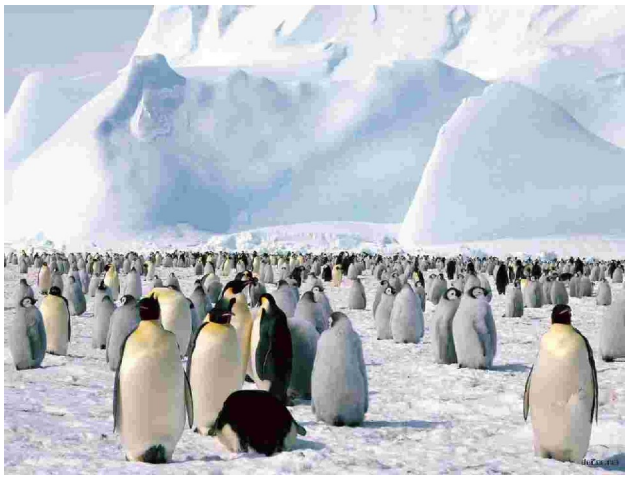
NMDG
LEADING BEYOND S-PARAMETERS

Switching amplifiers and Large-Signal Deembedding



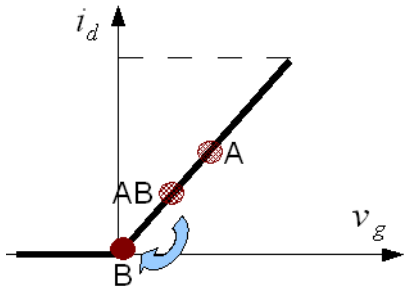
NVNA Users Meeting
IMS 2010

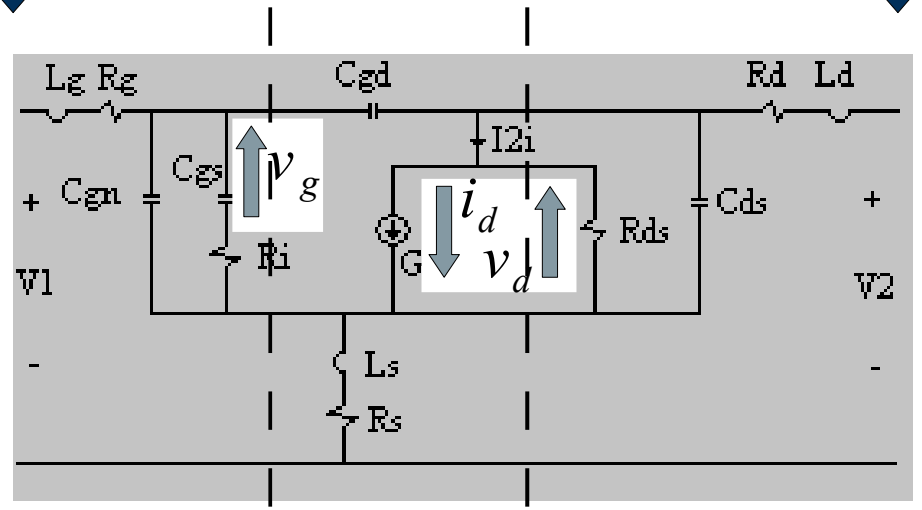
Outline

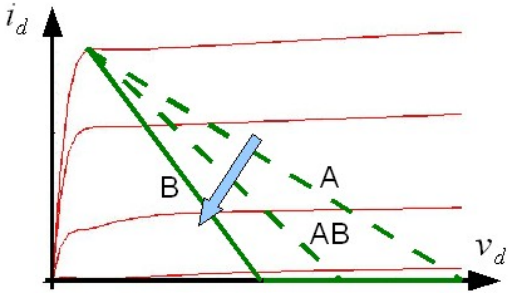
- Problem with Waveform Engineering for Switching Amplifiers
- Simulation of the “drain capacitance” effect
- Measurement setup
- Different De-embedding Steps with ICE
- Voltage – Current Measurement: capacitance effect
- Interactive De-embedding and Voltage – Current Measurement
- Re-tuning for improved performance
- Conclusions

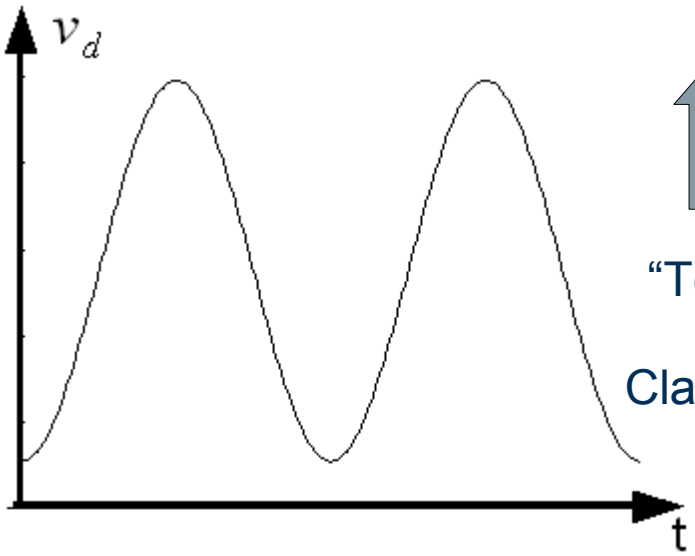
Problem with Waveform Engineering for Switching Amplifiers

Measurement Planes

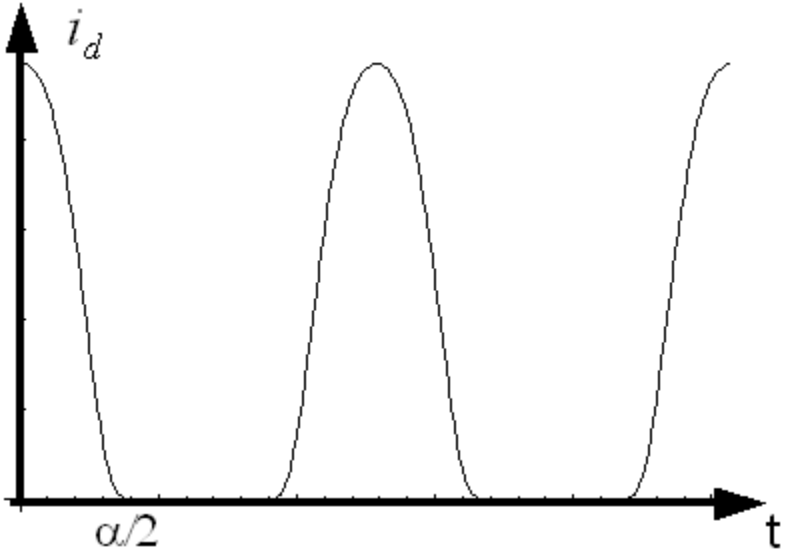




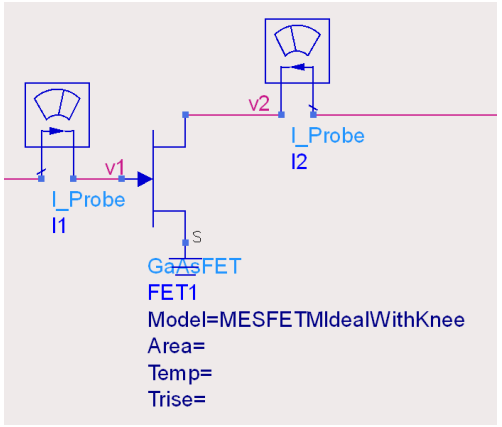




"Text book planes"
defining
Classes of amplifiers



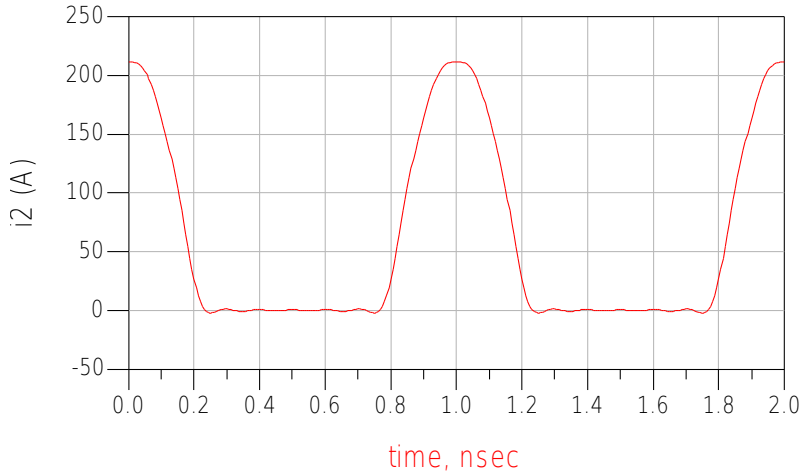
Simulation – without drain capacitance

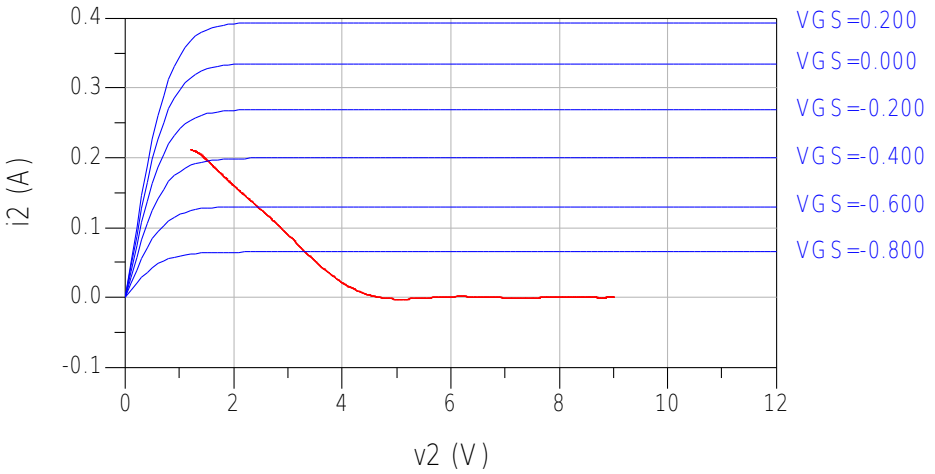


Ideal FET (static model)

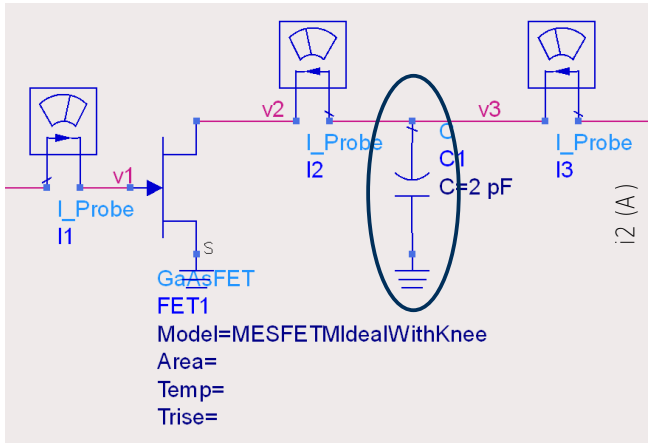
Biased in pinch off

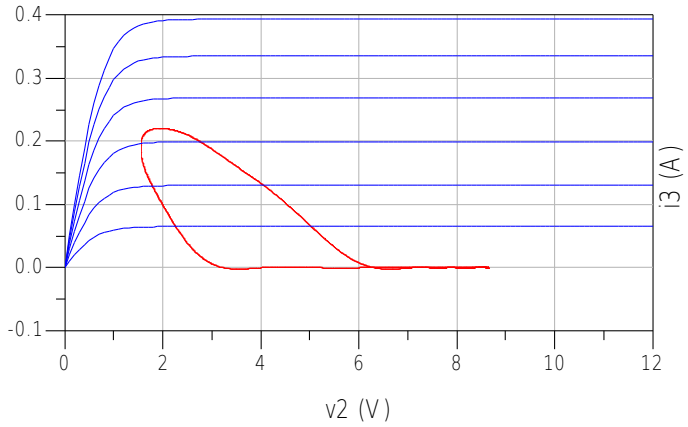
$$\Gamma(f_0) = -0.125$$
$$\Gamma(2f_0) = -1$$
$$\Gamma(3f_0) = -1$$
$$\Gamma(kf_0) = 0.$$

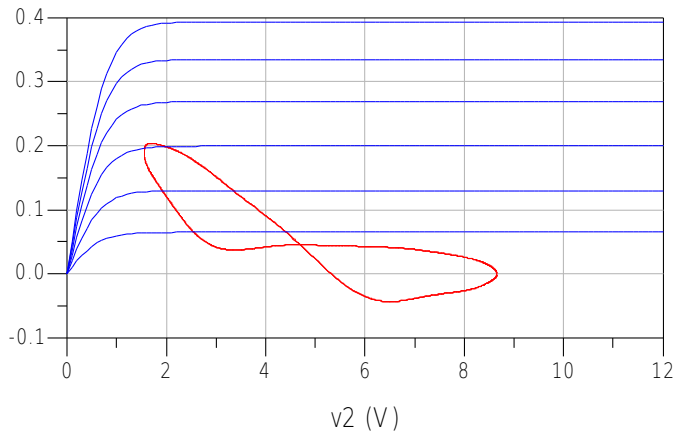


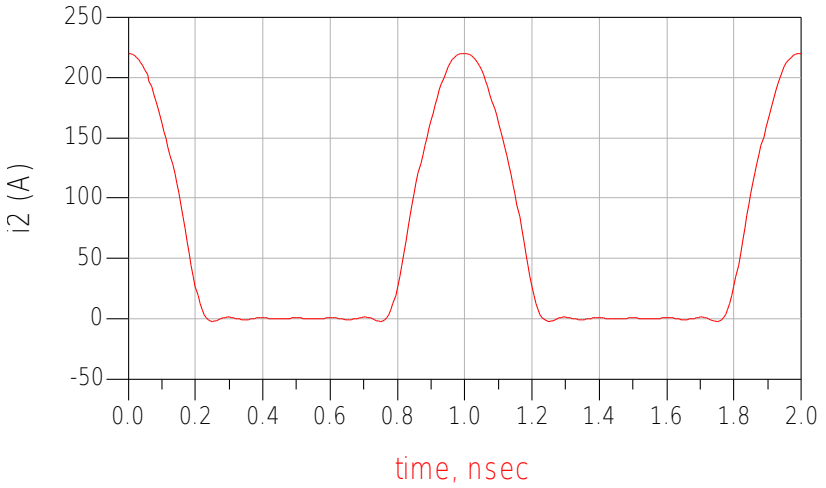


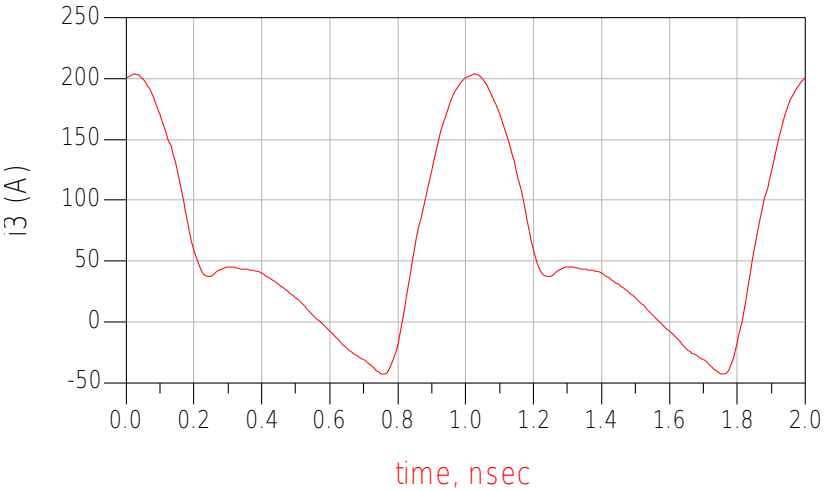
Simulation – with drain capacitance





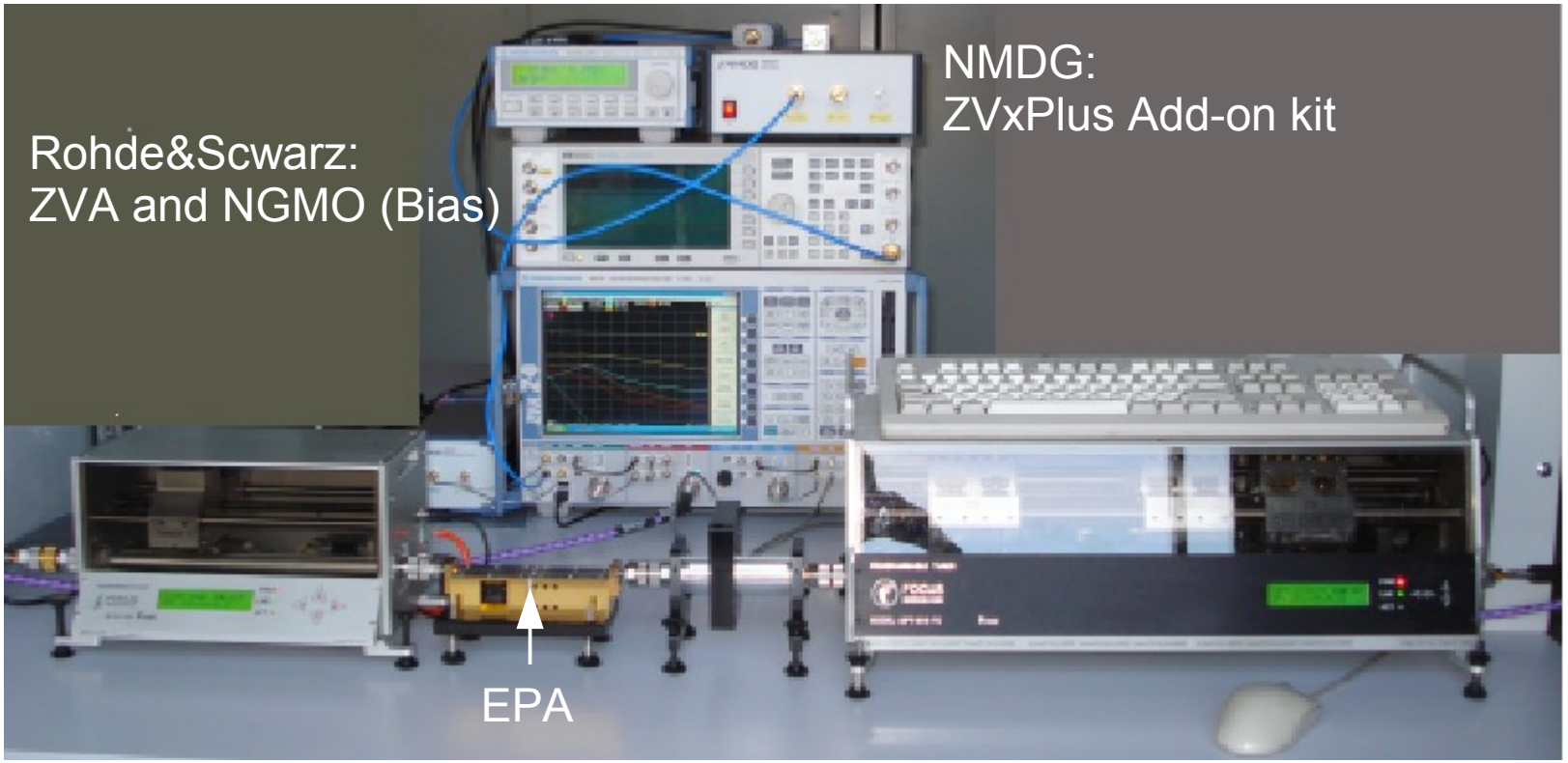






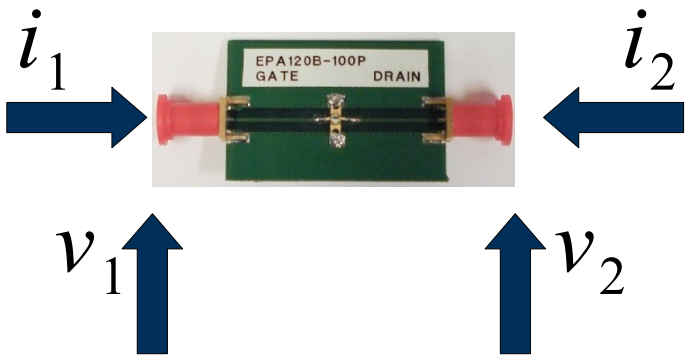
Case Study: EPA120B-100P

- EPA120B-100P
  - high efficiency heterojunction power FET
  - power output: + 29.0dBm typ.
  - power gain: 11.5dB typ. @ 12 GHz

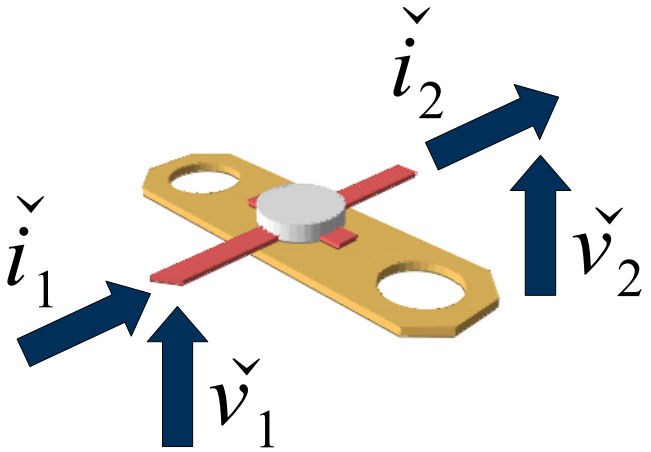


Focus Microwaves: CCMT Fixture Low-loss VIProbing MPT

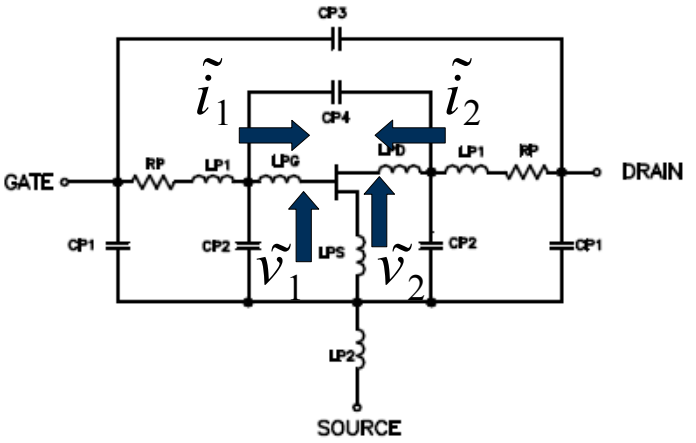
Different De-embedding Steps with ICE



Two-port de-embedding

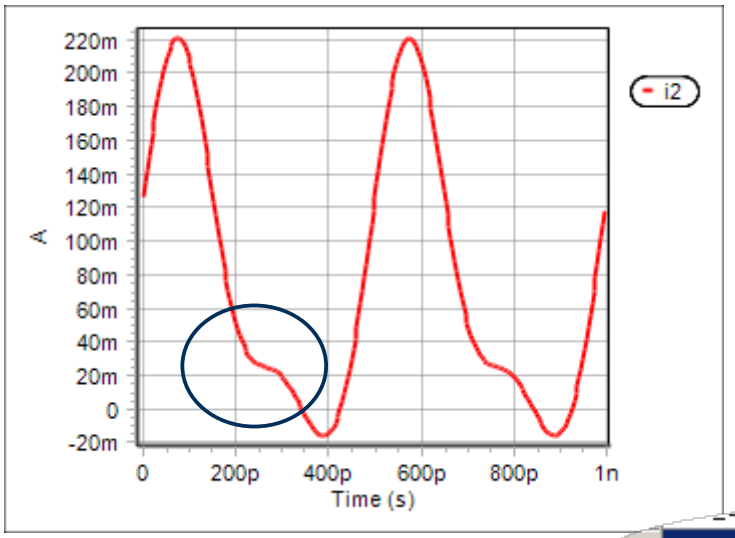


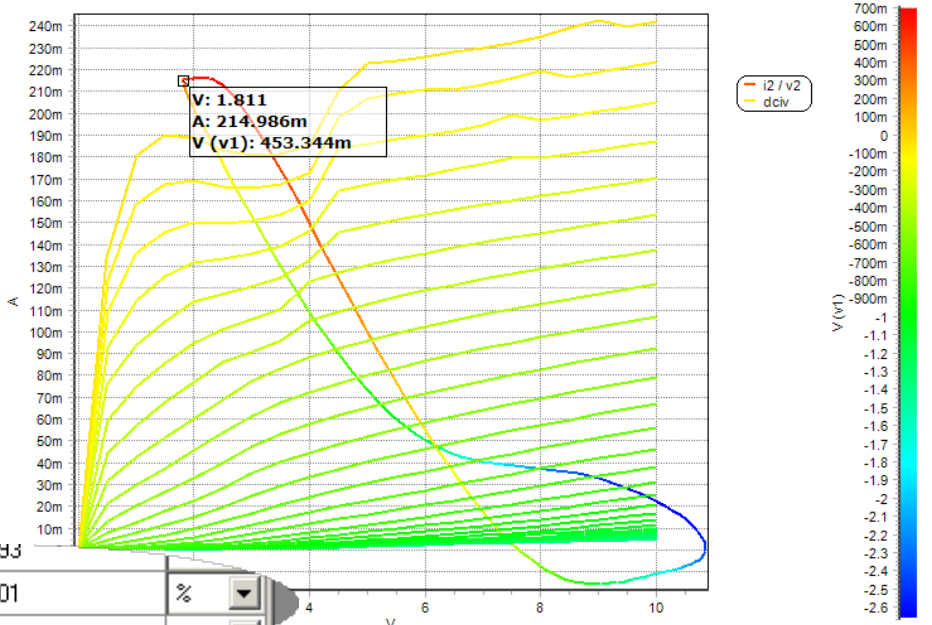
Four-port de-embedding



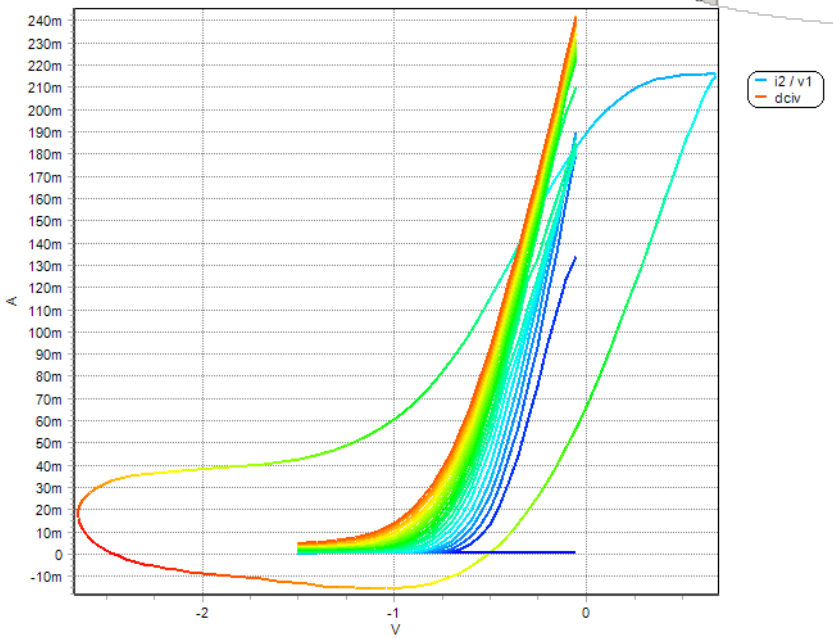
PACKAGED FET MODEL

Voltage – Current Measurement: capacitance effect

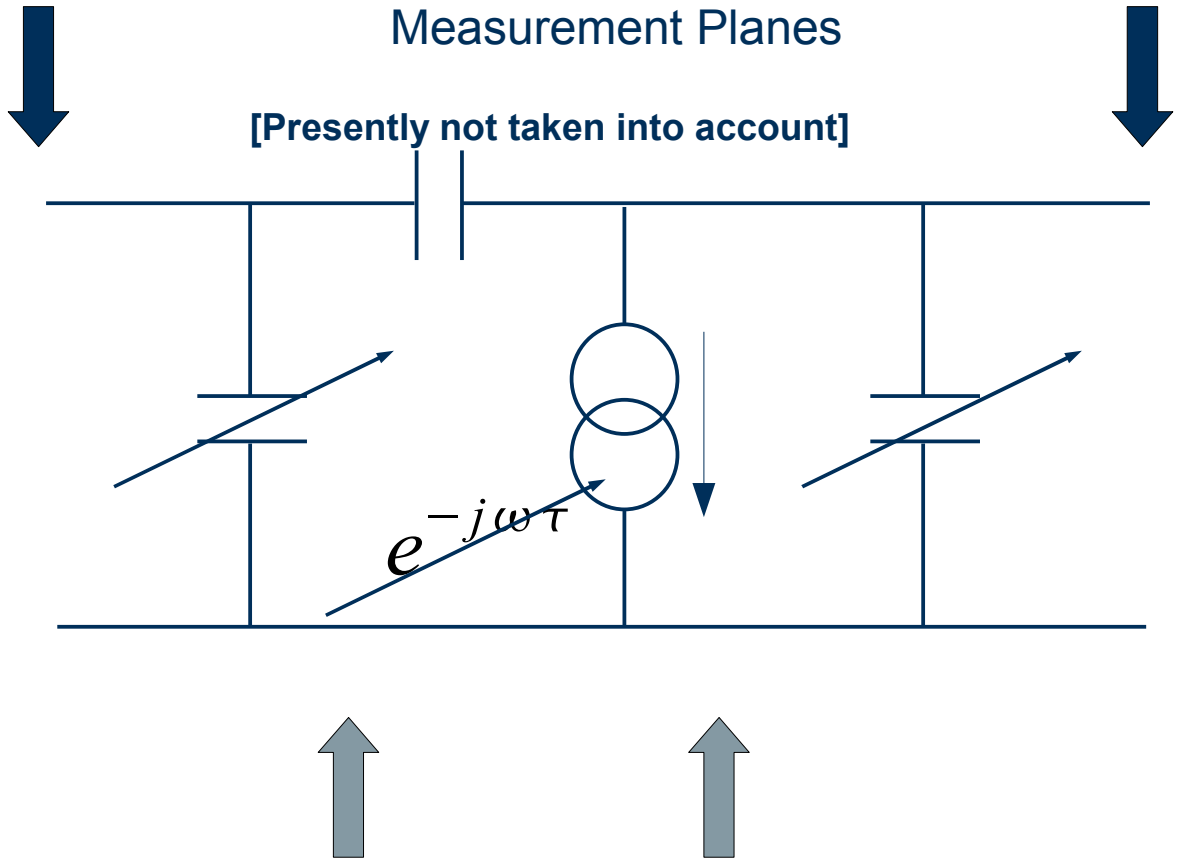




PAE 49.34201 %

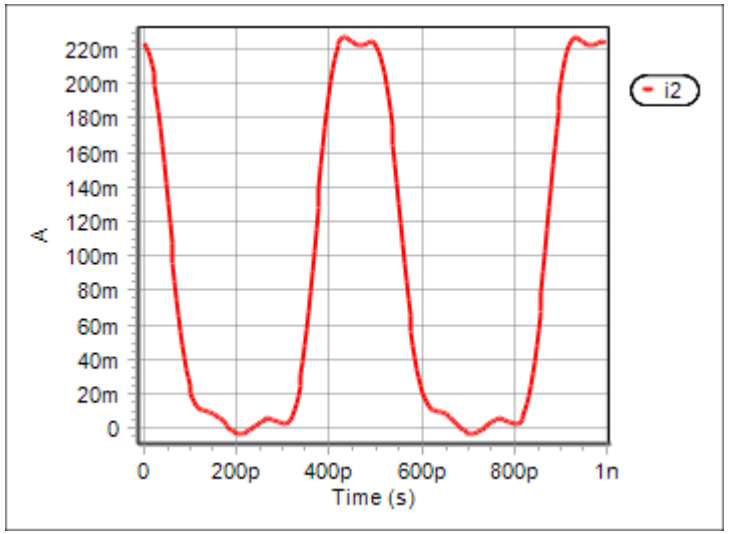


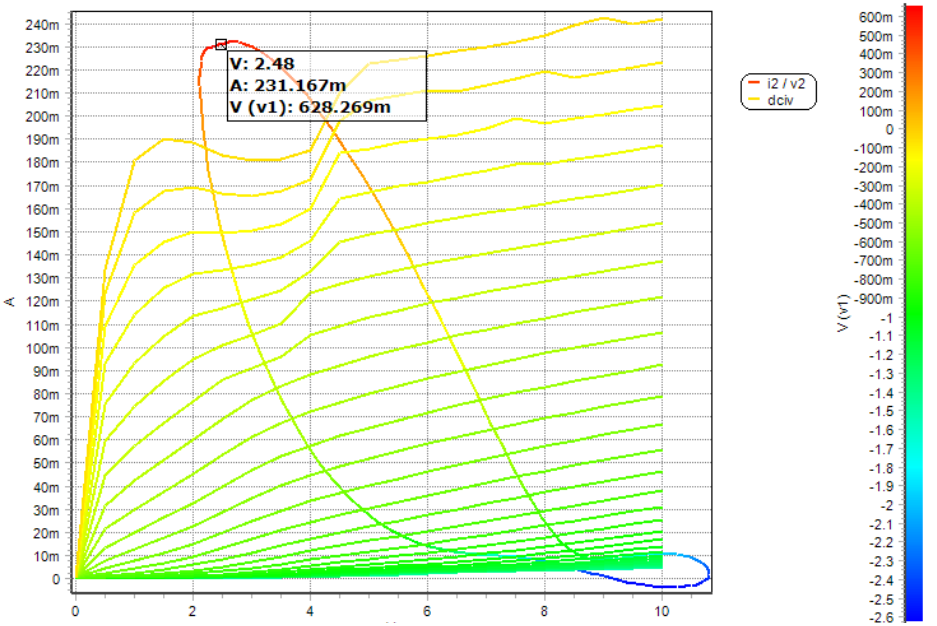
Interactive De-embedding

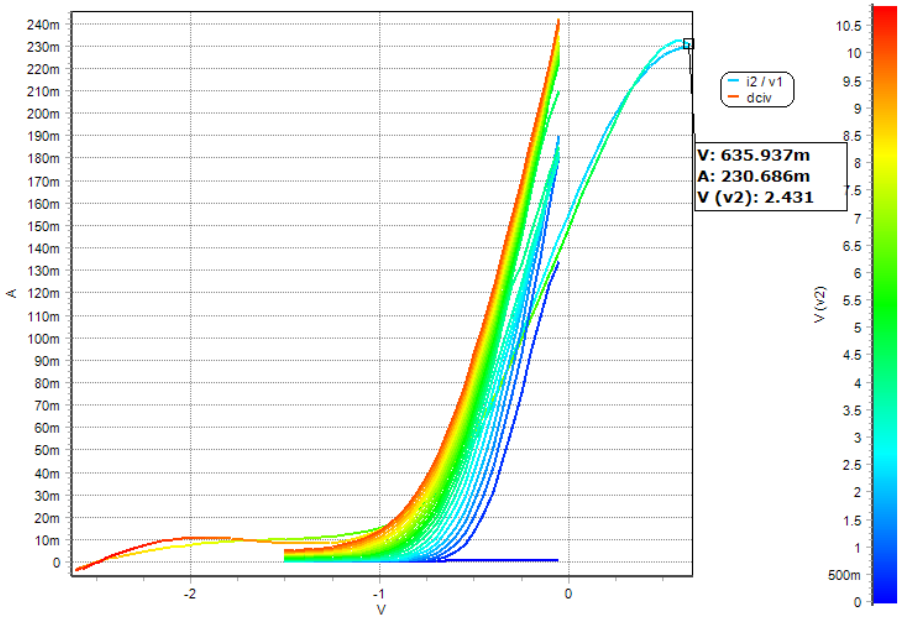


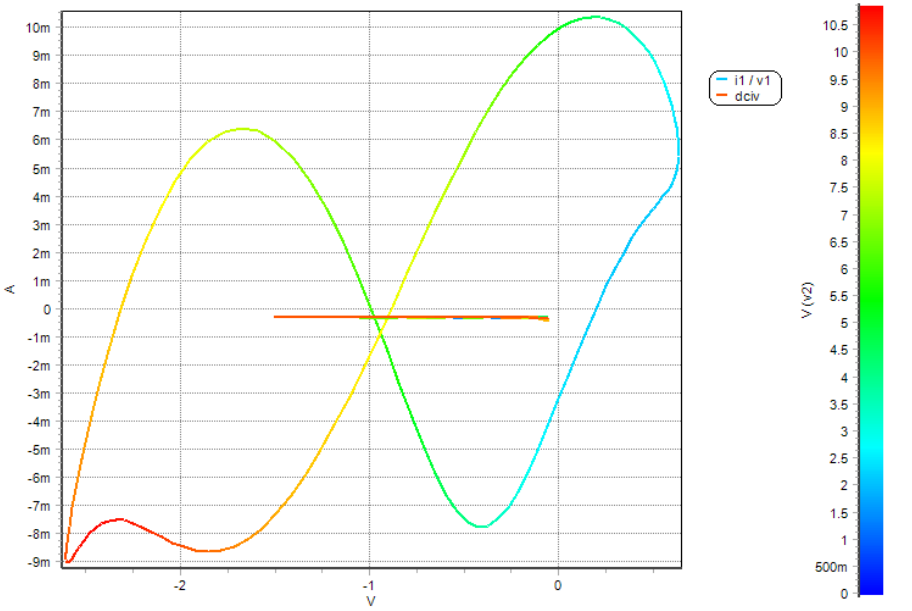
After interactive deembedding

Voltage – Current Measurement after de-embedding

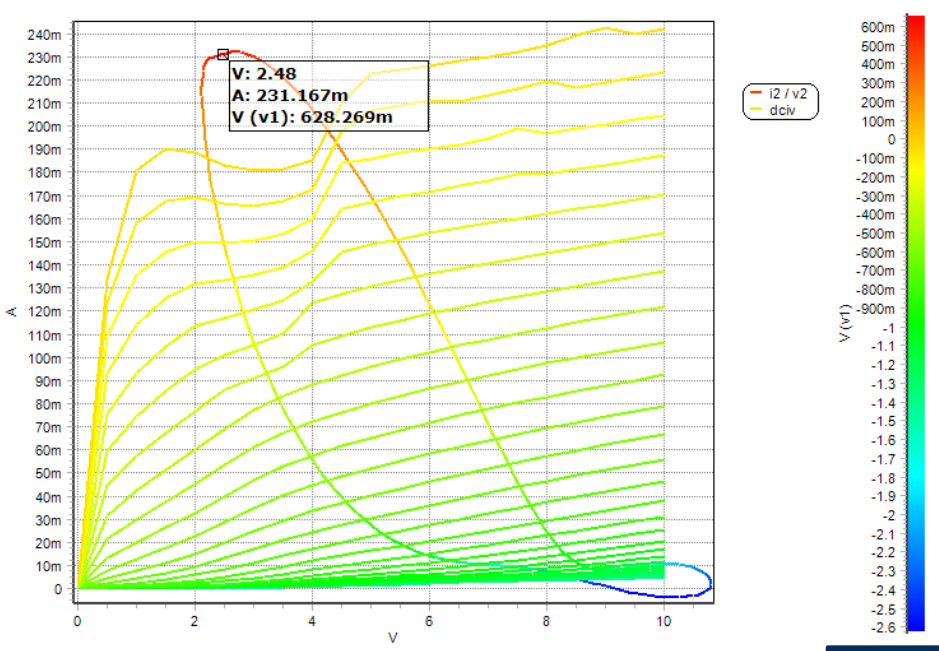


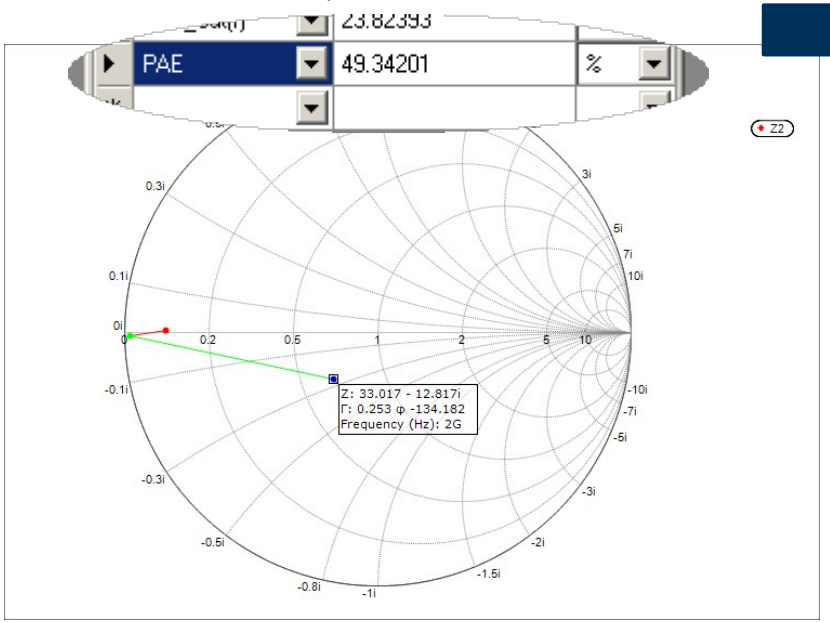


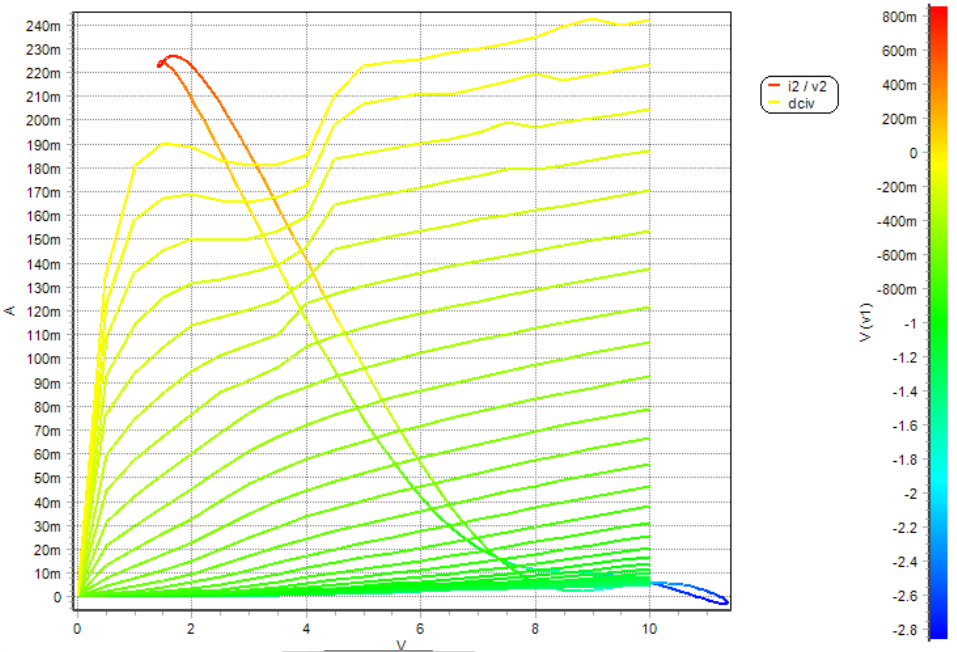


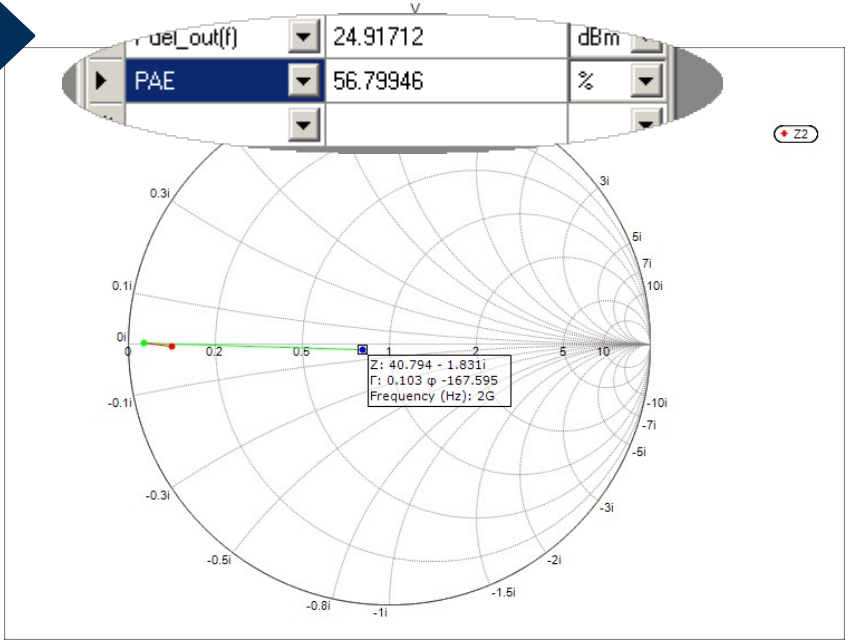


Re-tuning for improved performance









Conclusions

- The strength of waveform engineering requires proper de-embedding
- Interactive de-embedding of large-signal measurements can eliminate most important parasitics
- Re-tuning the device improves performance

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