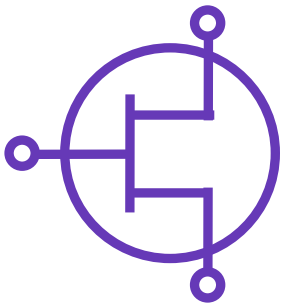
GaAs MESFET MODEL

Model Features

- Broadband (DC to 40 GHz)
- Large-signal model (Modelithics-Enhanced Angelov)
- Measurement Validations:
  - Pulsed I-V (25 C to 85 C)
  - Multi-bias S-parameters (25 C to 85 C)
  - Load pull (25 C), 12 and 18 GHz
  - Noise parameters (25 C)
  - 1/f noise
  - IP3 linearity validation, 12 GHz, 7 V 60%Idss
- Advanced model feature: enabling intrinsic I-V sensing



MES-MWT-MWT7F-001
MwT-7F
Discrete GaAs MESFET

Model Description

The MES-MWT-MWT7F-001 is a non-linear model for the MwT-7F a discrete 250 um GaAs MESFET(additional information is available at www.mwtinc.com). The model is based on the extraction of a customized Angelov non-linear model that is validated against the following Modelithics measurement data: I-V, S-parameters, load pull and IP3.

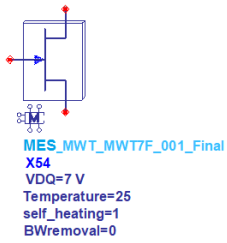
Technical Notes

- Model is optimized for 2, 4 and 7 V operation (22 mA (30% IDSS), 36 mA (50% IDSS) and 44 mA (60% IDSS)).
- Model Parameters:
  - **VDSQ:** For setting the optimum bias point of the model (default=7 V).
  - **Temperature:** represents the backside ambient temperature, validated at 25 C and 85 C.
  - **Self_heat:** switch for the electrothermal model (0 or 1), 0= self-heating is turned off, 1 (default)= self-heating is turned on.
  - **BWremoval:** 0 includes wire assembly (only) used in measurements, 1 (default) sets model reference planes at the center of the gate, drain, and source bond pads.
  - Modelithics Micro Probe Accessories part number 0503, 5 mil Alumina adapter substrates were used to access the bond pads of discrete die.

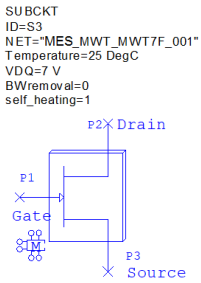
Model Simulation Settings

- **I-V:** self_heat: 0 for I-V simulations (self heating model turned OFF), Temperature=25 C
- **S-Parameters:** self_heat: 1 for CW bias, Temperature=25 C
- **Load Pull Single-tone and two tone validations:** self_heat: 1 for CW bias; Temperature=25 C.

Model Representation

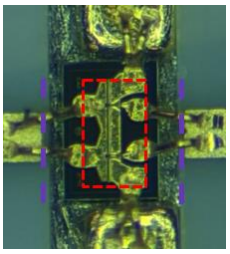


Keysight ADS



NI AWR

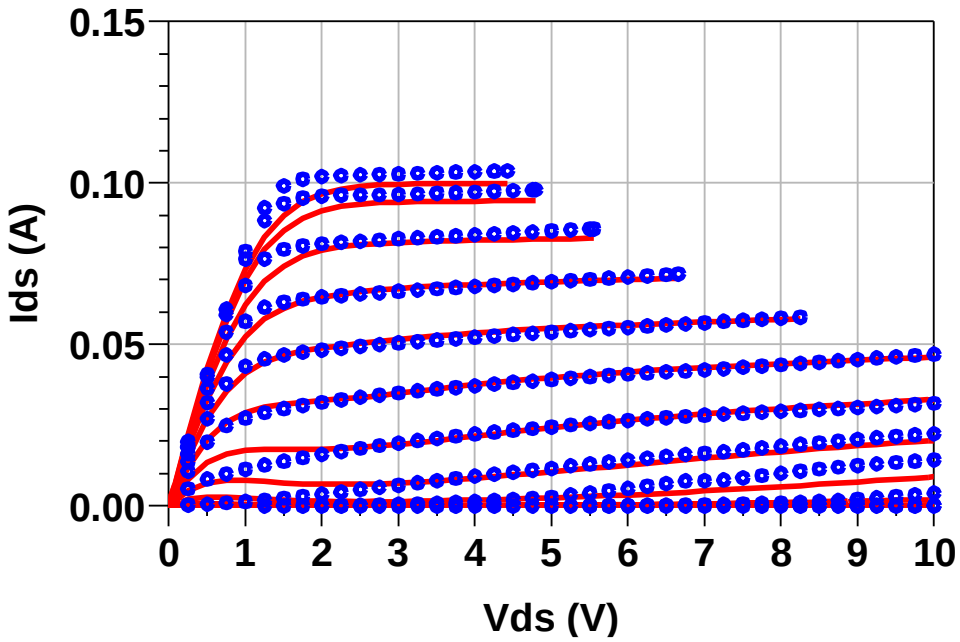
Reference Planes



Model and Measurement Reference Planes (BWremoval=1)

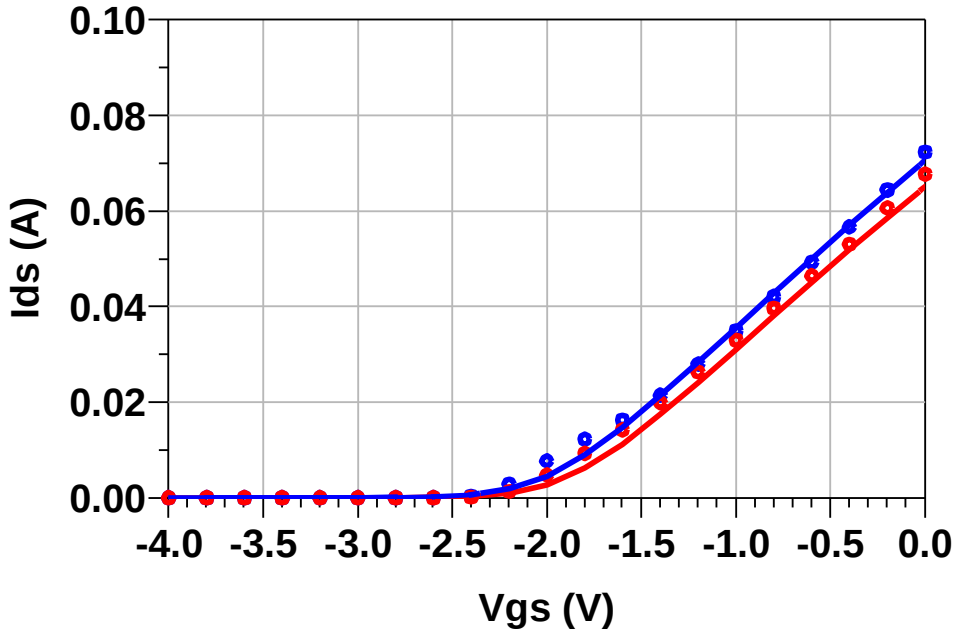
Model and Measurement Reference Planes (BWremoval=0)

DC I-V Characteristics: VDSQ = 7 V, 25 C



Legend: Red Solid lines - Model data, O Symbols - Measured data
Simulated at 25 C with VGS varying from -4 to 1 V in steps of 0.4 V,
VDS varying from 0 to 10 V in steps of 0.25 V. Model self_heat = 0.

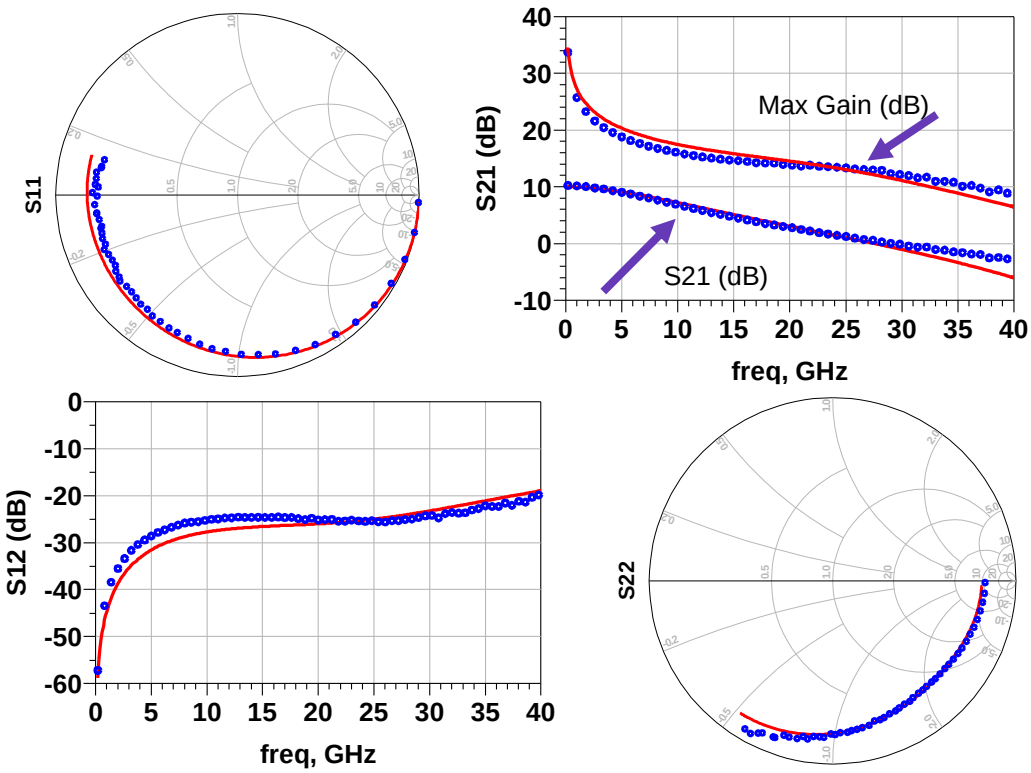
Model vs. Measurement Temperature IV Characteristics



Legend: Red Solid lines: 85 C, Blue Solid lines: 25 C.
Solid lines - Model data, Symbols - Measured data
Simulated at 25 C and 85 C, VDSQ of 7 V. Model self_heat = 0.

S-Parameters Model vs. Measured:

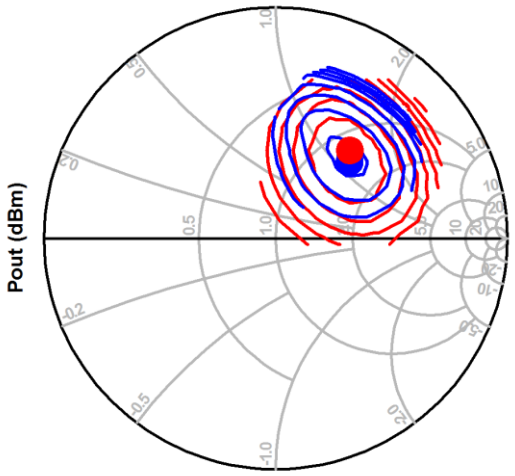
VDS = 7 V, VGS = -0.74 V, IDS = 43.5 mA (60% IDSS), 25 C



Legend: Red Solid lines - Model data, O Symbols - Measured data
Simulated at 25 C with the frequency range from 0.2 – 40 GHz. 50 Ω Smith Charts
BWremoval = 0

Load Pull Validation: Frequency = 12 GHz
VDS = 7 V, VGS = -0.74 V, IDS = 43.5 mA (60% IDSS),
Input Power = 10 dBm, Z0 = 50 Ω Center, 25 C

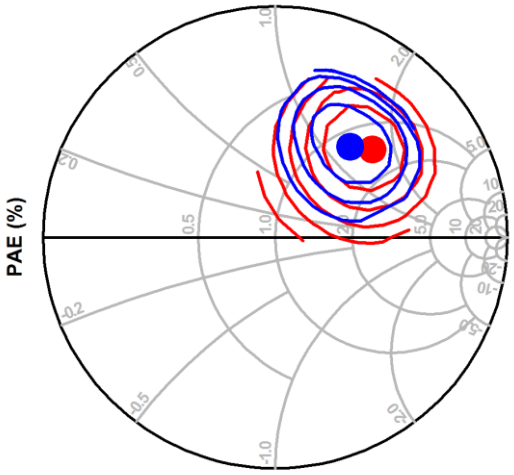
Power Tuning (0.5 dB contour step)



Test Bench Impedances (Ohms):

ZS = 11.8 + j*29.6
ZS2 = 72.5 - j*42.8
ZS3 = 56.8 - j*31.7
ZLoad2 = 41.7 - j*15.1
ZLoad3 = 19.9 + j*26.6

Efficiency Tuning (5% contour step)



Legend: Red Solid lines – Model, Blue Solid lines – Measured, BWremoval = 0

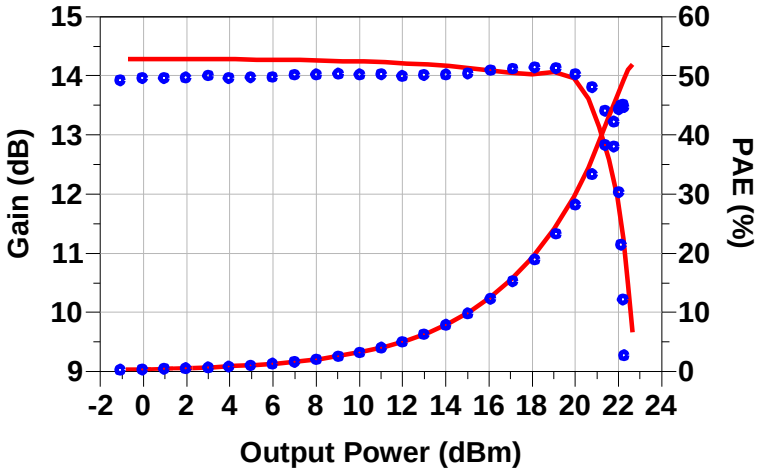
Load Pull Summary	Max Power Load Impedance (Ohms)	Max Power Value (dBm)	Max PAE Load Impedance (Ohms)	Max PAE Value (%)
Measured	68.8 + j*57.9	22.0	60.4 + j*64.3	44.8
Model	57.1 + j*55.3	22.1	67.9 + j*73.4	49.5

Load pull data has been processed for contour display

Single Tone Power Sweep: Frequency = 12 GHz
VDS = 7 V, VGS = -0.74 V, IDS = 43.5 mA (60% IDSS), 25 C

Load Condition: Measured Power Tuned

Transducer Gain and Power Added Efficiency (PAE)



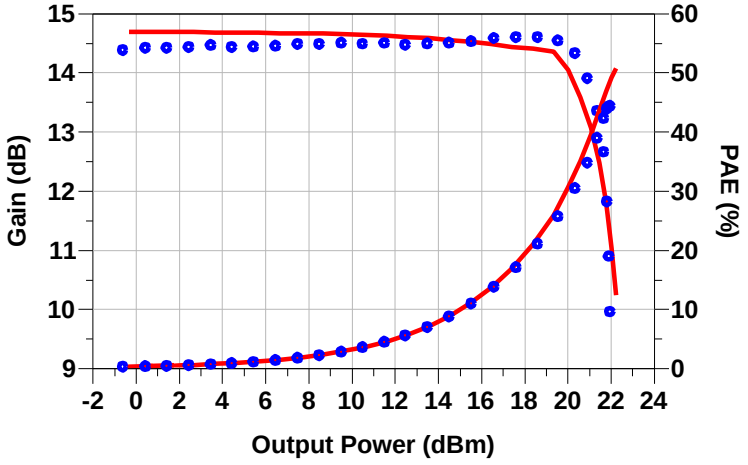
Load Condition: Power Tuned
Test Bench Impedances (Ohms):

ZS = 11.8 + j*29.6
ZS2 = 72.5 - j*42.8
ZS3 = 56.8 - j*31.7
ZLoad = 53.4 + j*60.3
ZLoad2 = 58.0 - j*5.1
ZLoad3 = 24.2 + j*11.5

Legend: Red Solid lines - Model data, O Symbols - Measured data, BWremoval = 0

Load Condition: Measured PAE Tuned

Transducer Gain and Power Added Efficiency (PAE)

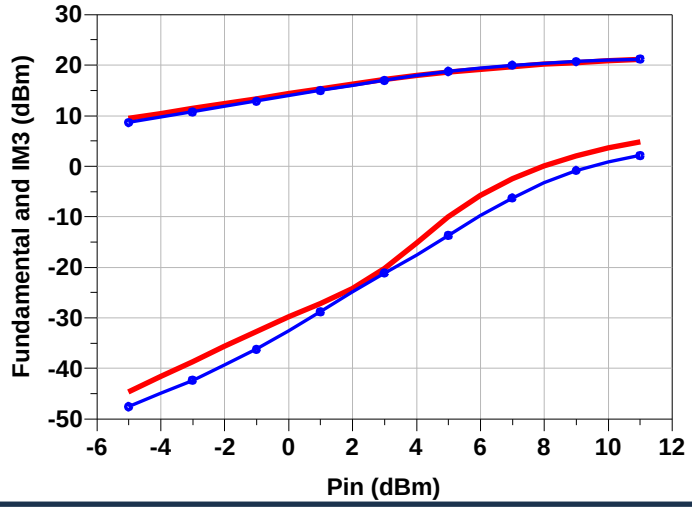


Load Condition: PAE Tuned
Test Bench Impedances (Ohms):

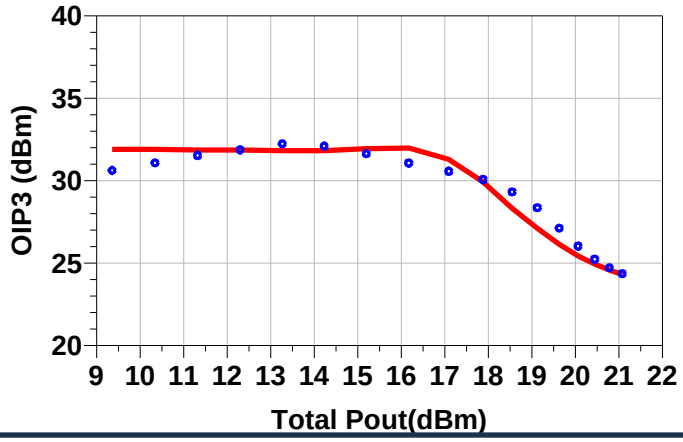
ZS = 11.8 + j*29.6
ZS2 = 72.5 - j*42.8
ZS3 = 56.8 - j*31.7
ZLoad = 49.1 + j*67.4
ZLoad2 = 54.0 - j*10.3
ZLoad3 = 21.8 + j*12.0

Legend: Red Solid lines - Model data, O Symbols - Measured data, BWremoval = 0

Two Tone Validation 12 GHz



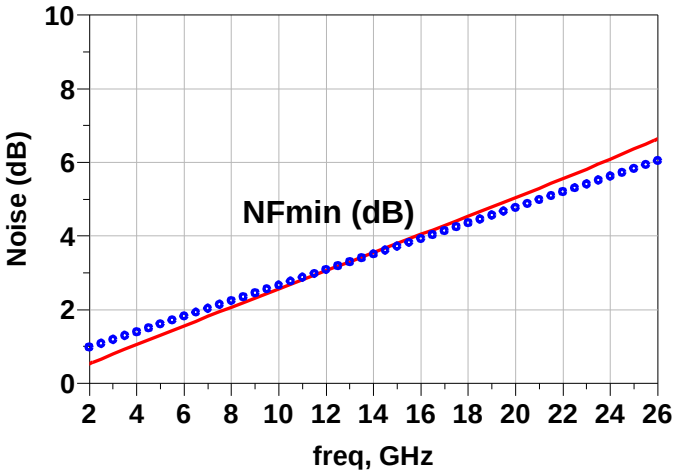
Simulated (solid line) and measured (symbols) tuned for max PAE.
Source impedance = (11.6 + j*28.8) Ohms, load impedance = (53.8 + j*66.4) Ohms.
Frequency =12 GHz, 5 MHz tone spacing, Vds = 7 V, 44 mA (60%Idss)

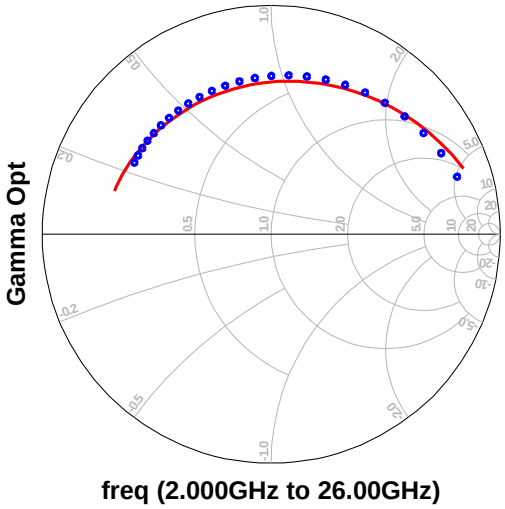


Simulated (solid line) and measured (symbols) tuned for max PAE.
Source impedance = (11.6 + j*28.8) Ohms, load impedance = (53.8 + j*66.4) Ohms.
Frequency =12 GHz, 5 MHz tone spacing, Vds = 7 V, 44 mA (60%Idss)

Noise Model vs. Measured Data:

VDS = 4 V, VGS = -1.10 V, IDS = 50 mA, 25 C





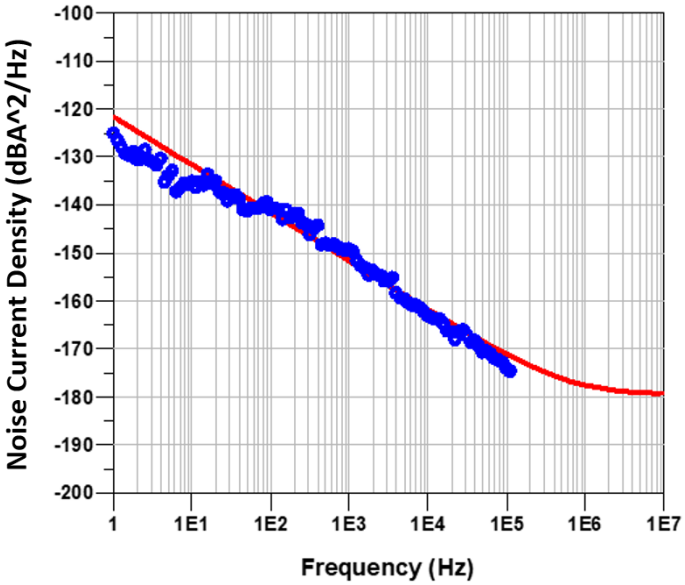
Legend: Red Solid lines - Model data, O Symbols - Measured data

Simulated at 25 C with the frequency range from 2 – 26 GHz, BWremoval = 0

50 Ω Smith Chart.

1/f Noise Performance

VDS = 4 V, VGS = -1.15 V, IDS = 22 mA, 25 C



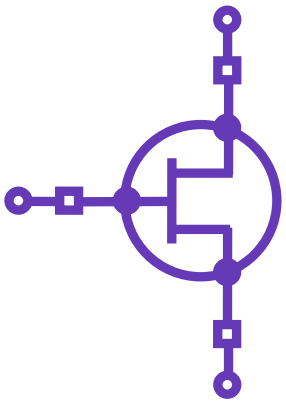
Legend: Red Solid lines - Model data simulated to 10 MHz offset, O Symbols - Measured data to 110 kHz

Simulated at 25 C, BWremoval = 0

Advanced Model Features:

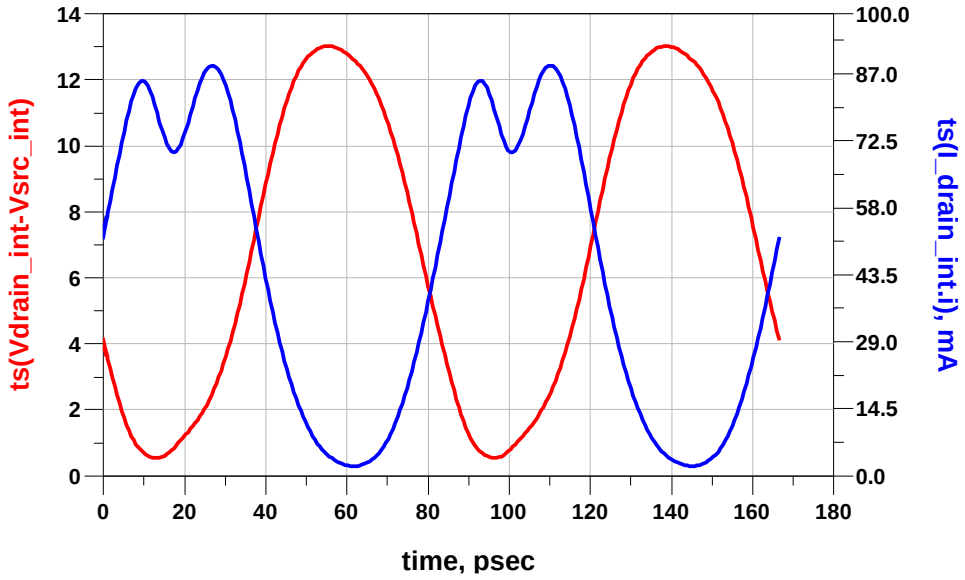
Intrinsic Voltage/Current Sensing

Get Vds and Ids model data near current generator intrinsic planes while tuning.



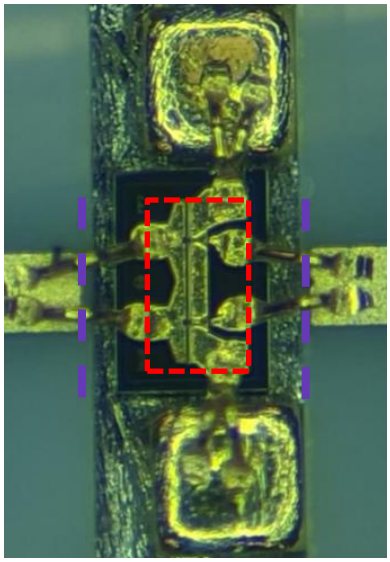
- External Model Planes
- Internal Model Planes for I/V waveform analysis
- Parasitic networks available separately from intrinsic I/V model

Example Plot of internal node Ids and Vds



Results based on harmonic balance simulation at 8 dBm input power, PAE matched at 12 GHz, 7 V, and 43.5 mA. ZS = (11.8 + j*29.6) Ohms, ZS2 = (72.5 - j*42.8) Ohms, ZS3 = (56.8 - j*31.7) Ohms, ZLoad = (53.4 + j*60.3) Ohms, ZLoad2 = (58.0 - j*5.1) Ohms, ZLoad3 = (24.2 + j*11.5) Ohms

Assembly Diagram



Test fixture details:
Modelithics Micro Probe Accessories part number 0503, 5 mil Alumina adapter substrates were used to access the bond pads of discrete die.

- Device thickness: 3.93 mil
- Test board thickness: 5 mil
- Bond-wire diameter: 1 mil gold
- Gate bond-wire length: 8 mil +/-2 (average)
- Drain bond-wire length: 6 mil +/-2 (average)
- Source bond-wire length (two wires per source pad): 6 mil +/-2 (average)
- Metal standoff external next to each source pad is 4 mil thick, its purpose is to shorten the bondwire lengths to the source/ground.
- Blue line is model planes with bondwires ON (BWremoval=0)
- Red line is model planes with bondwires OFF (BWremoval=1)

Model and Datasheet Revision Notes

03/07/2023	Original model and datasheet development
06/21/2023	Datasheet updated with IP3 validation