SIEMENS

I&S IT PS

Information Technology Plant Solutions

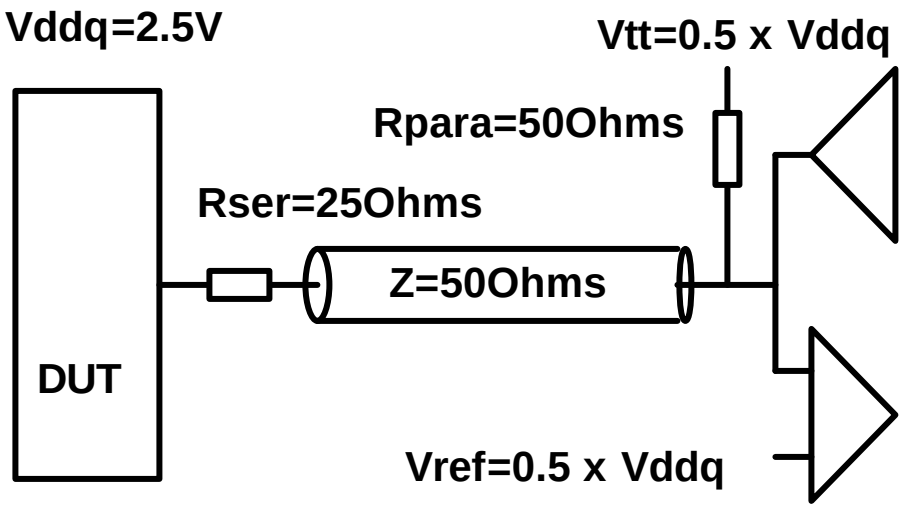
SSTL_2 Modeling Experiences

B. Unger

Solution
Multivendor
Simulation

Introduction

- **SSTL_2 ⟶ Stub Series Terminated Logic for 2.5V**



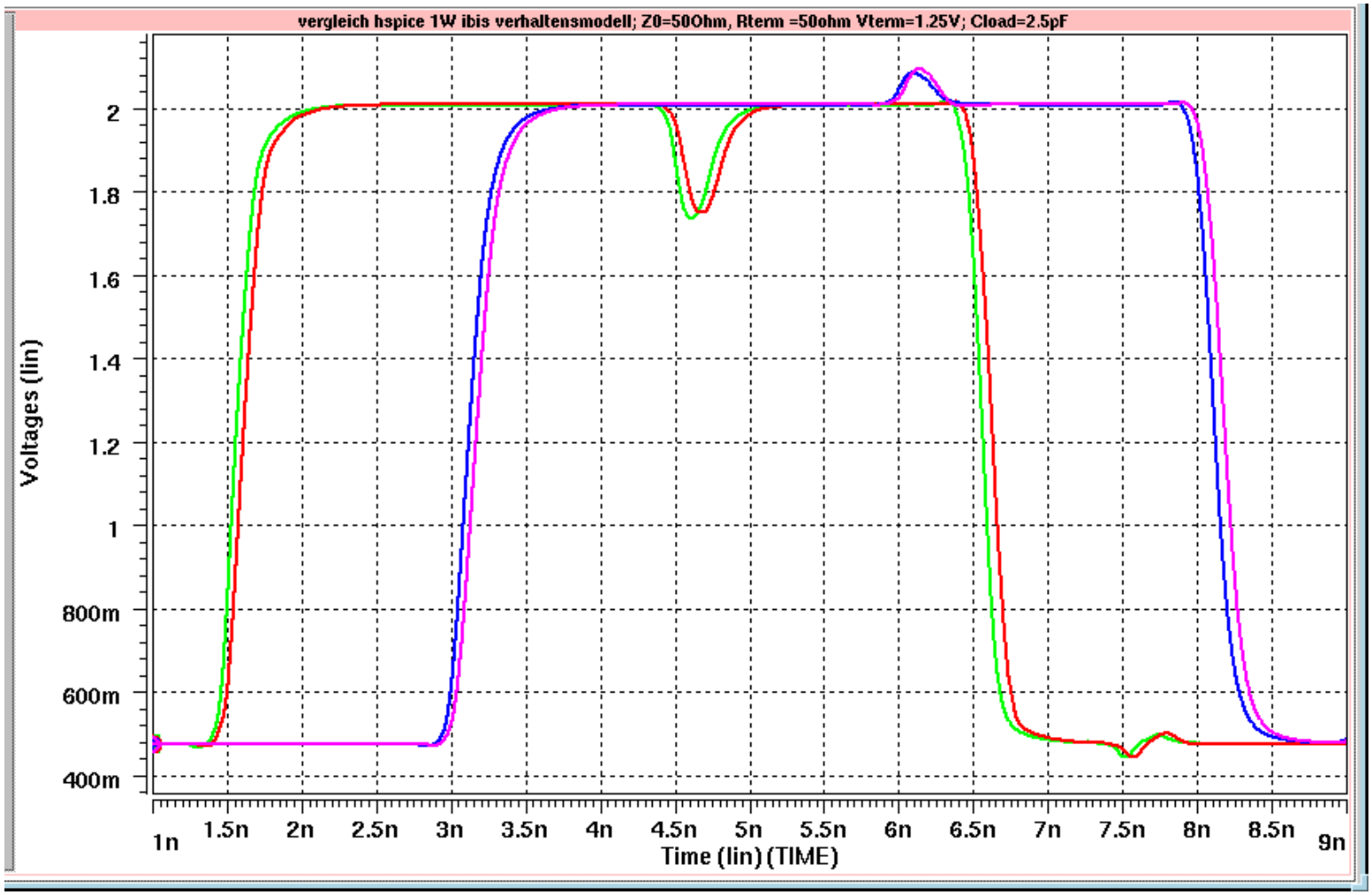
SSTL_2 Class I symmetrically single parallel terminated output load and series resistor

SSTL_2 Analysis

- Comparison of transistor level SPICE simulations with HSPICE B-Model behavioral simulations
- SPICE based generation of one waveform and two waveform IBIS models
  - One waveform: R_fixture = 50Ohms, V_fixture = Vccq/2 = 1.25V
  - Two waveform: R _fixture = 50Ohms, V_fixture = 0V and , V_fixture = 2.5V
- Comparison of both models for different loading conditions
  - Case 1: parallel terminated tr-line (Z0=50Ohms, td=1.5ns); Rpara=50Ohms; Vterm=1.25V; Cload=2.5pF
  - Case 2: unterminated tr-line (Z0=50Ohms, td=1.5ns); Cload=2.5pF
  - Case 3: parallel and series terminated tr-line (Z0=50Ohms, td=1.5ns); Rser=25Ohms; Rpara=50Ohms; Vterm=1.25V; Cload=2.5pF
- Model quality dependence on the assumption of the multiplier relationship

One Waveform Model

CASE 1: parallel terminated tr-line (Z0=50Ohms, td=1.5ns); Rpara=50Ohms; Vterm=1.25V; Cload=2.5pF

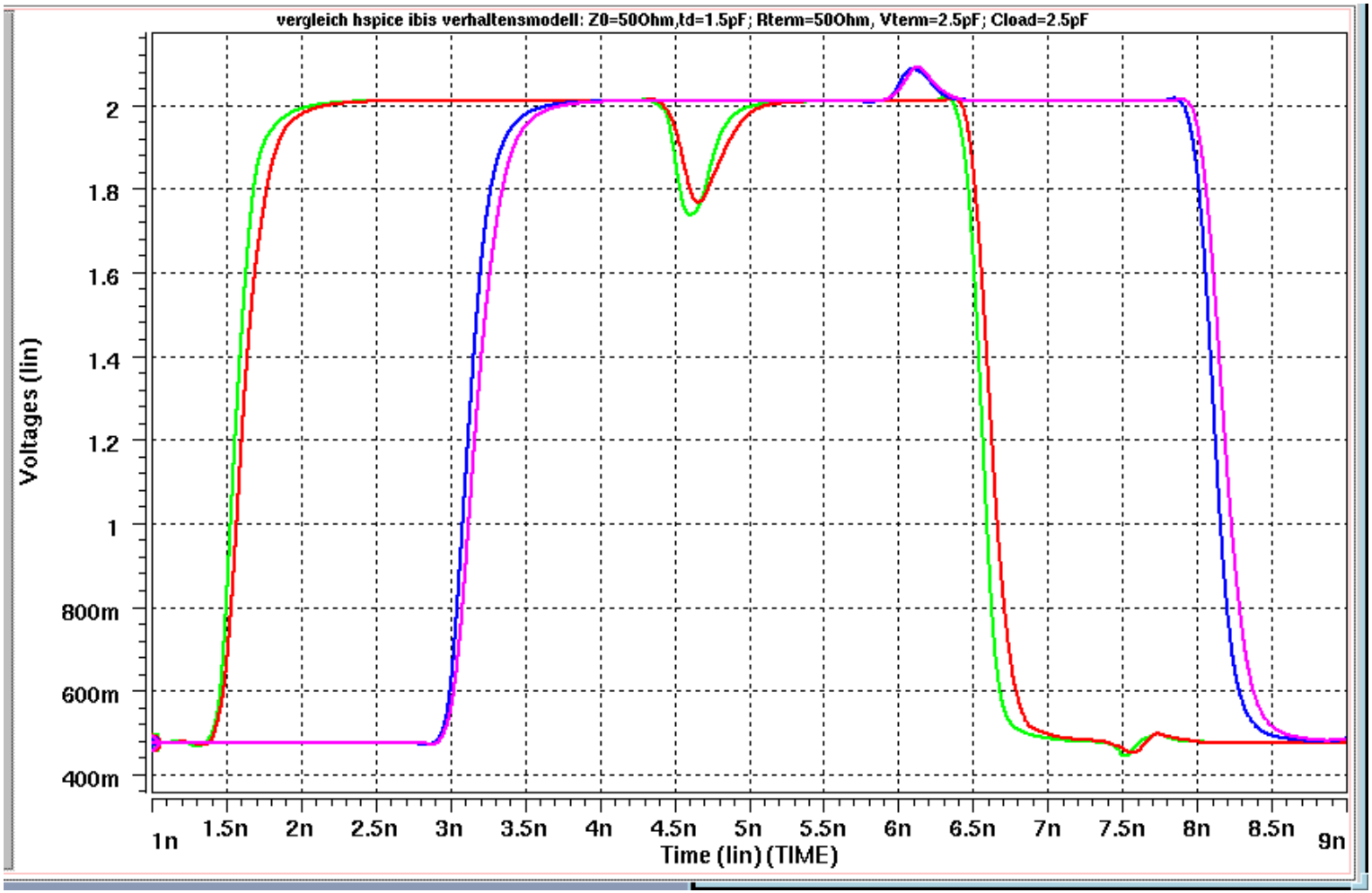


Node OUT:
Transistor based
Behavioral

Node END:
Transistor based
Behavioral

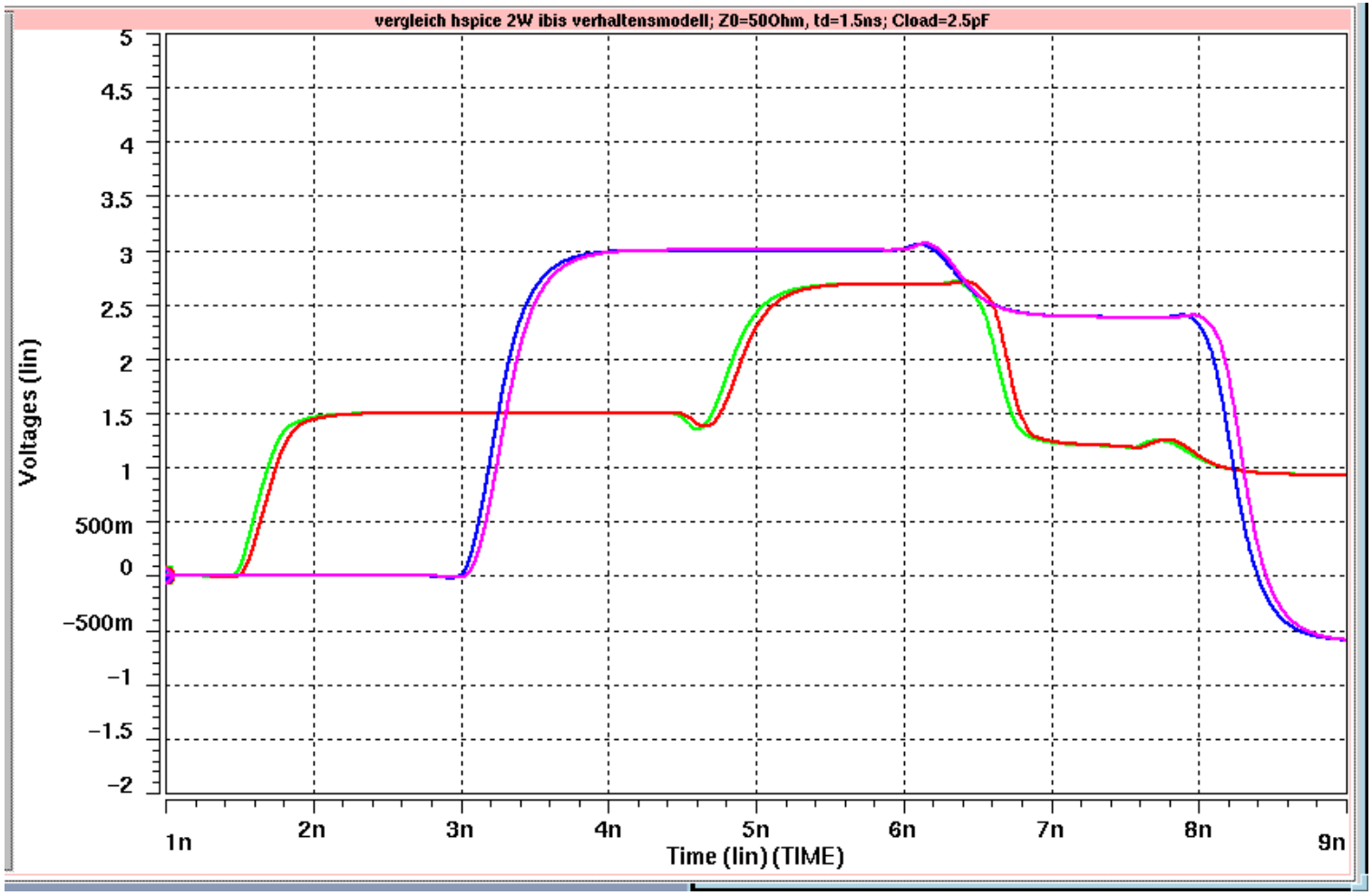
Two Waveform Model

CASE 1: parallel terminated tr-line (Z0=50Ohms, td=1.5ns); Rpara=50Ohms; Vterm=1.25V; Cload=2.5pF



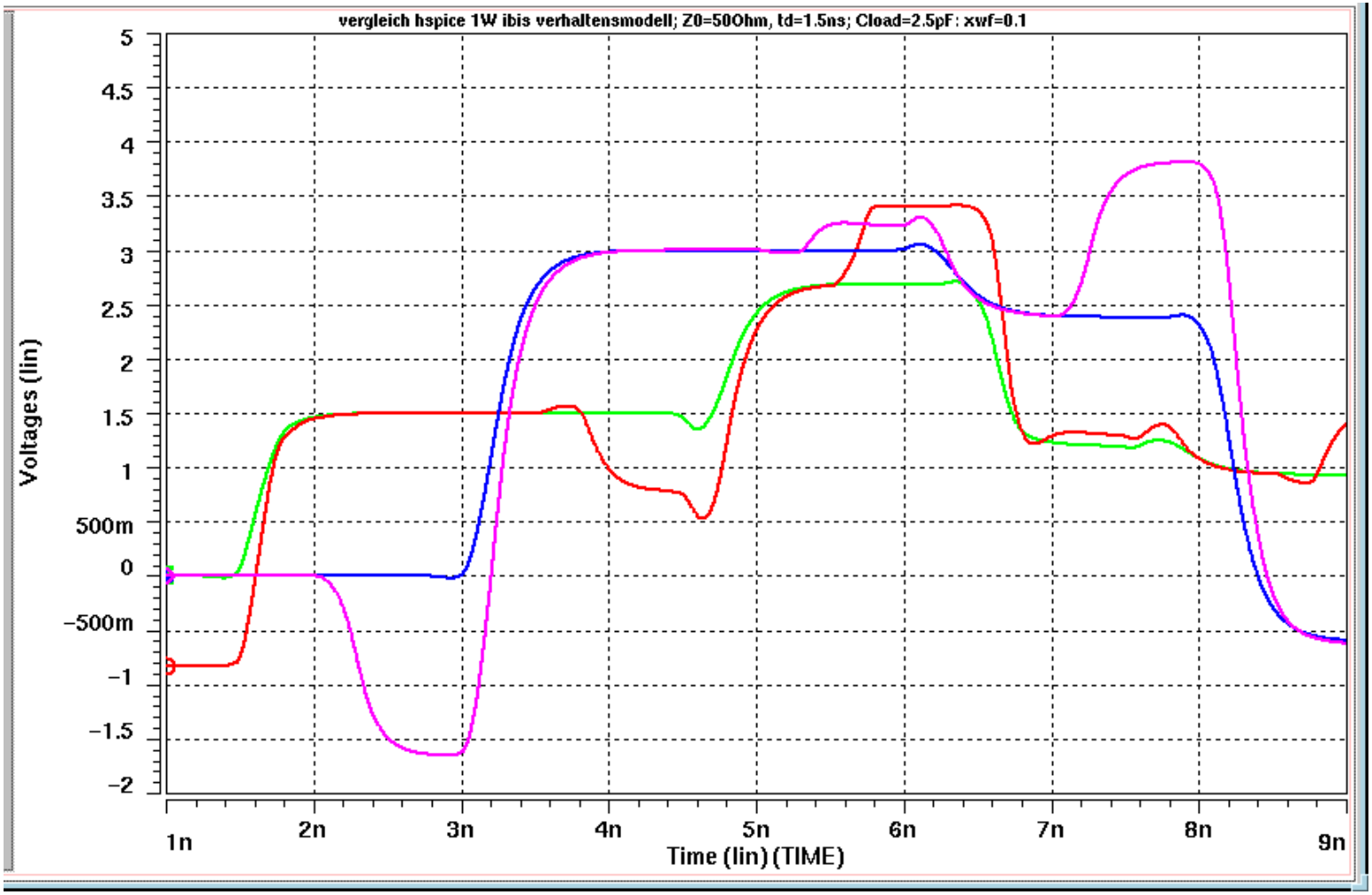
Two Waveform Model

CASE 2: unterminated tr-line (Z0=50Ohms, td=1.5ns); Cload=2.5pF



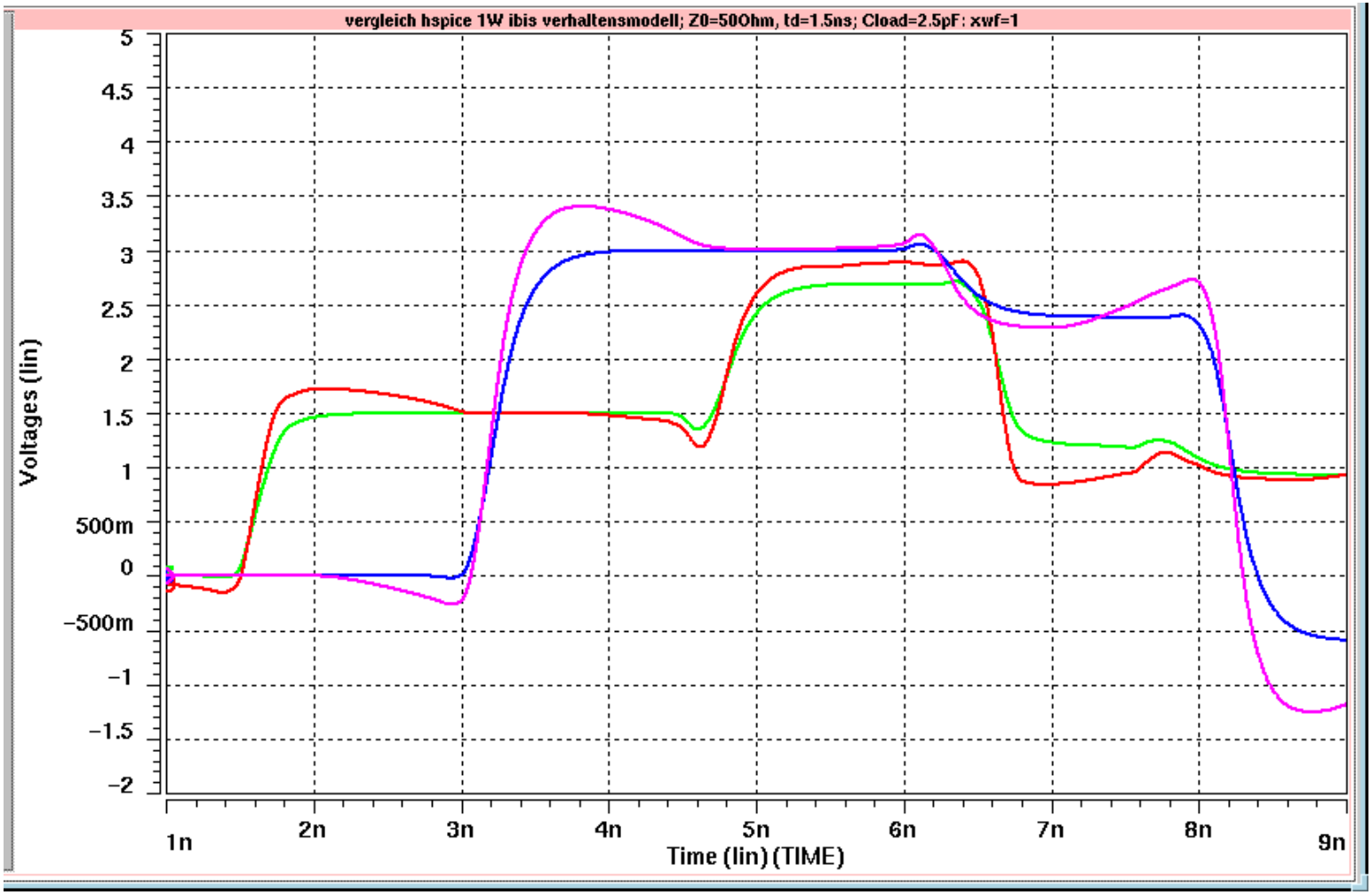
One Waveform Model with Parameter r/fwf=0.1

CASE 2: unterminated tr-line (Z0=50Ohms, td=1.5ns); Cload=2.5pF



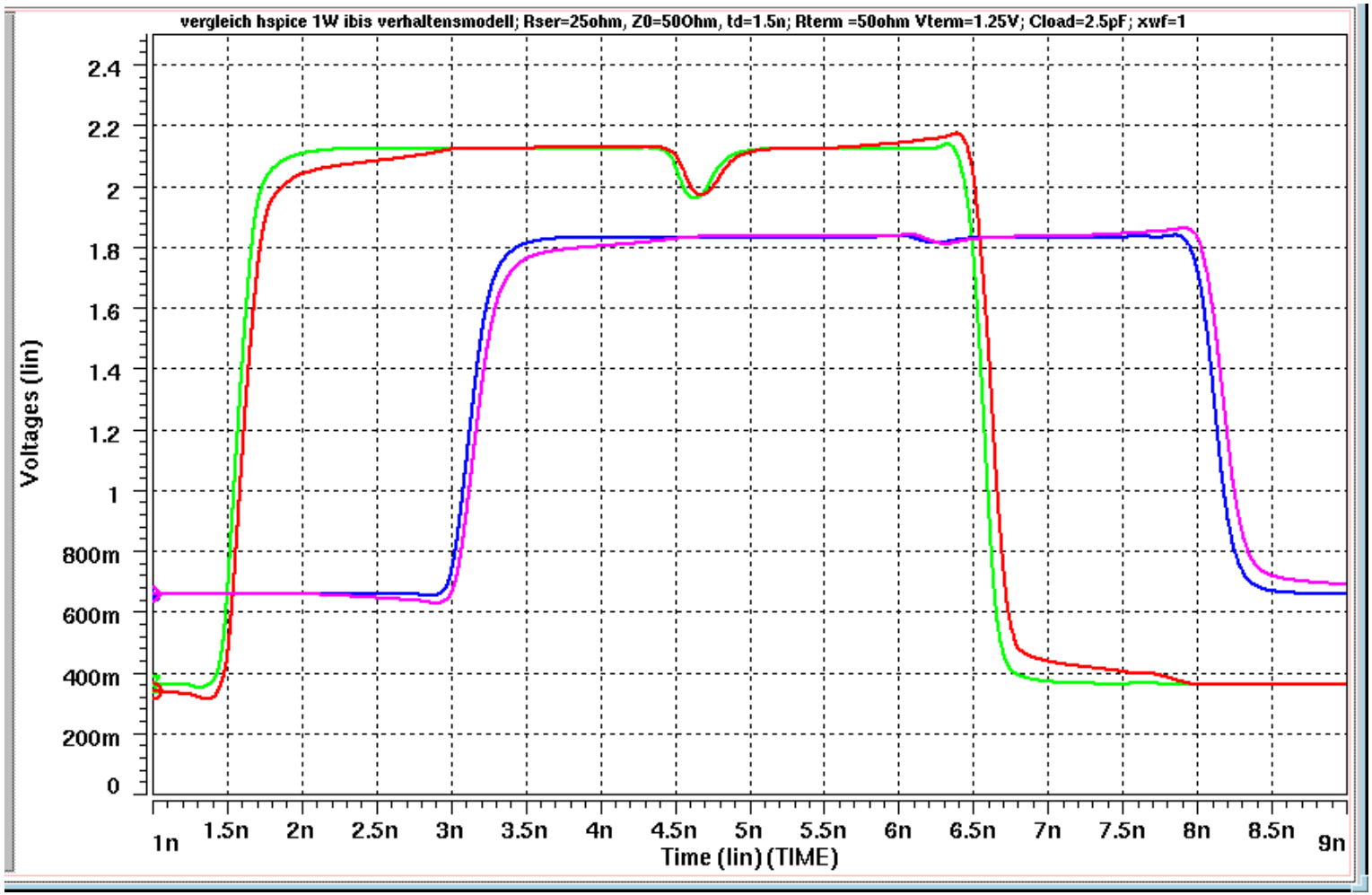
One Waveform Model with Parameter r/fwf=1

CASE 2: unterminated tr-line (Z0=50Ohms, td=1.5ns); Cload=2.5pF



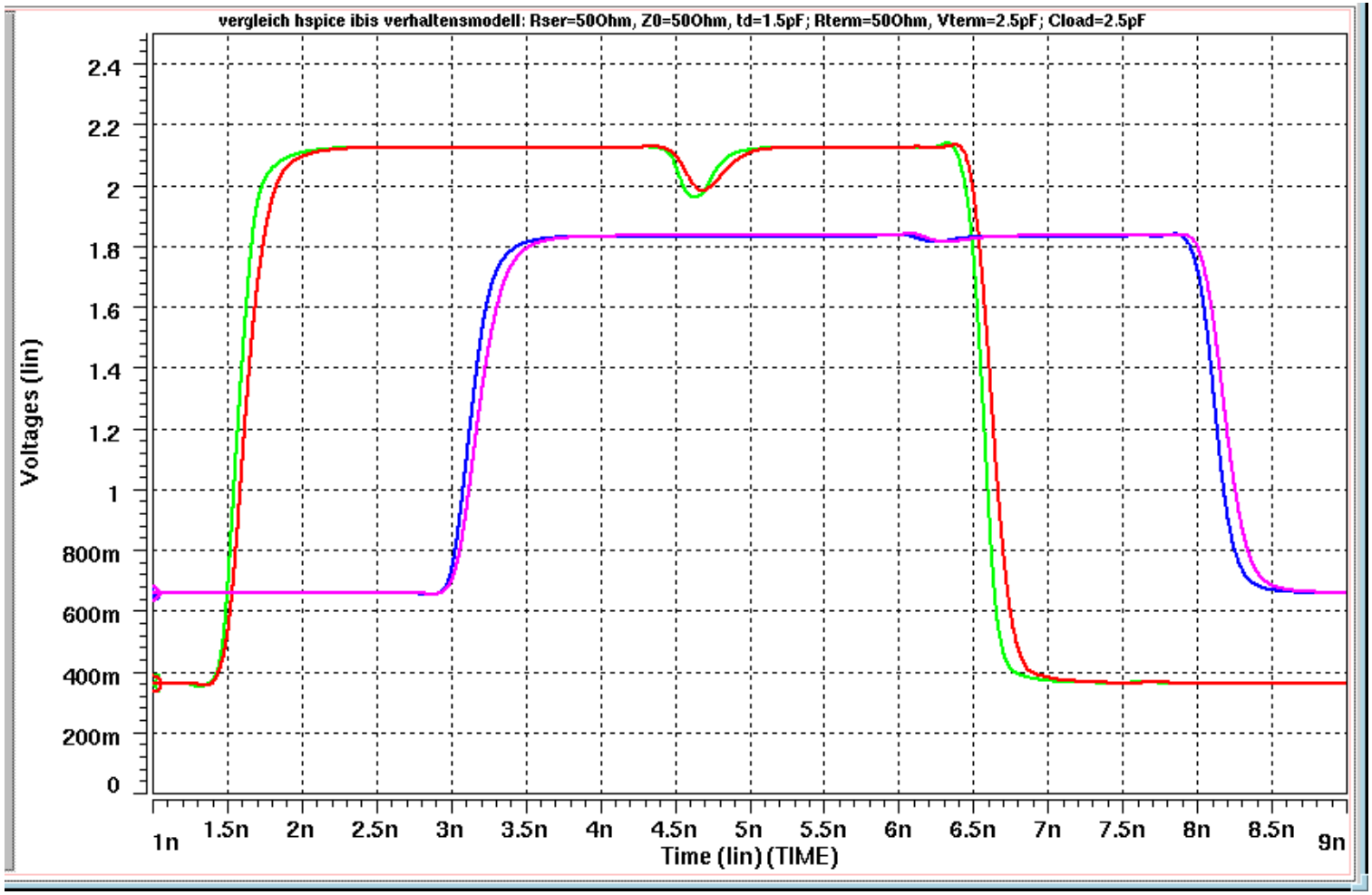
One Waveform Model with Parameter r/fwf=1

CASE 3: parallel and series terminated tr-line (Z0=50Ohms, td=1.5ns); Rser=25Ohms; Rpara=50Ohms; Vterm=1.25V; Cload=2.5pF



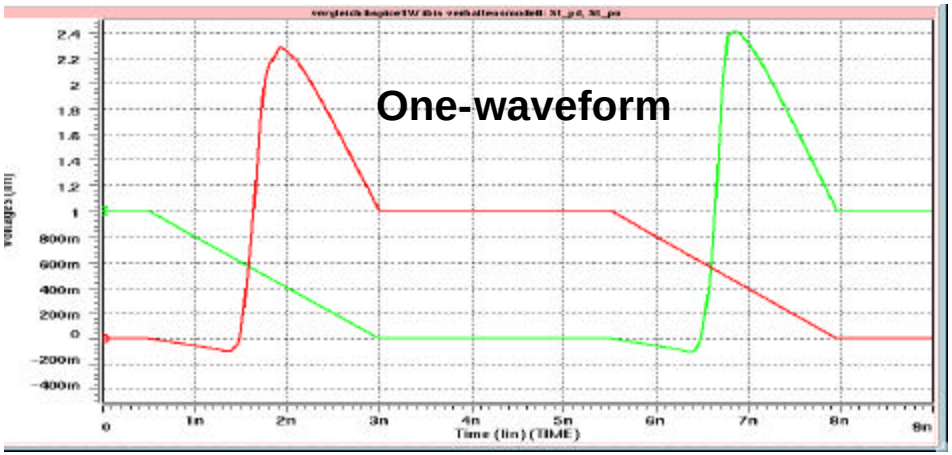
Two Waveform Model

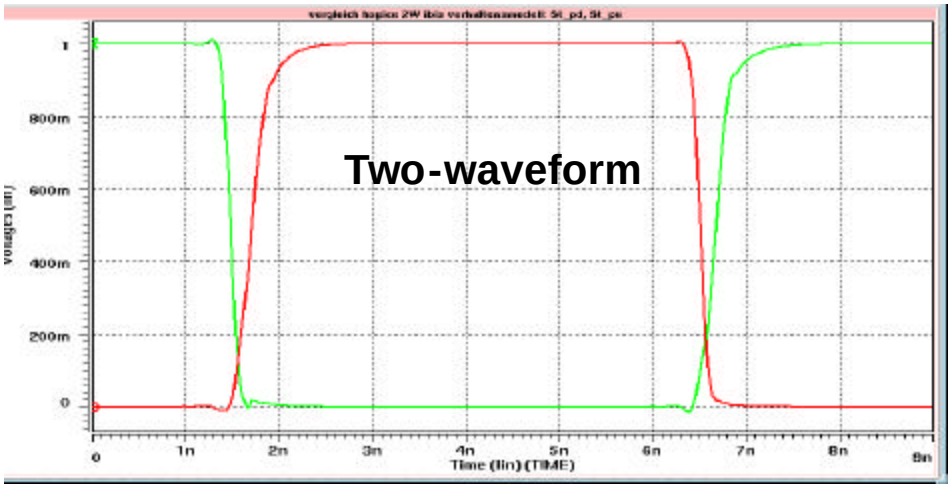
CASE 3: parallel and series terminated tr-line (Z0=50Ohms, td=1.5ns); Rser=25Ohms; Rpara=50Ohms; Vterm=1.25V; Cload=2.5pF



Kpu(t) and Kpd(t) Multiplier Relationships

HSPICE B-model St_pd(t) (green) and St_pu(t) (red) multiplier functions





Model types:

- **One-waveform model**

  Vt-tables for only 1 load condition per edge available. Arbitrarily assumption of the multiplier relationships

  - HSPICE B-model:
    ramp funktion for **kpdr(t)** and **kpuf(t)**
    ramp can be tuned by **rwf/fwf** parameters

  - Other assumption
    kpur/f(t) + kpdr/f(t) = 1; function range: 0 to 1

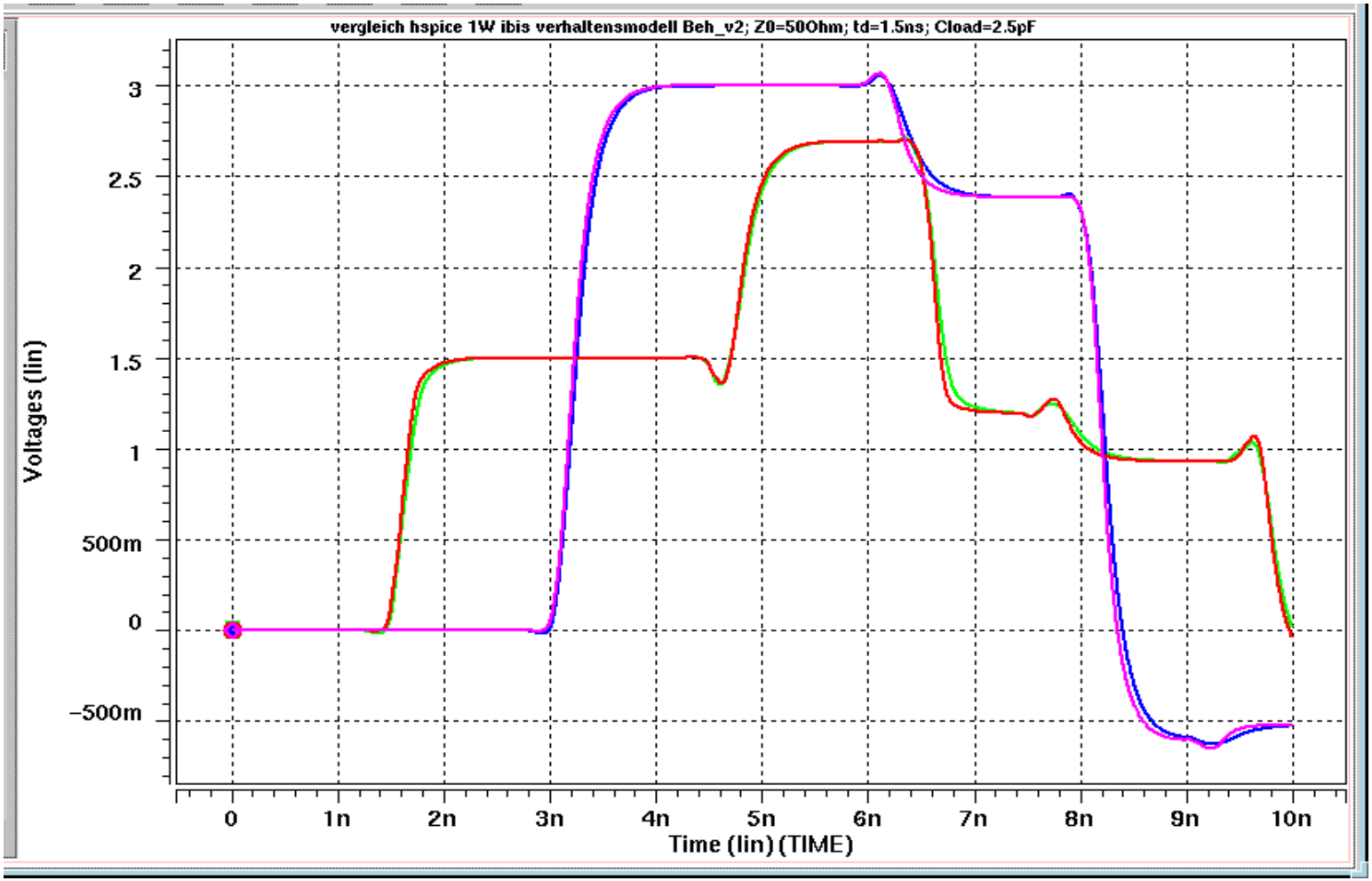
- **Two-waveform model**

  Vt-tables for at least 2 load conditions available
  None assumption of the multiplier relationships

  kpur/f(t); kpdr/f(t); function range: 0;1 to 1;0

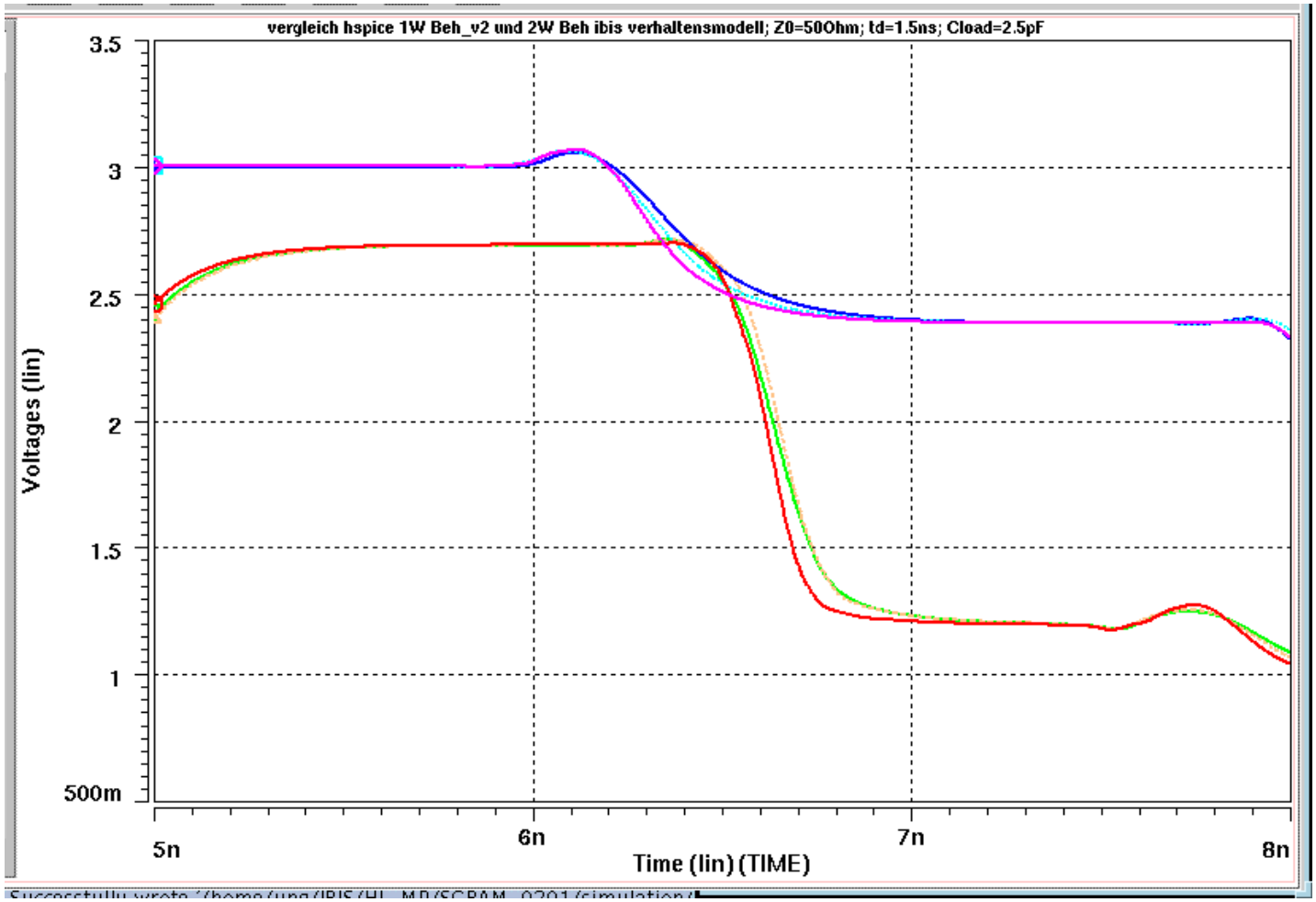
One Waveform Model with kpu(t) + kpd(t) = 1

CASE 2: unterminated tr-line (Z0=50Ohms, td=1.5ns); Cload=2.5pF



One and Two Waveform Model

CASE 2: unterminated tr-line (Z0=50Ohms, td=1.5ns); Cload=2.5pF



Node OUT:
Transistor based
1W Behavioral
2W Behavioral

Node END:
Transistor based
1W Behavioral
2W Behavioral

Conclusions

- Generation conditions: R_fixture = 50Ohms, V_fixture = Vccq/2 = 1.25V : best results for single parallel terminated output load
- Generation conditions: R _fixture = 50Ohms, V_fixture = 0V and , V_fixture = 2.5V best results for unterminated output load
- Model quality of „One Waveform“ models strongly depends on loading conditions and assumption of multiplier relationship
- IBIS models with golden waveforms are a real need to check the quality
  - of the tool dependent behavioral models
  - in case of real world application conditions