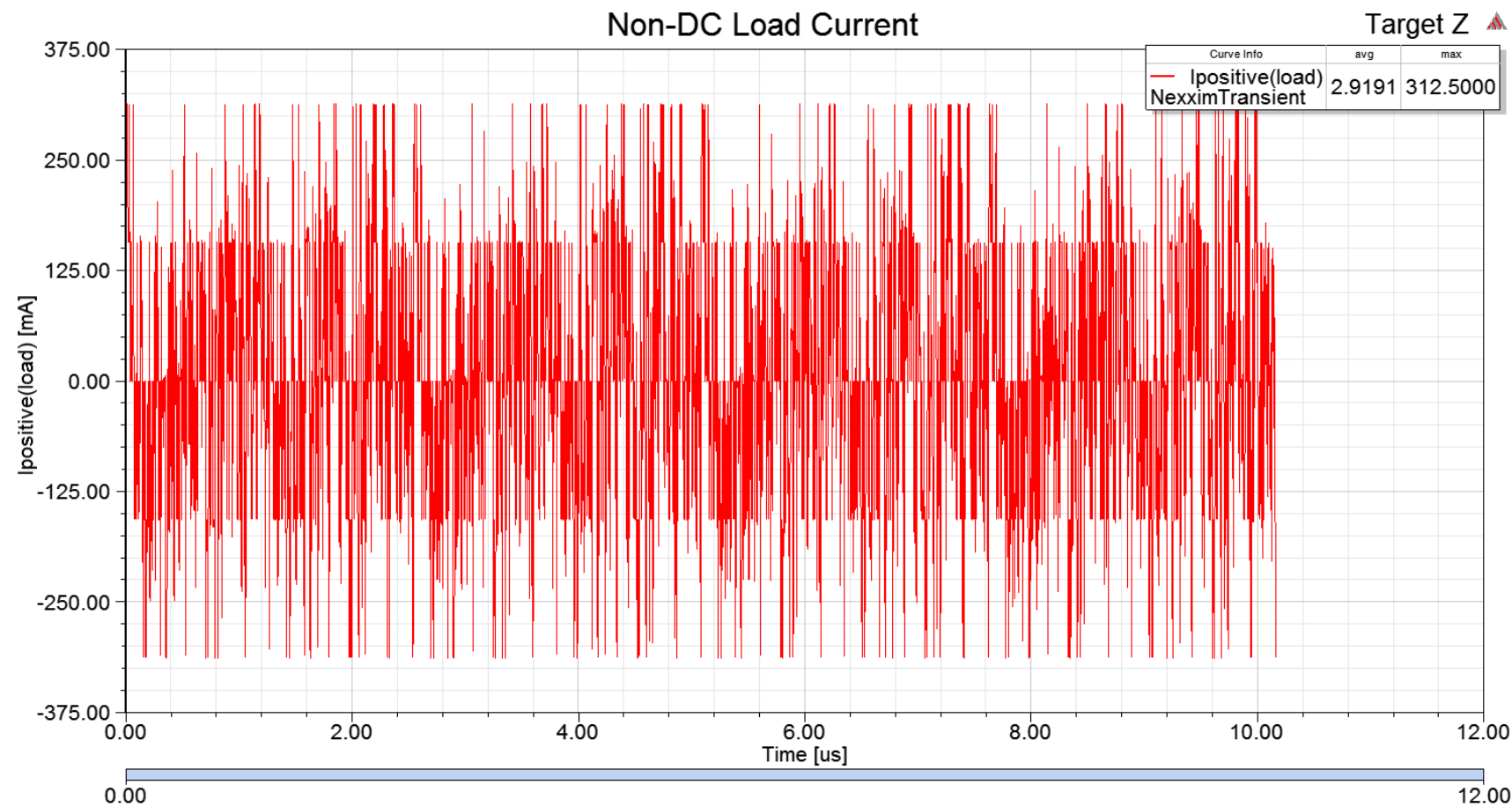


# Plotting Load Current

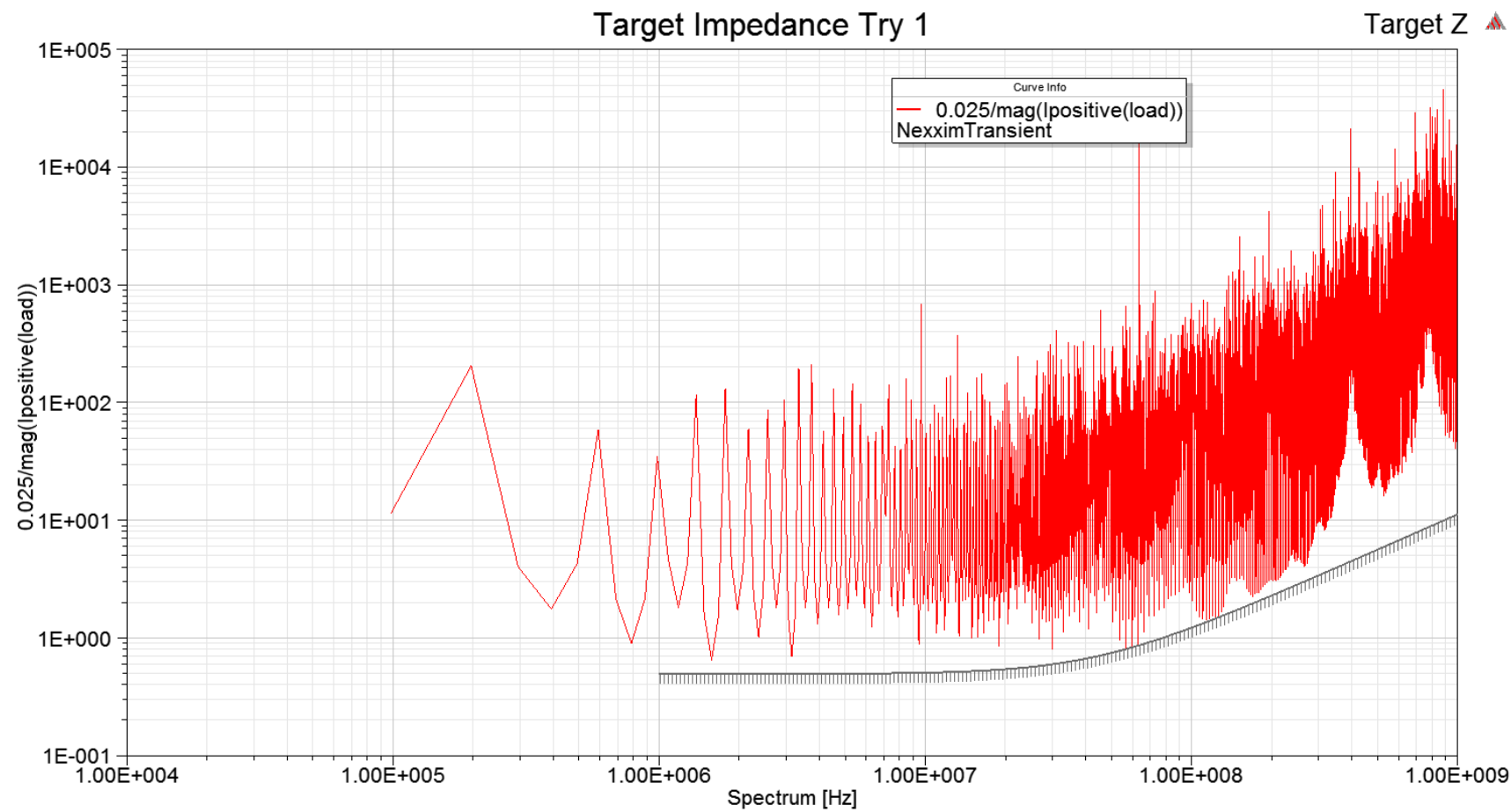
- Double click the Target Z design in the Project Manager to open the schematic for the circuit used to define the target impedance
- Expand Target Z > Analysis, right click on the NexximTransient solution setup, and click Analyze to run the simulation
- Expand Target Z > Results and double click on the plot named Non-DC Load Current to open the plot of the load current



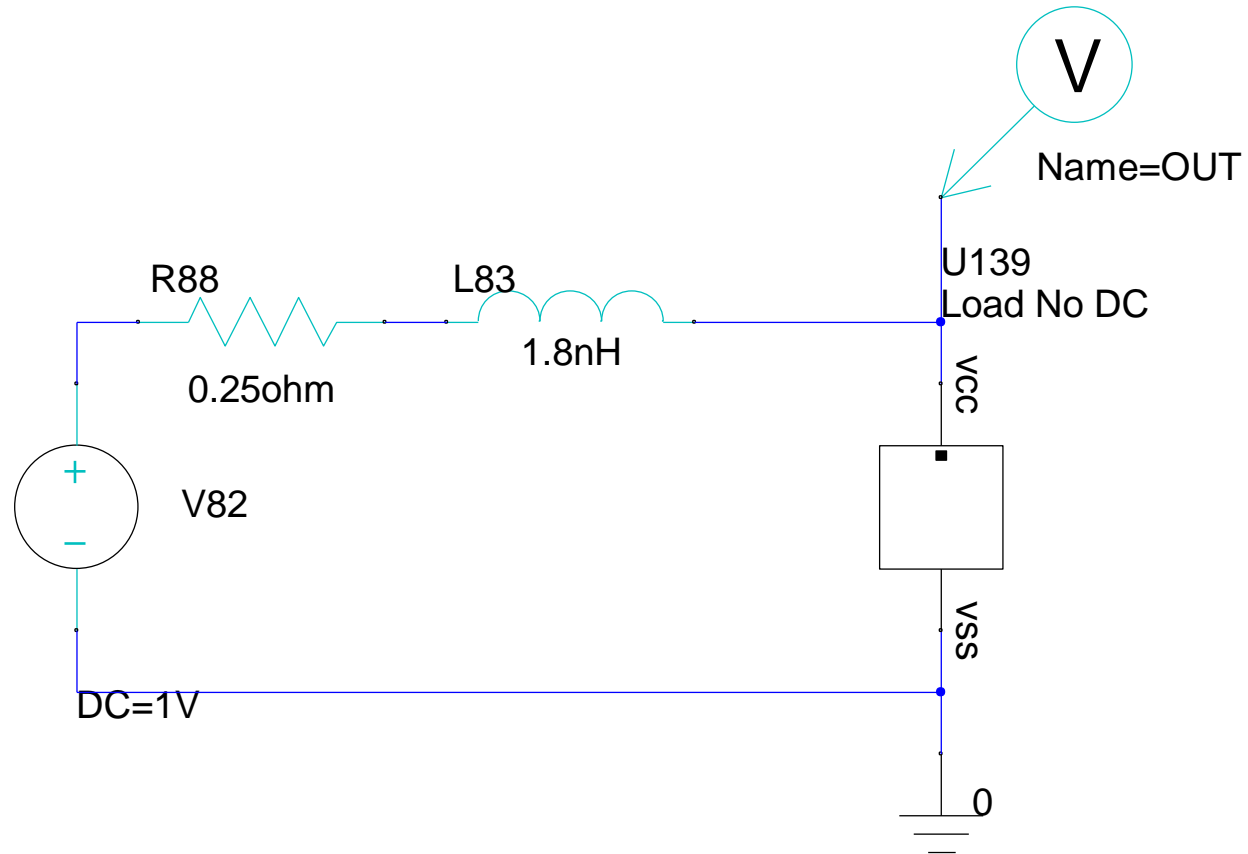
# Load Current Without DC Component



# Apparent Target Impedance: 0.25 ohm + 1.8 nH

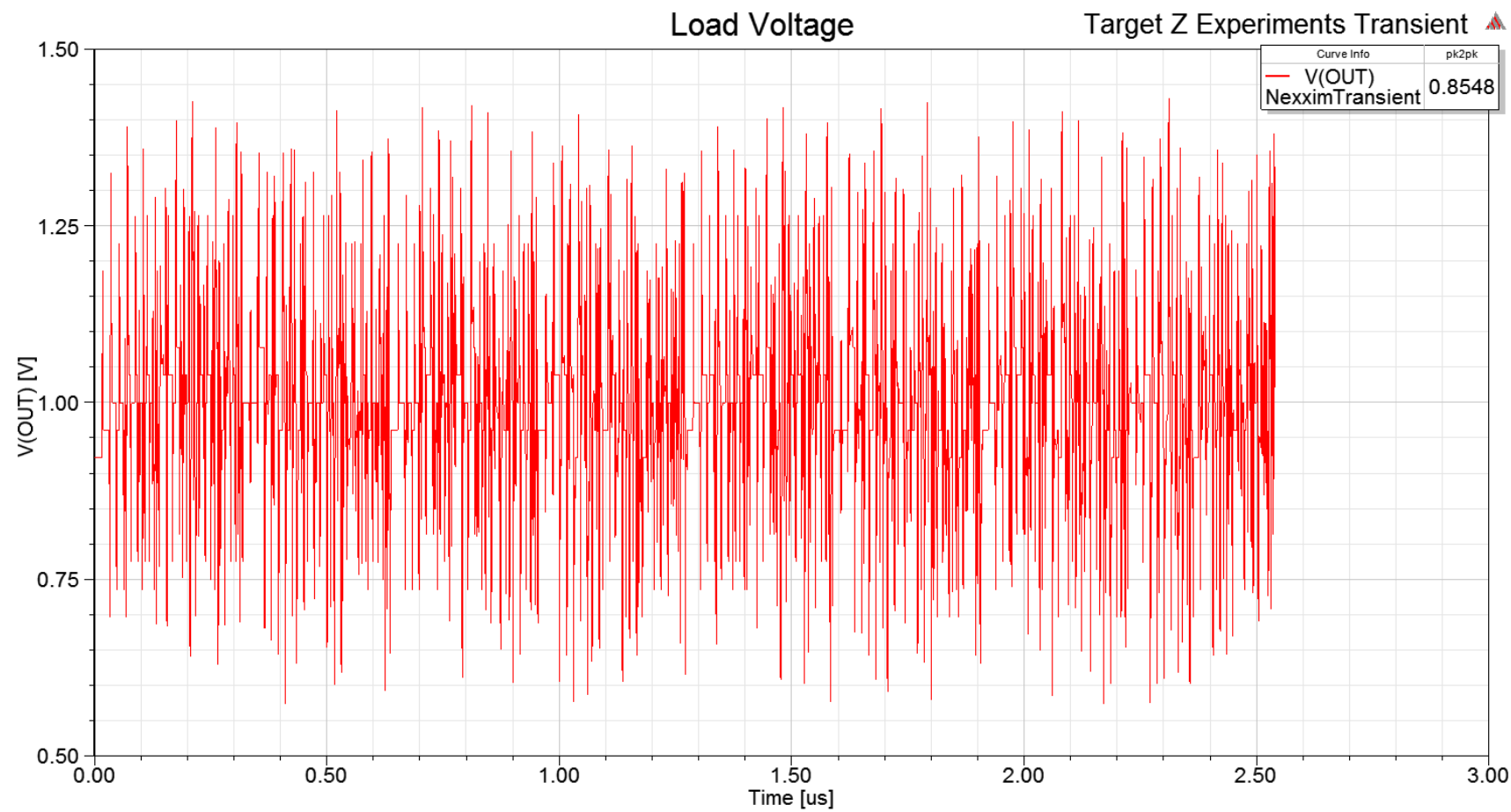


# Test Target Impedance Calculation



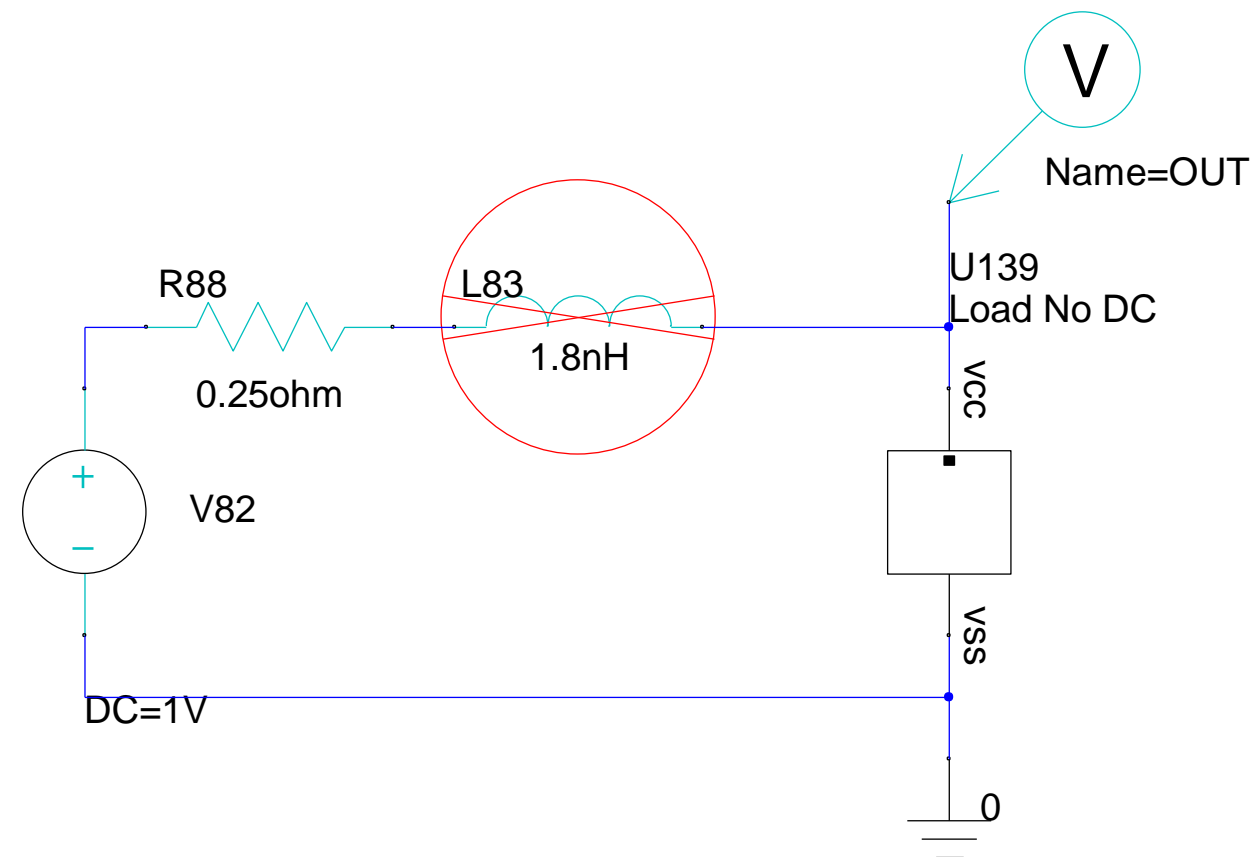


# Load Voltage Swing Too Large

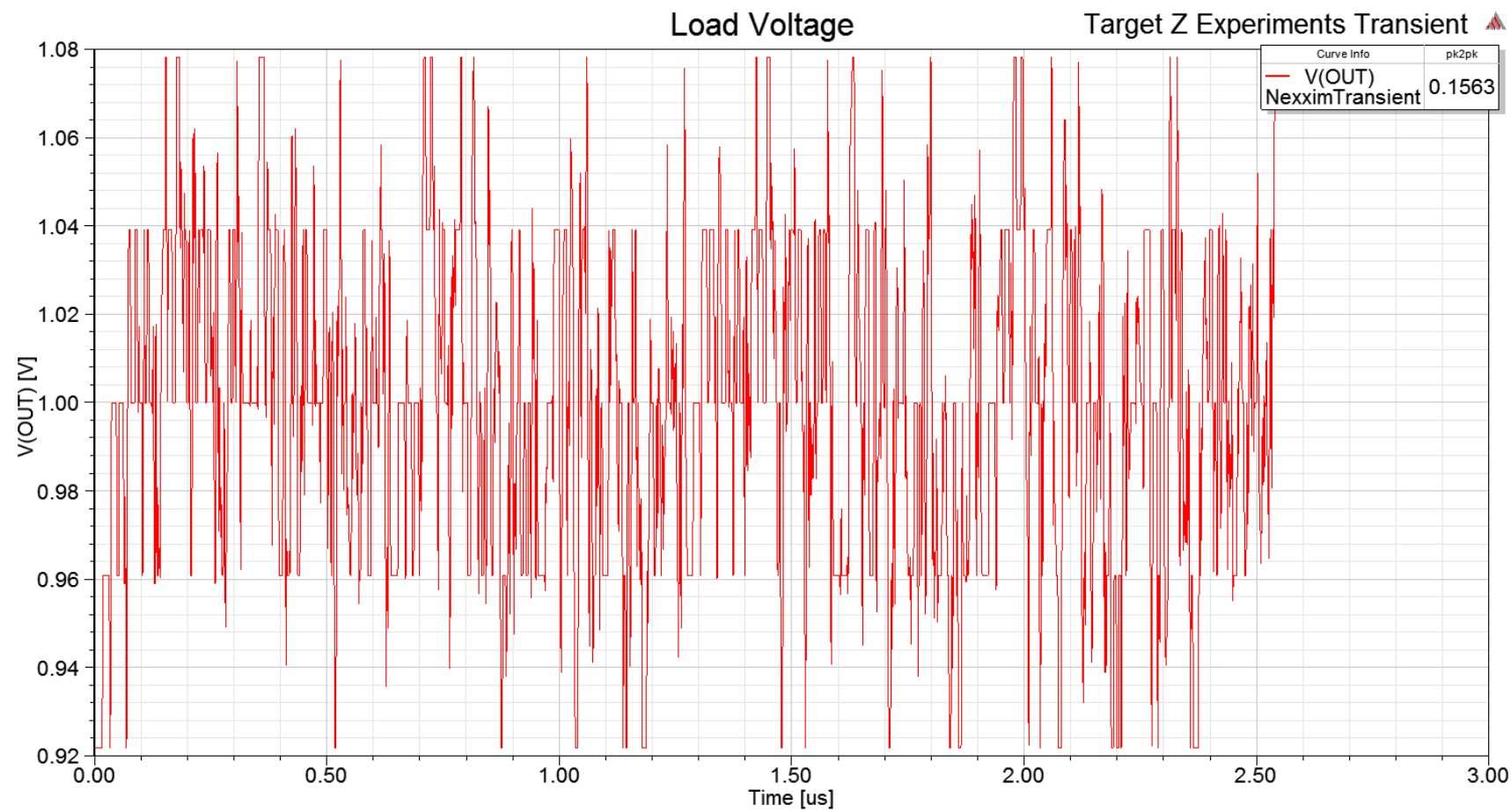




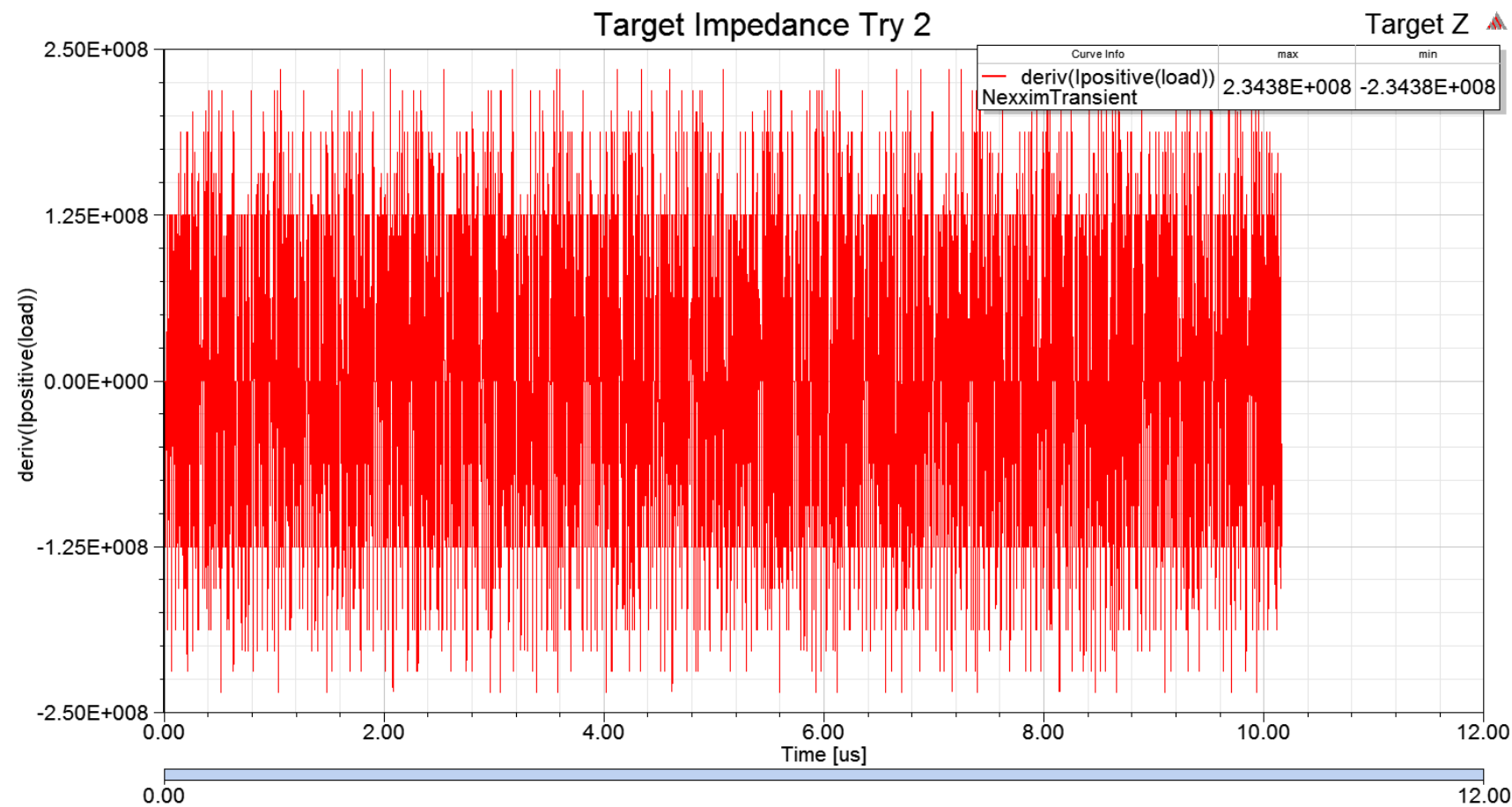
# Maybe Try Solely Resistive PDN?



# Load Voltage Swing Still Too Large



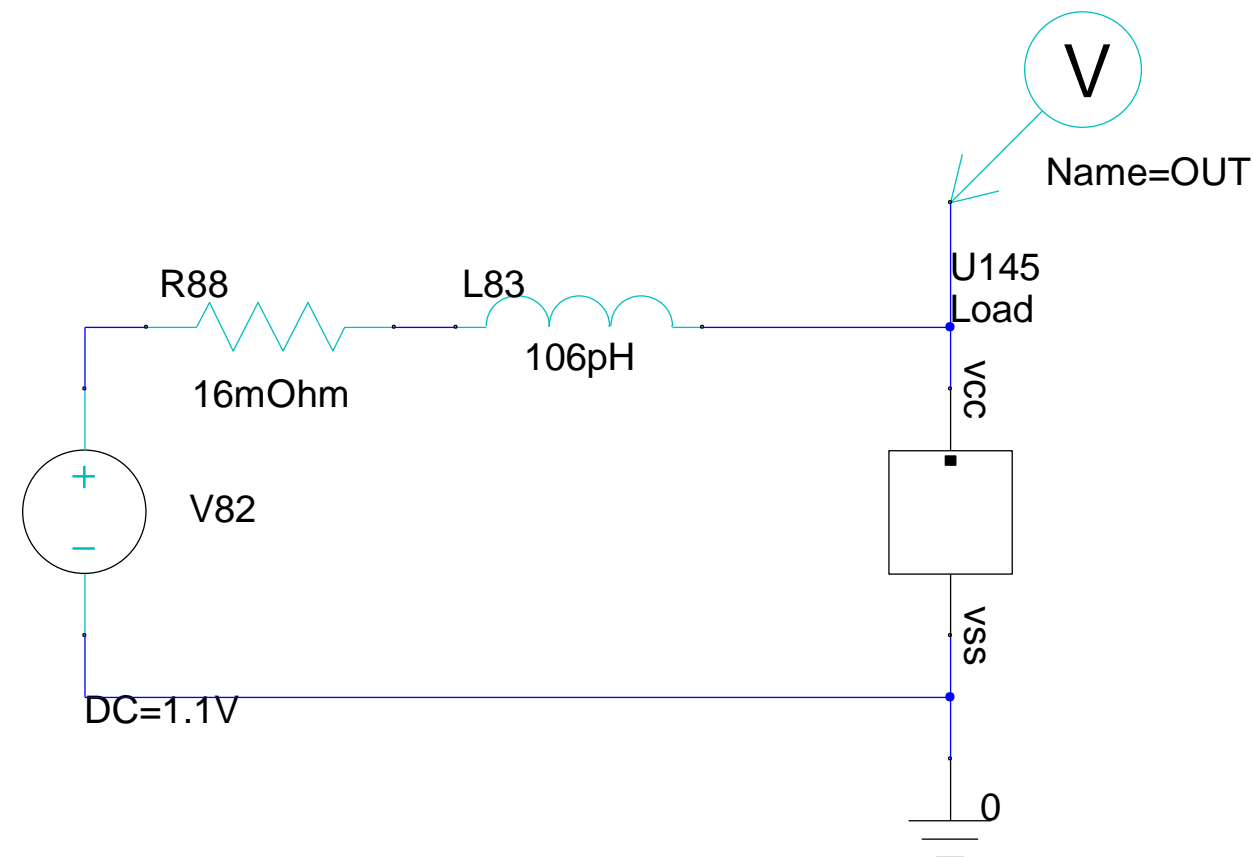
# Why? Inductance (di/dt) Dominates!



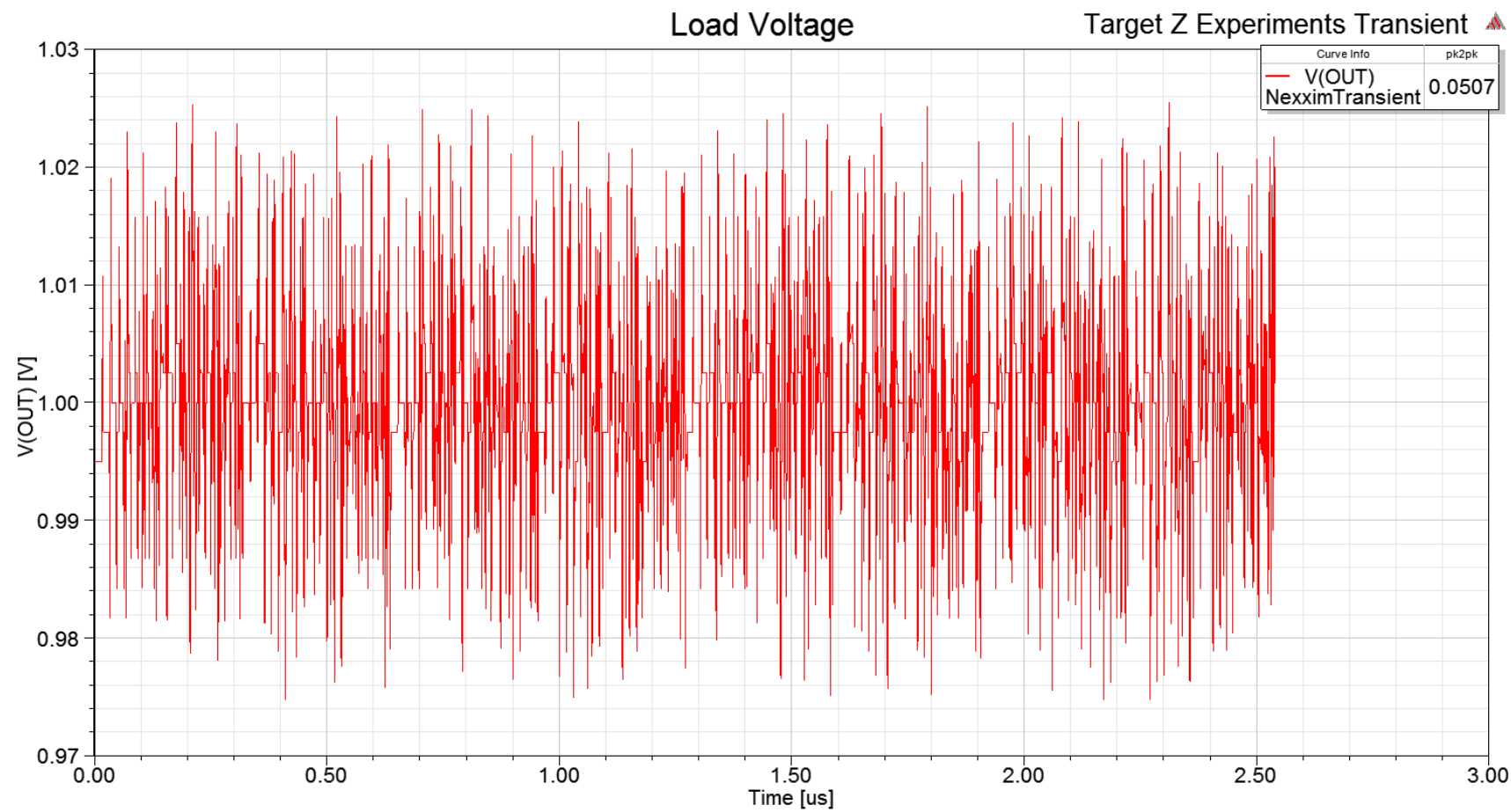
# A Better Way To Calculate Target Impedance

- Calculate target inductance as:  
 $L = (\text{allowed one-sided voltage swing}) / \max(\text{deriv}(\text{Iload}))$   
 $L = (25 \text{ mV}) / (2.3438\text{e}8 \text{ A/s})$   
 $L = 106 \text{ pH}$
- Calculate target resistance as:  
 $R = (\text{allowed power loss}) / (\text{avg}(\text{Iload}))^2$   
 $(\text{allowed power loss}) = (\text{supplied power}) * 0.1$   
 $(\text{allowed power loss}) = (1 \text{ V})(6.25 \text{ A}) * 0.1 = 625 \text{ mW}$   
 $R = (0.625 \text{ W}) / (6.25 \text{ A})^2$   
 $R = 16 \text{ mohm}$

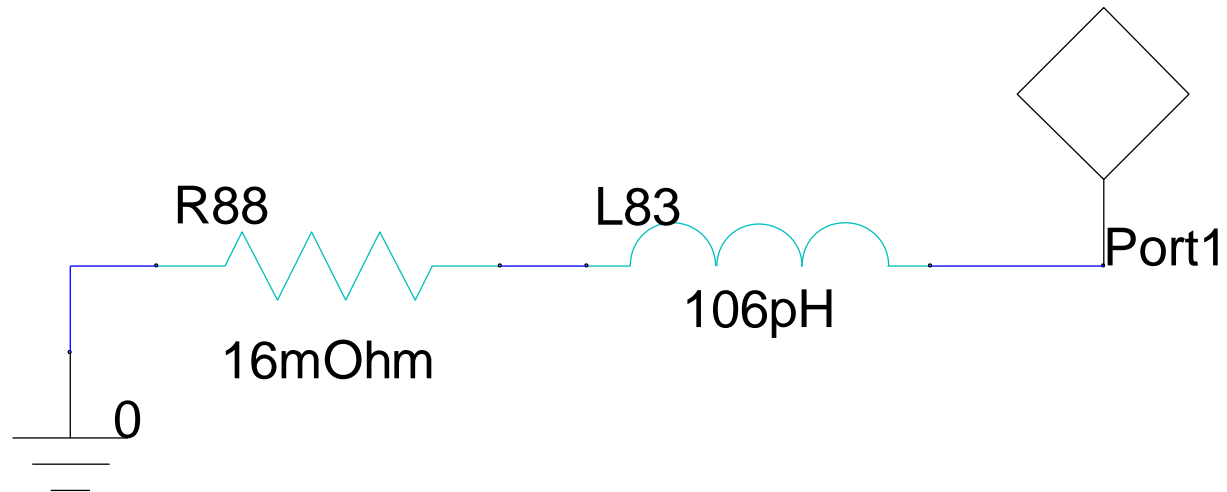
# New Ideal VRM Equivalent



# Load Voltage Swing (Almost) Under Control



# Impedance of Ideal VRM Equivalent





# Defining Target Impedance for PI Advisor

