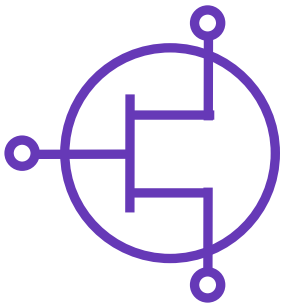
GaAs MESFET MODEL

MES-MWT-MWT1F-001

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
  - IP3 linearity validation, 12 GHz, 7 V 60%Idss
- Advanced model feature: enabling intrinsic I-V sensing



MES-MWT-MWT1F-001
MwT-1F
Discrete GaAs MESFET

Model Description

The MES-MWT-MWT1F-001 is a non-linear model for the MwT-1F a discrete 630 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.

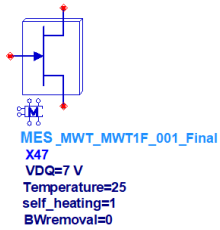
Technical Notes

- Model is optimized for 2, 4 and 7 V operation (55 mA (30% IDSS), 91 mA (50% IDSS) and 110 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.

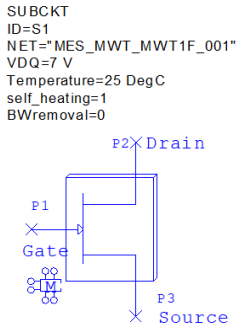
Model Simulation Settings

- **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

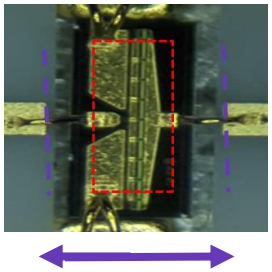


Keysight ADS



NI AWR

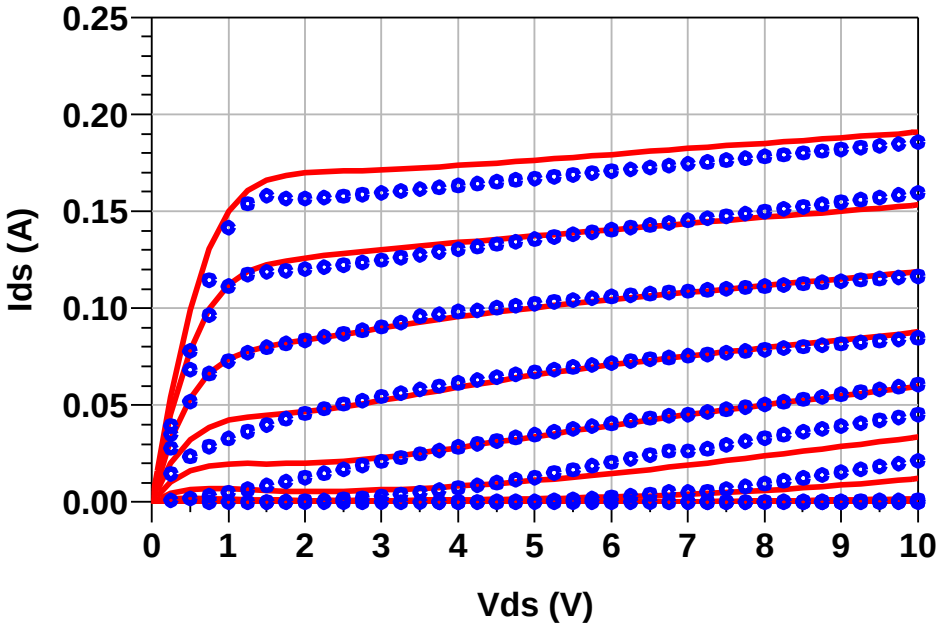
Reference Planes



Model and Measurement Reference Planes (BWremoval=1)

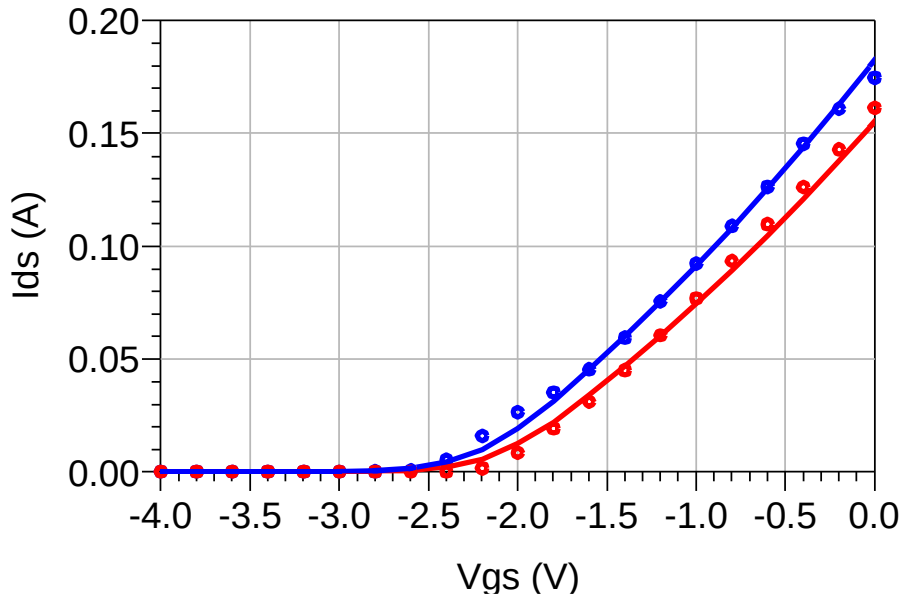
Model and Measurement Reference Planes (BWremoval=0)

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 0 V in steps of 0.4 V,
VDS varying from 0 to 10 V in steps of 0.25 V. Model self_heat = 0.

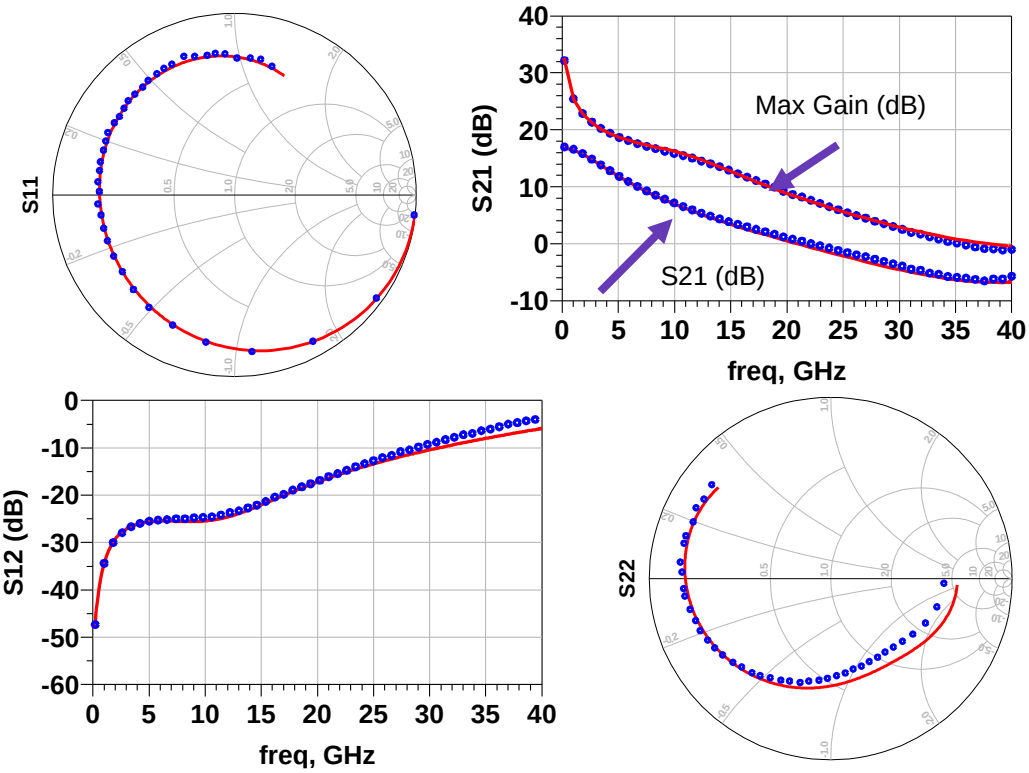
Model vs. Measurement Temperature IV Characteristics



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:

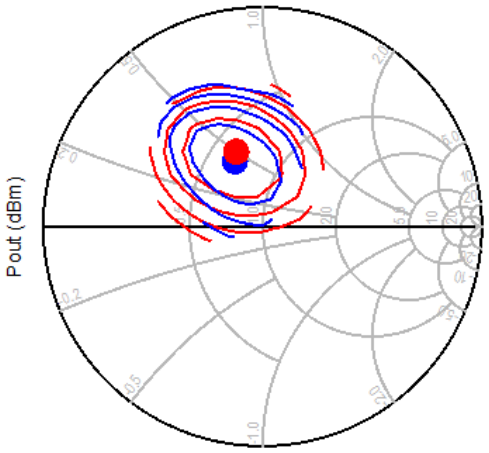
VDS = 7 V, VGS = -0.76 V, IDS = 109.6 mA (60% IDSS), 25 C



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 = -0.76 V, IDS = 109.6 mA (60% IDSS),
Input Power = 16 dBm, Z0 = 50 Ω Center, 25 C

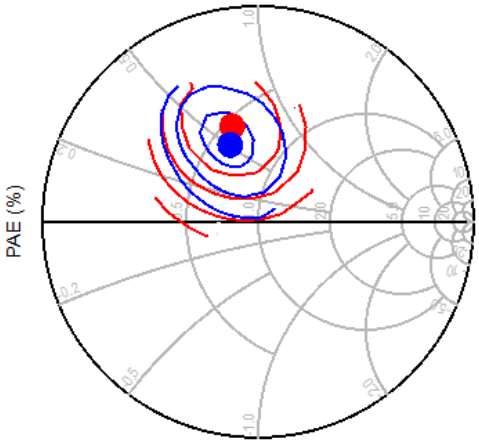
Power Tuning (0.5 dB contour step)



Test Bench Impedances (Ohms):

ZS = 8.2 + j*5.4
ZS2 = 77.7 + j*30.5
ZS3 = 40.7 + j*23.7
ZLoad2 = 67.0 - j*19.6
ZLoad3 = 39.9 - j*32.2

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	33.0 + j*21.9	25.8	30.5 + j*25.4	43.1
Model	31.7 + j*24.9	25.4	27.2 + j*30.5	40.2

Load pull data has been processed for contour display

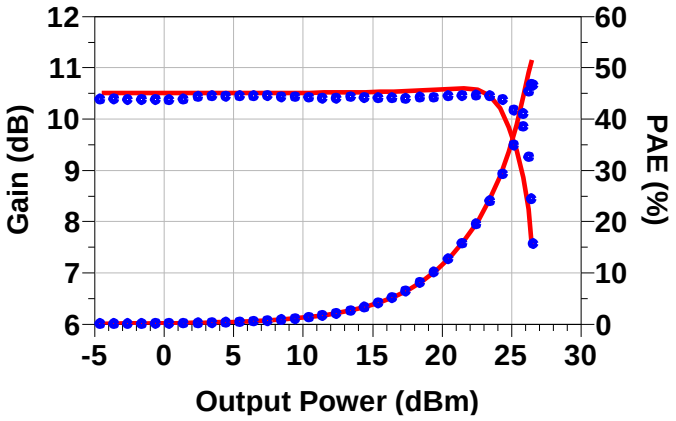
Single Tone Power Sweep: Frequency = 12 GHz
VDS = 7 V, VGS = -0.76 V, IDS = 109.6 mA (60% IDSS), 25 C

Load Condition: Measured Power Tuned

Transducer Gain and Power Added Efficiency (PAE)

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

ZS = 8.2 + j*5.4
ZS2 = 77.7 + j*30.5
ZS3 = 40.7 + j*23.7
ZLoad = 30.8 + j*19.1
ZLoad2 = 84.9 - j*10.2
ZLoad3 = 128.8 + j*27.1



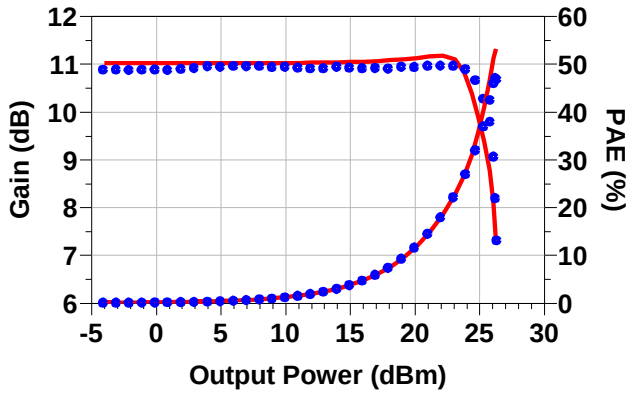
Legend: Red Solid lines - Model data, O Symbols - Measured data, BWremoval = 0

Load Condition: Measured PAE Tuned

Transducer Gain and Power Added Efficiency (PAE)

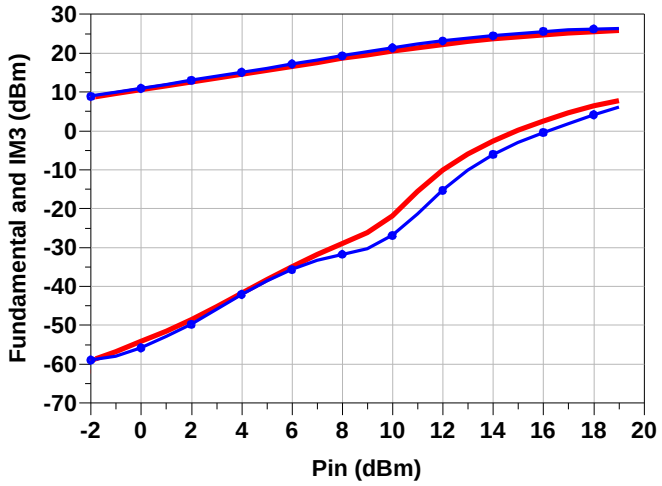
Load Condition: PAE Tuned
Test Bench Impedances
(Ohms):

ZS = 8.2 + j*5.4
ZS2 = 77.7 + j*30.5
ZS3 = 40.7 + j*23.7
ZLoad = 30.5 + j*25.4
ZLoad2 = 73.8 - j*11.7
ZLoad3 = 119.6 - j*25.7

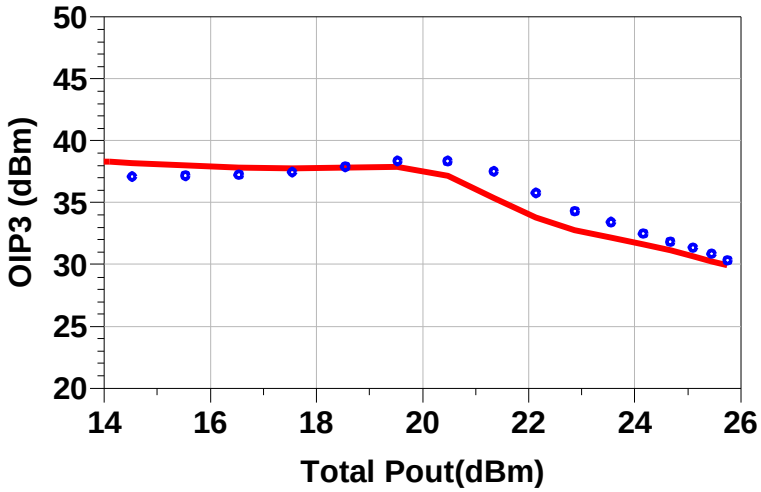


Legend: Red Solid lines - Model data, O Symbols - Measured data, BWremoval = 0

Two Tone Validation 12 GHz



Simulated (solid line) and measured (symbols) tuned for max Power.
Source impedance = (7.0 + j*3.6) Ohms, load impedance = (32.4 + j*18.6) Ohms.
Frequency =12 GHz, 5 MHz tone spacing, Vds = 7 V, 109.6 mA (60%Idss)



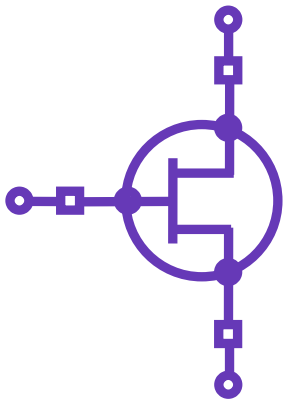
Simulated (solid line) and measured (symbols) tuned for max Power.
Source impedance = (7.0 + j*3.6) Ohms, load impedance = (32.4 + j*18.6) Ohms.
Frequency =12 GHz, 5 MHz tone spacing, Vds = 7 V, 109.6 mA (60%Idss)

Notice: Modelithics models represent as-measured characteristics of sample devices using specific testing and fixture configurations. The accuracy of models may vary as a result of differing device characteristics, test fixtures, or test conditions. No liability shall be assumed by Modelithics for use of its models, or for any infringement of rights of third parties that may result from their use. Modelithics reserves the right to revise its models and its product line without prior notice.

Advanced Model Features:

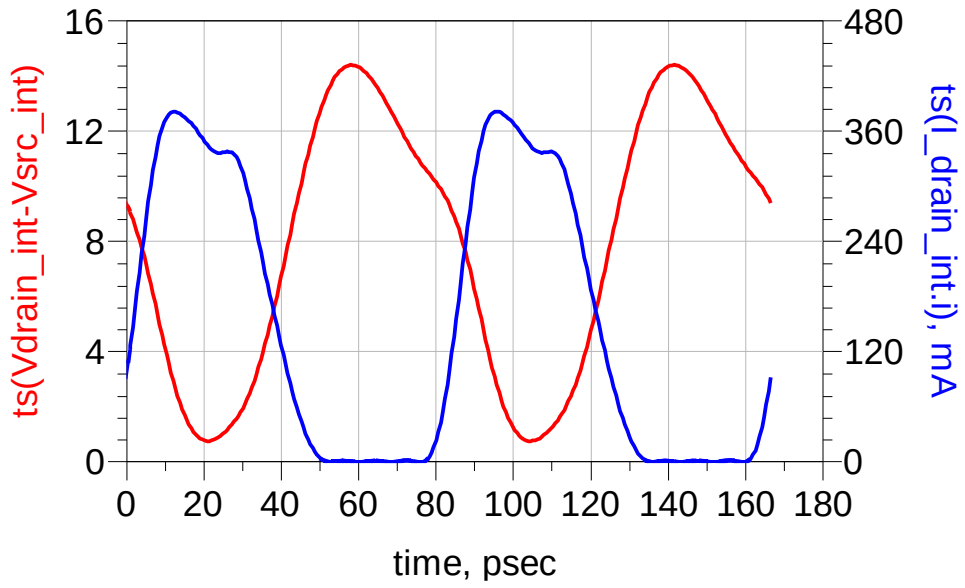
Intrinsic Voltage/Current Sensing

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 19 dBm input power, PAE matched at 12 GHz, 7 V, and 110 mA. ZS = (8.2 + j*5.4) Ohms, ZS2 = (77.7 + j*30.5) Ohms, ZS3 = (40.7 + j*23.7) Ohms, ZLoad = (30.8 + j*19.1) Ohms, ZLoad2 = (84.9 - j*10.2) Ohms, ZLoad3 = (128.8 + j*27.1) Ohms

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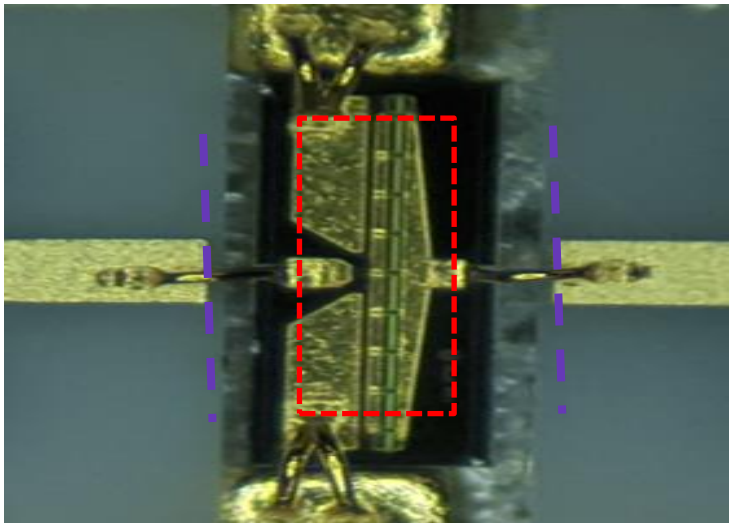
Assembly Diagram



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 and Drain single 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

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