

PLECS meets SPICE

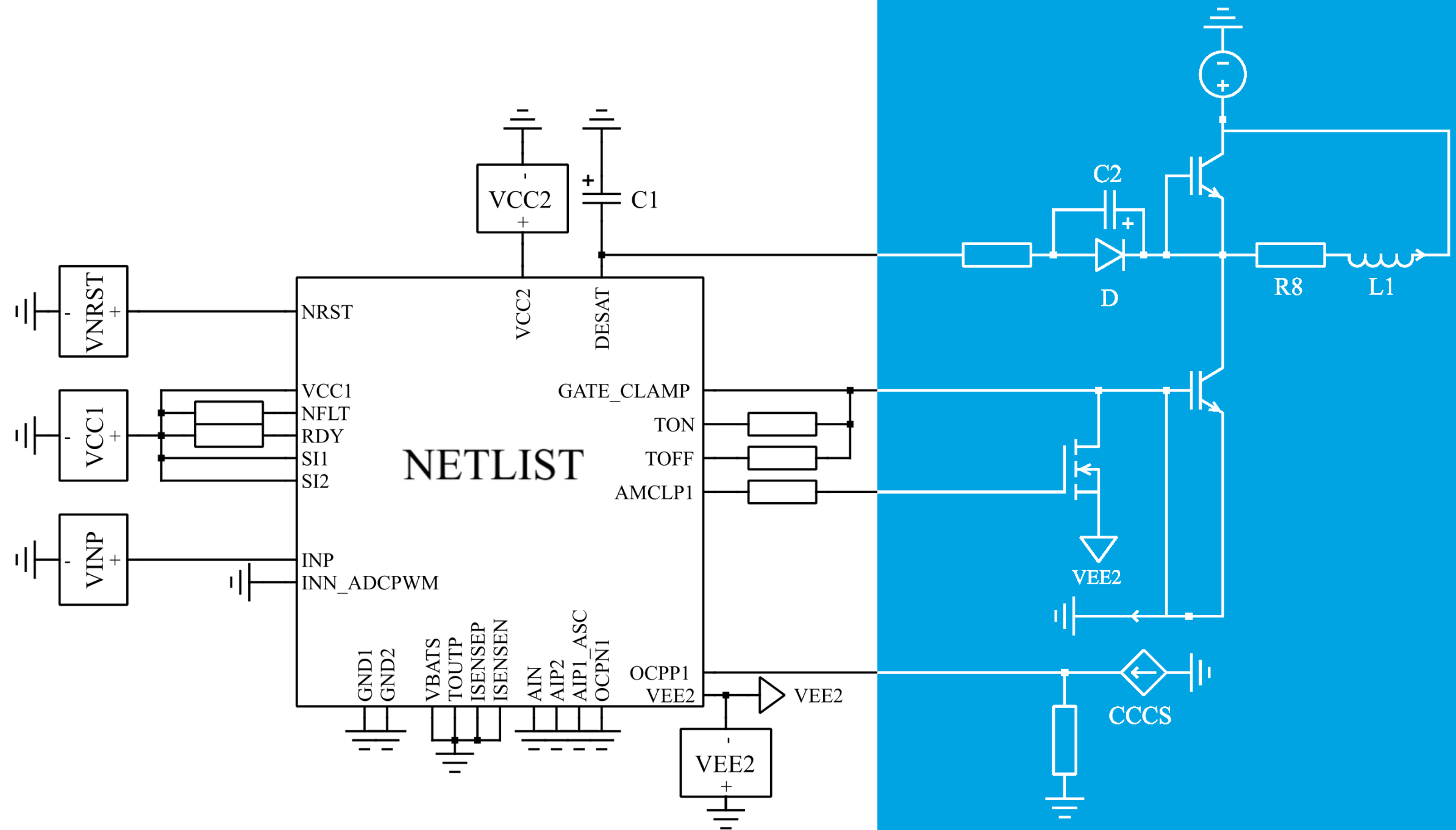
Eli Hanak, Sales Engineer, Plexim GmbH

**Bodo's
Wide Bandgap
Event 2025**

Making WBG Designs Happen

GaN

One model. From Systems to Semiconductors.



SPICE Ingredients

Modified Nodal
Analysis
(MNA)

Netlist
Parser

Compact
Models

Implicit
Solver

Variable
Stepsize

Convergence
Helpers

Modified Nodal Analysis (MNA)

Step 1 Write KCL at each node

node ① $-i_V - i_R = 0$

node ② $i_R - i_C = 0$

Step 2 Apply branch eqs. using KVL

resistor $i_R = \frac{1}{R}v_R$

KVL $v_R = v_1 - v_2$

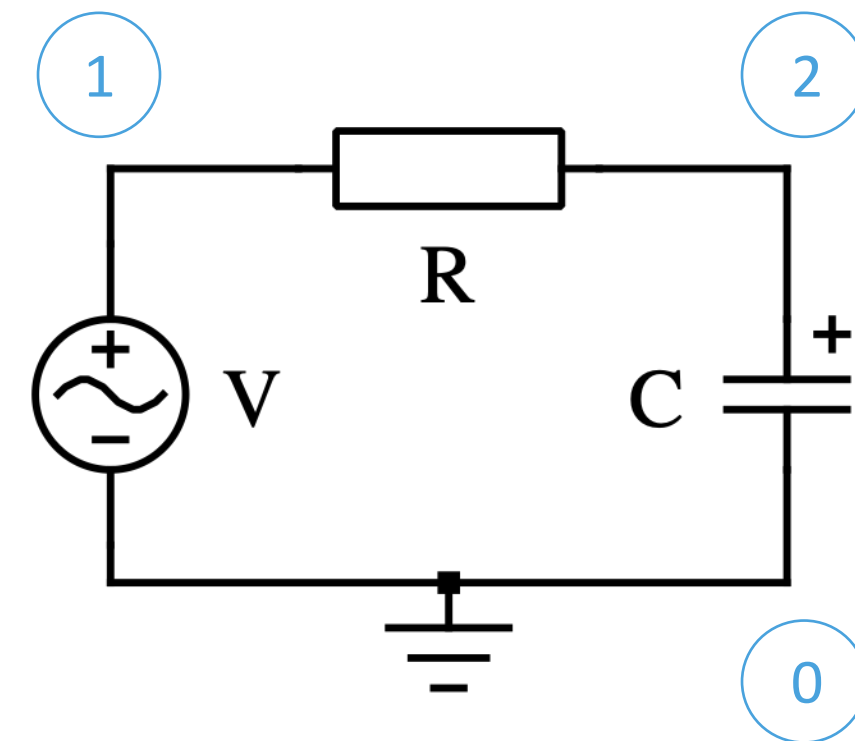
Step 3 Add source and dynamical eqs. using KVL

capacitor

$$\frac{d}{dt}Cv_2 = i_C$$

source

$$v_1 = V$$



$$\begin{aligned} -i_V - \frac{1}{R}(v_1 - v_2) &= 0 \\ \frac{1}{R}(v_1 - v_2) - i_C &= 0 \end{aligned}$$

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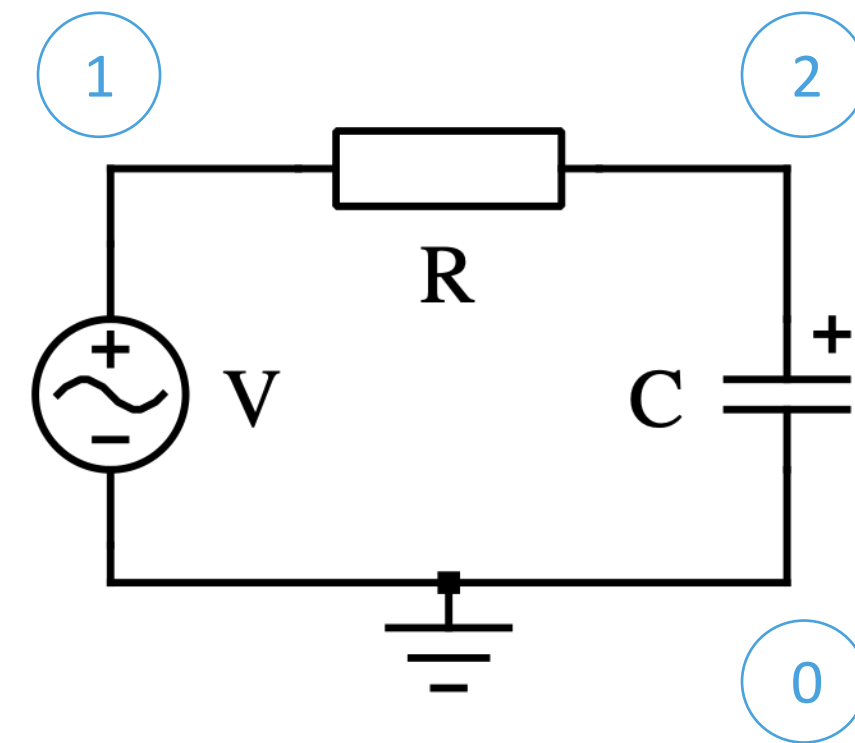
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Comparing Formulations

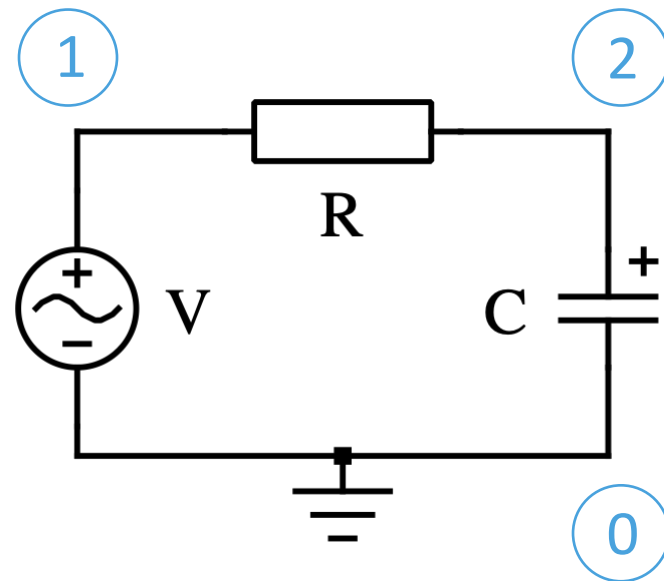
SPIKE

DAE System

$$\frac{d}{dt}\mathbf{q}(\mathbf{x}) = \mathbf{f}(\mathbf{x})$$

$$\mathbf{0} = \mathbf{g}(\mathbf{x}, t)$$

→ 4 eqs.



Differential Algebraic Equations (DAE)

$$\frac{d}{dt}Cv_2 = i_C$$

$$v_1 - V = 0$$

$$-i_V - \frac{1}{R}(v_1 - v_2) = 0$$

$$\frac{1}{R}(v_1 - v_2) - i_C = 0$$

PLECS

State Space System

$$\frac{d}{dt}\mathbf{x} = \mathbf{Ax} + \mathbf{Bu}$$

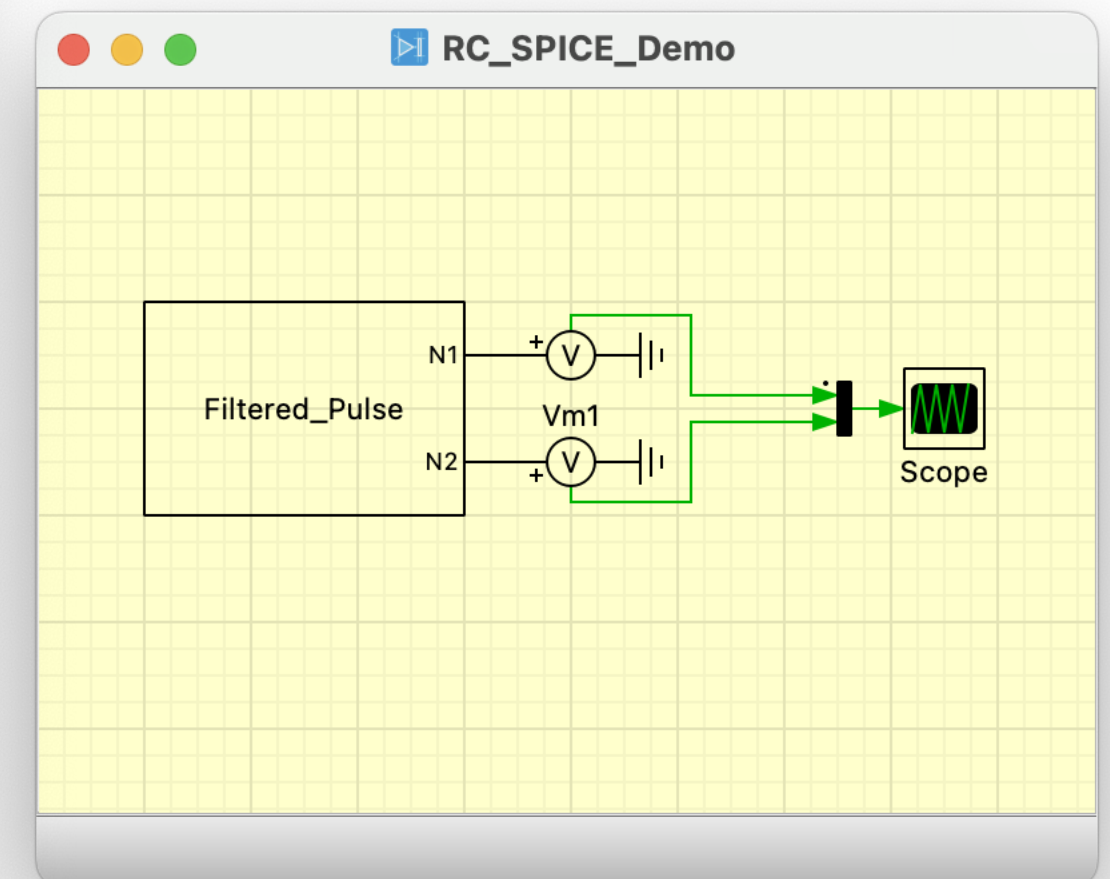
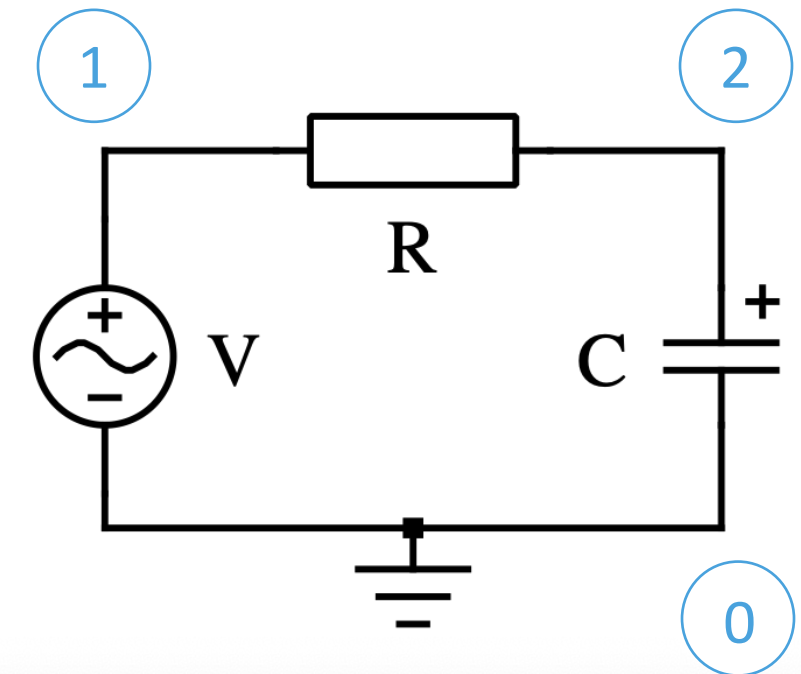
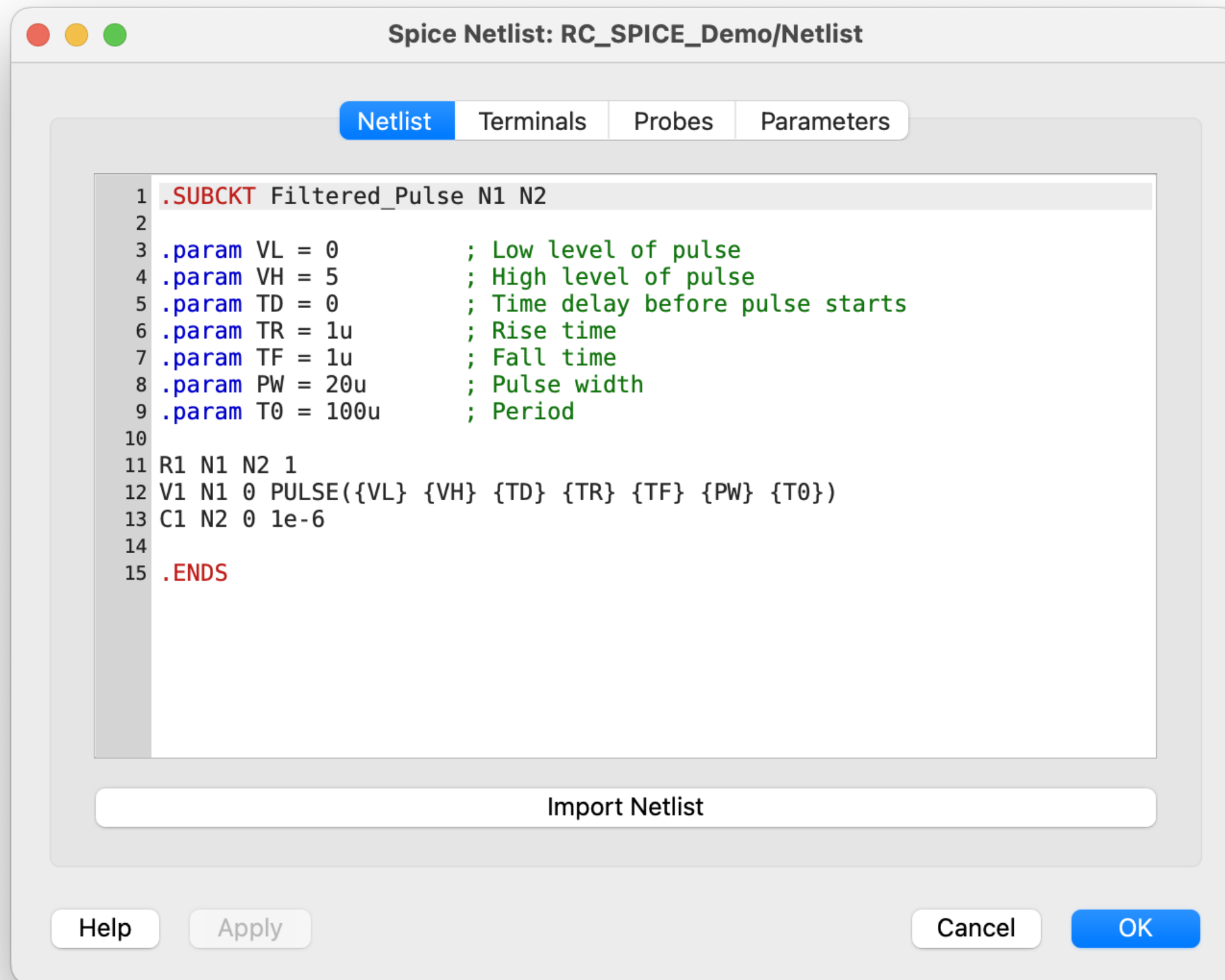
$$\mathbf{y} = \mathbf{Cx} + \mathbf{Du}$$

→ 1 eq.

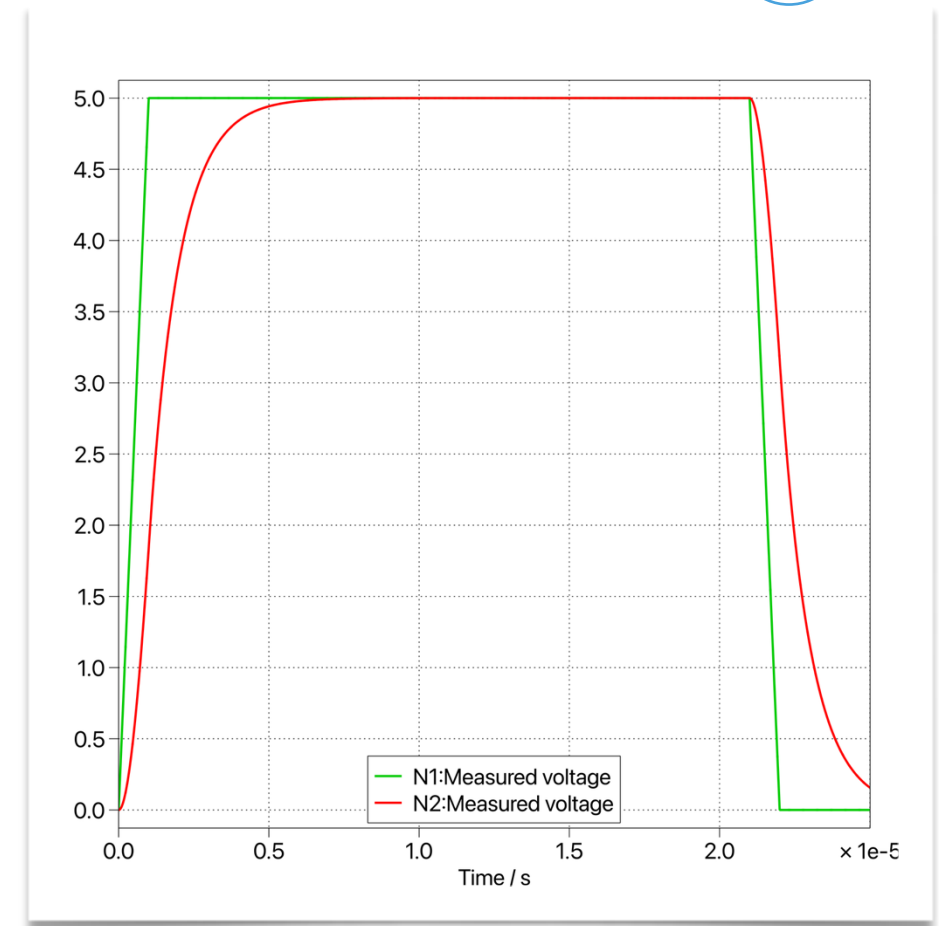
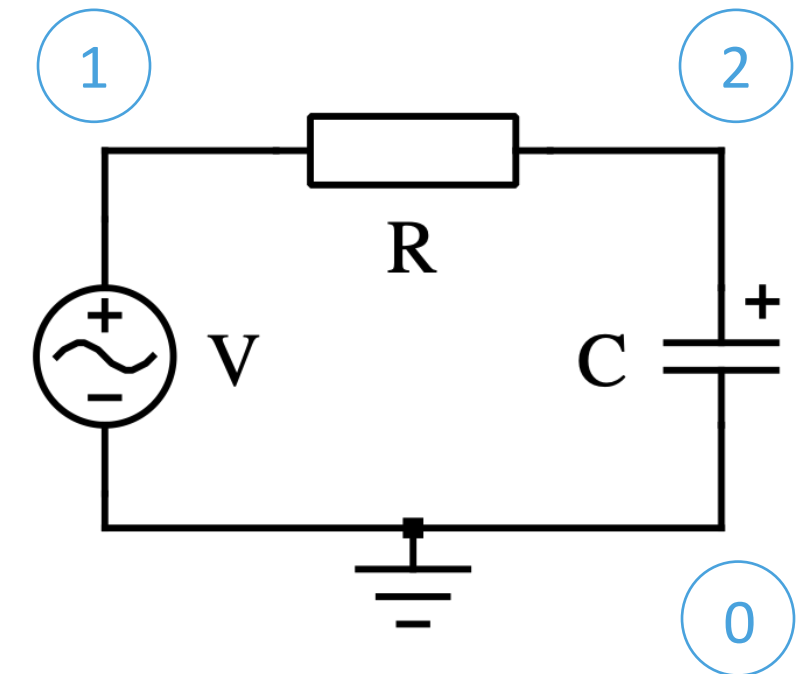
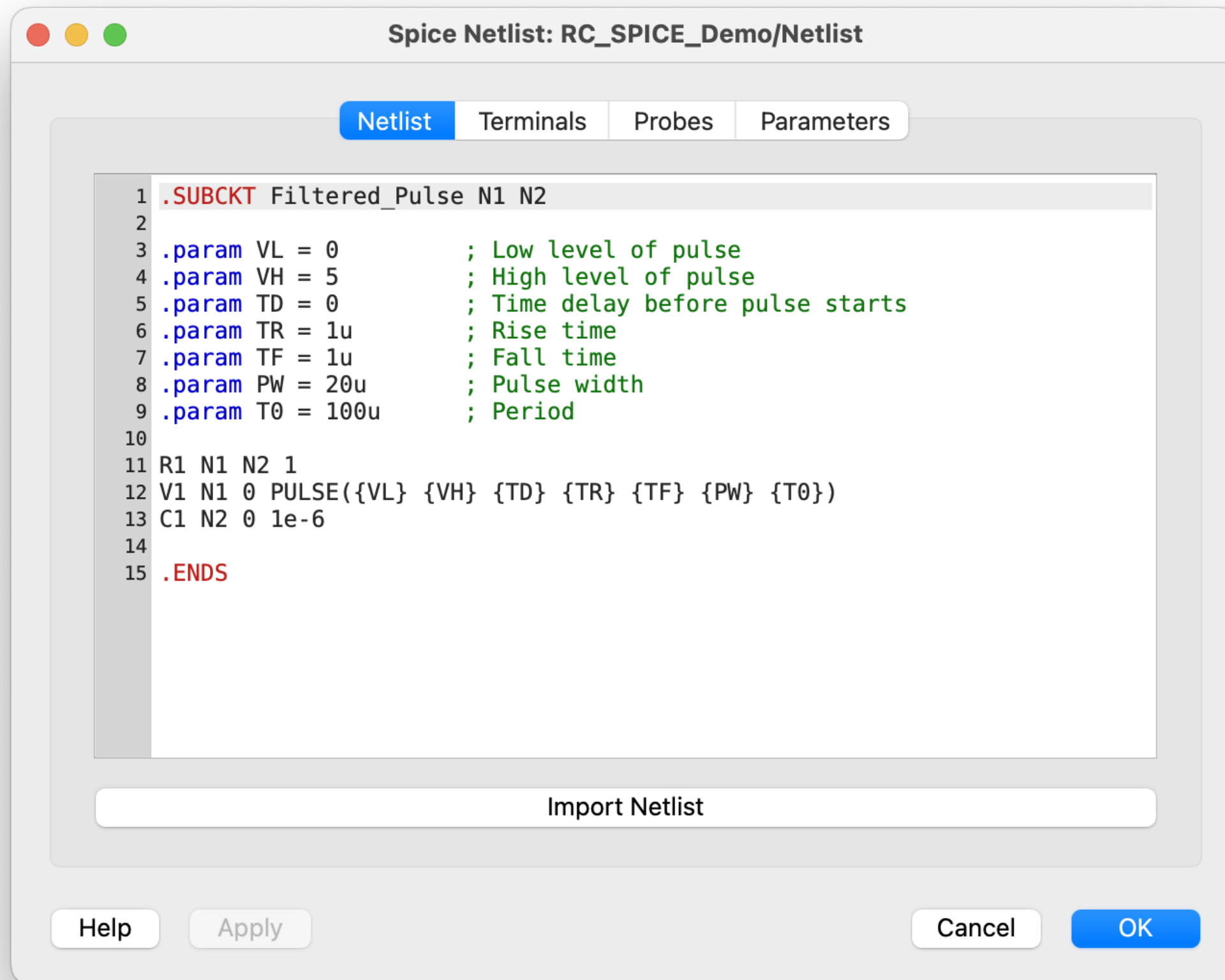
Ordinary Differential Equations (ODE)

$$\frac{d}{dt}v_C = \frac{1}{RC}V - \frac{1}{RC}v_C$$

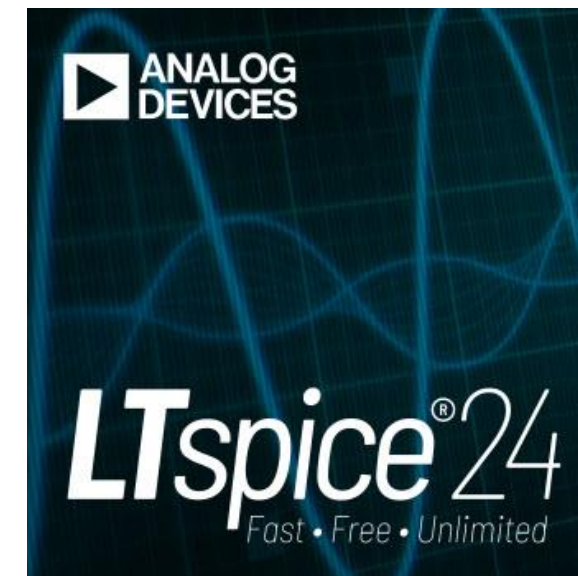
Netlist



Netlist



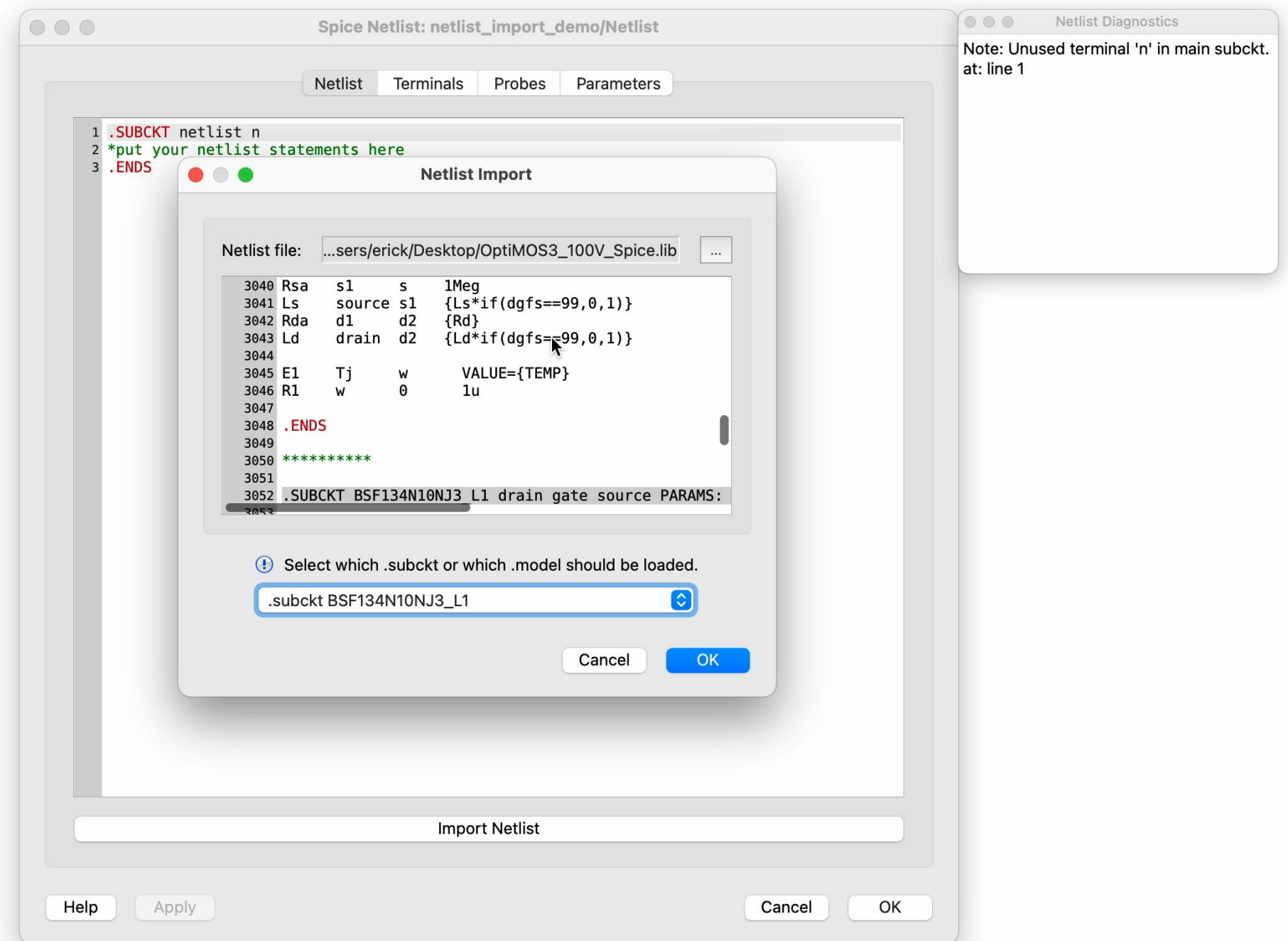
Existing dialects



Netlist Import

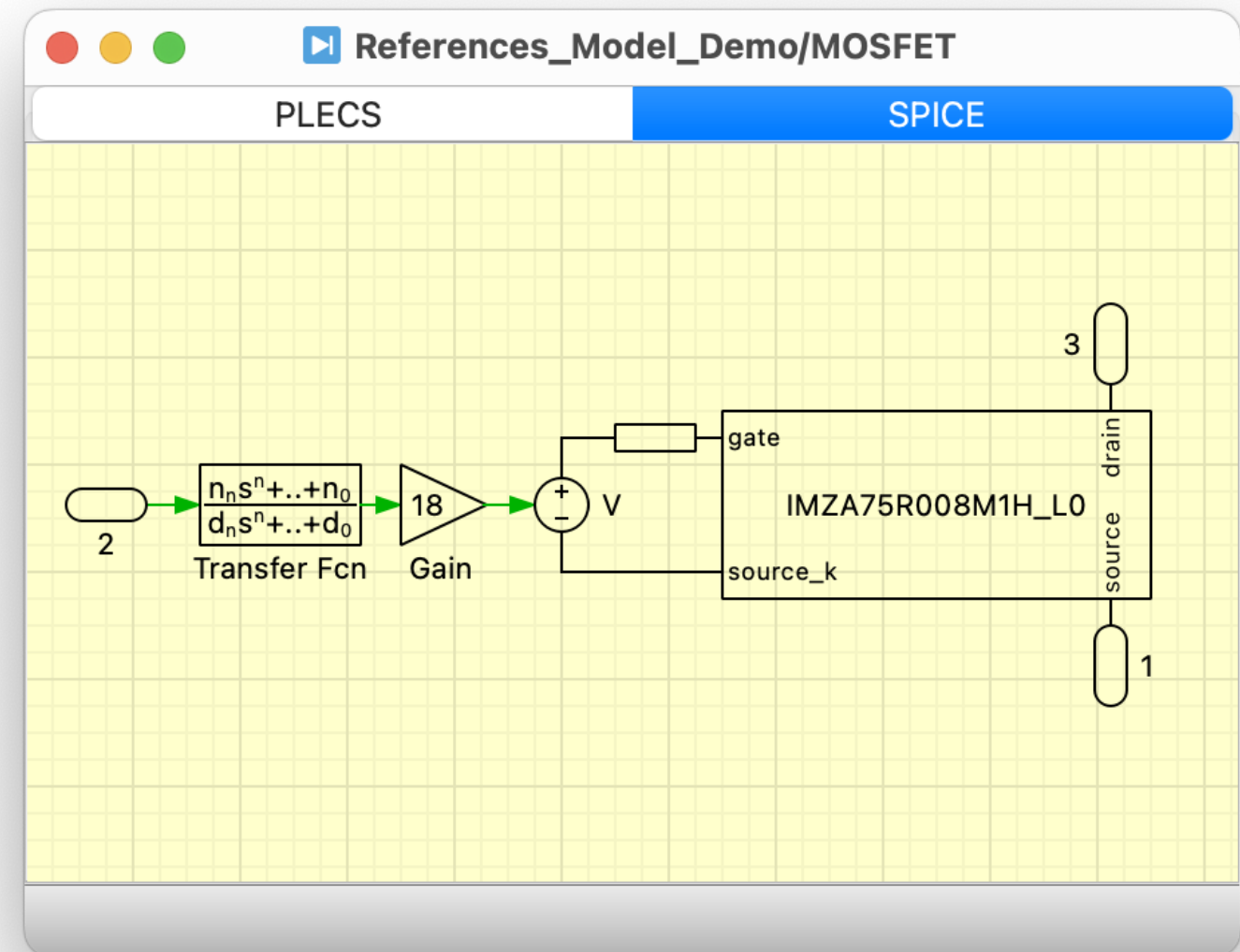
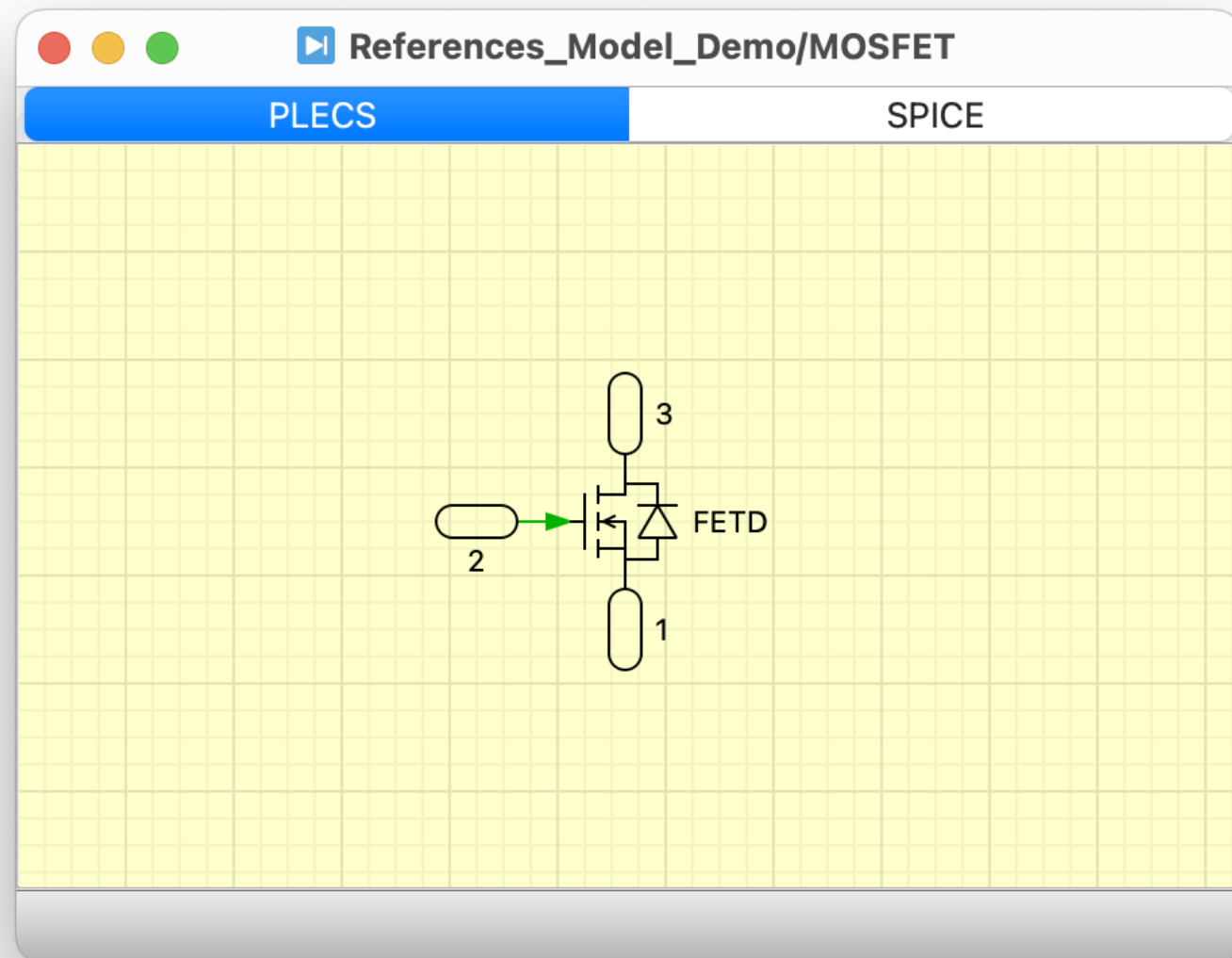
Netlist component

- ▶ Drop-down selection
- ▶ Chosen SUBCKT placed on top
- ▶ Automatic import of dependencies

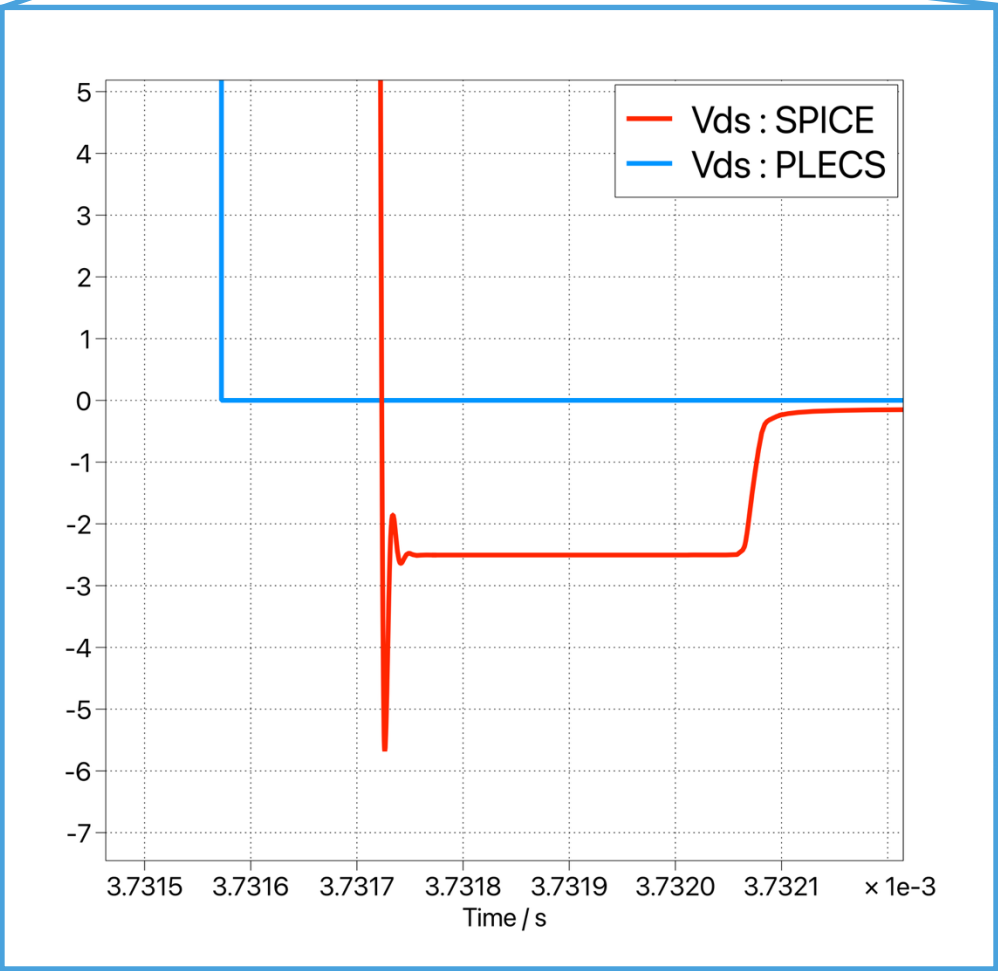
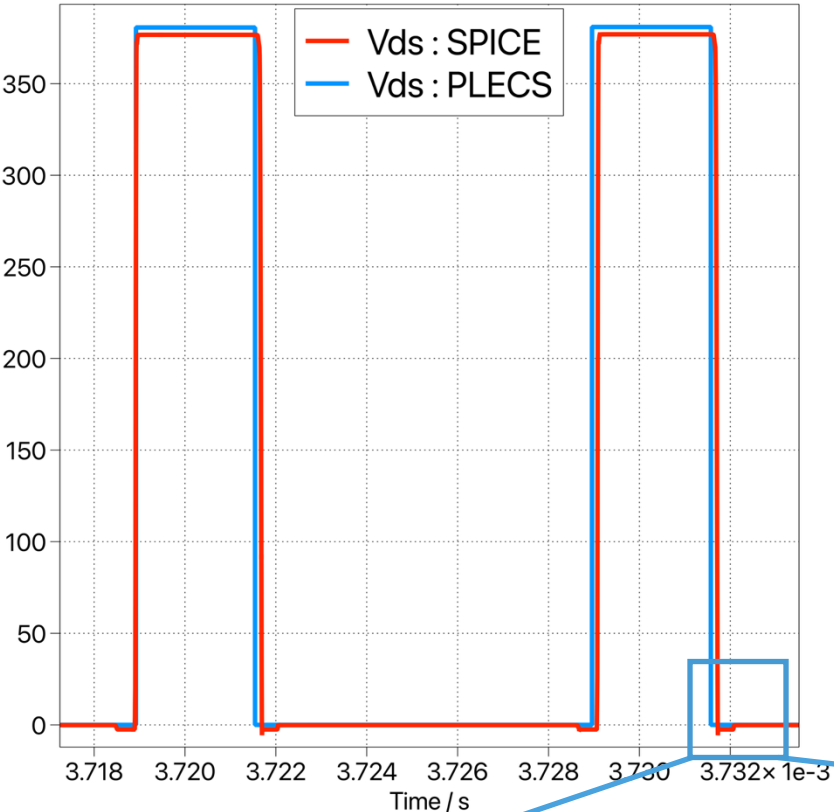


Configurable subsystems

- ▶ Configurable subsystems admit the formulation type of their active configurations.



Comparing PLECS to SPICE



Simulation Parameters: References_Model_Demo

SolverOptionsDiagnosticsInitializationSpice options

System state

Initialize from:

Block parameters

Stored system state

Store current state...

Model initialization commands

```
1 % PLECS or SPICE
2 SystemType='SPICE';
3
4 % Grid
5 Vin = 220*sqrt(2); % Grid voltage (V)
6 F = 50.0; % Grid frequency (Hz)
7
8 % Plant
9 C = 400e-6; % Output capacitor (C)
10 L = 1.5e-3; % Choke inductance (H)
11 Rl = 0.001; % Choke resistance (ohms)
12
13 fs = 100e3; % Switching frequency (Hz)
```

HelpApply

CancelOK

A photograph of a modern exhibition stand for Plexim. The stand is composed of several blue and white rectangular blocks. The top white block features the Plexim logo and the text 'electrical engineering software'. The stand is suspended from a metal truss system in a large hall.

plexim
electrical engineering software



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