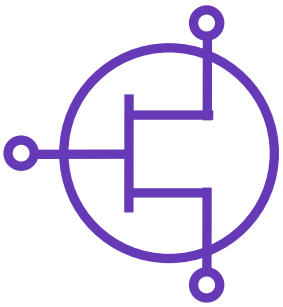
# GaAs MESFET MODEL

HMT-MWT-MWT7F-001

## Model Features

- Broadband (DC to 40 GHz)
- Large-signal model (Modelithics-Enhanced Angelov)
- Measurement Validations:
  - Pulsed I-V (25C to 85C)
  - Multi-bias S-parameters (25C to 85C)
  - Load pull (25C)
  - Noise parameters (25C)
  - 1/f noise
- Advanced model feature: enabling intrinsic I-V sensing
- IP3 validated against MwT spec



**HMT-MWT-MWT7F-001**
**MwT-7F**
**Discrete GaAs MESFET**

## Model Description

The HMT_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.

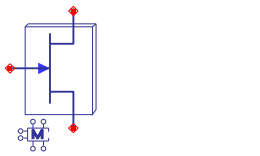
## Technical Notes

- Model is optimized for 2, 4 and 7V operation (21.75Ma (30% IDSS), 36.25mA (50% IDSS) and 43.5mA (60% IDSS)).
- Model Parameters:
  - **VDSQ:** For setting the optimum bias point of the model (default=7V).
  - **Temperature:** represents the backside ambient temperature, validated at 25C and 85C.
  - **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.

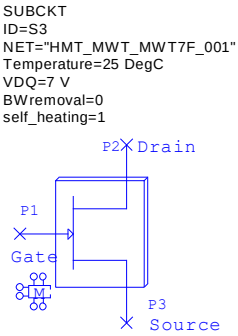
## Model Simulation Settings

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

## Model Representation

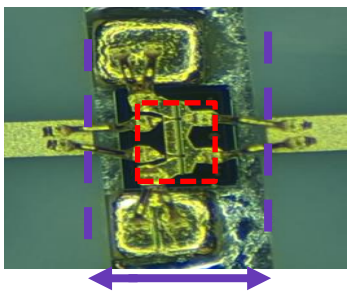



Keysight ADS




NI AWR

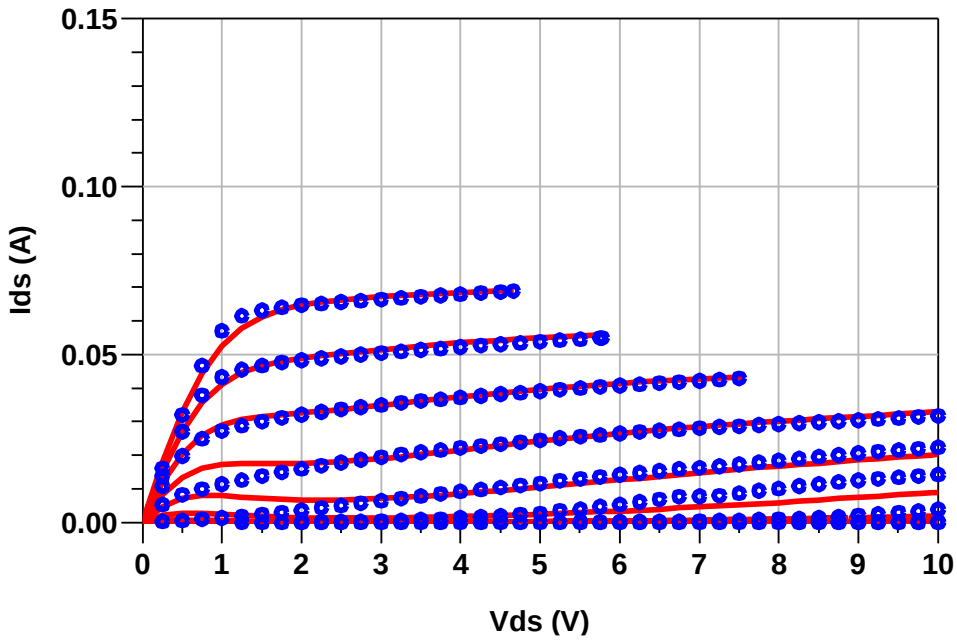
## Reference Planes



Model and Measurement Reference Planes (BWremoval=1)

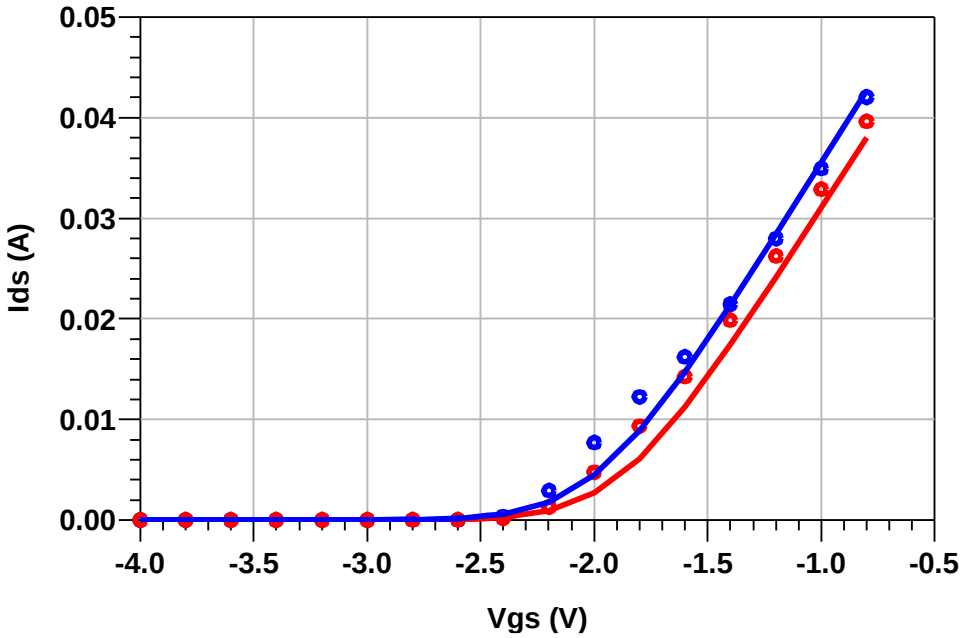
Model and Measurement Reference Planes (BWremoval=0)

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




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

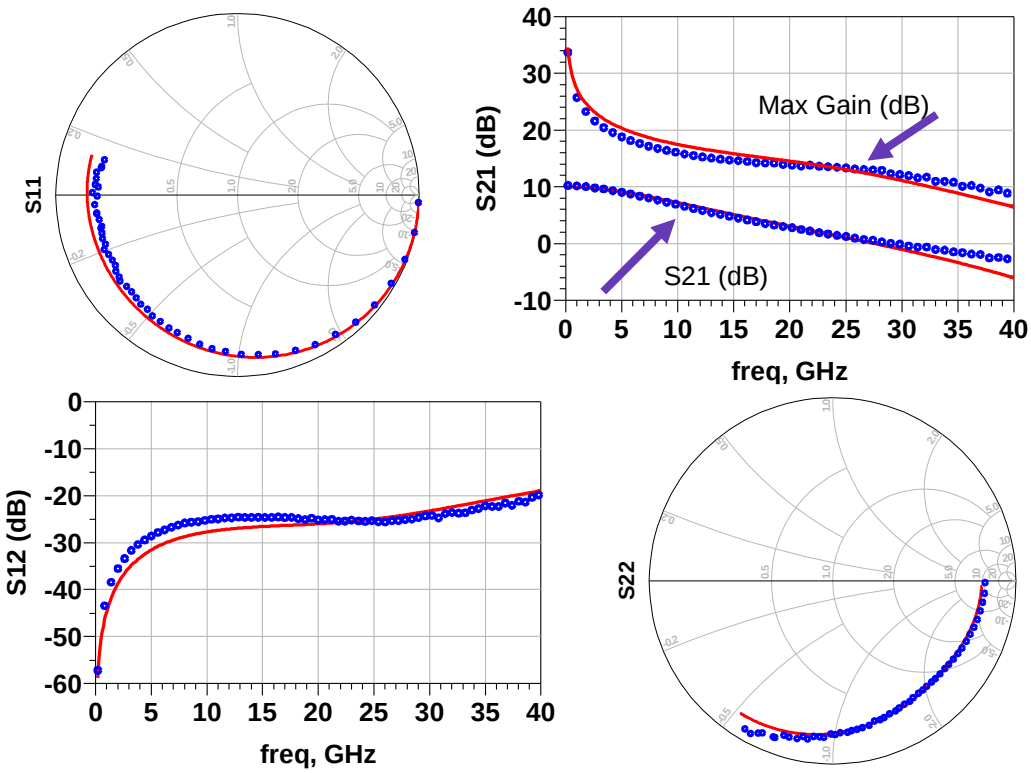
## Model vs. Measurement Temperature IV Characteristics




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

## S-Parameters Model vs. Measured:

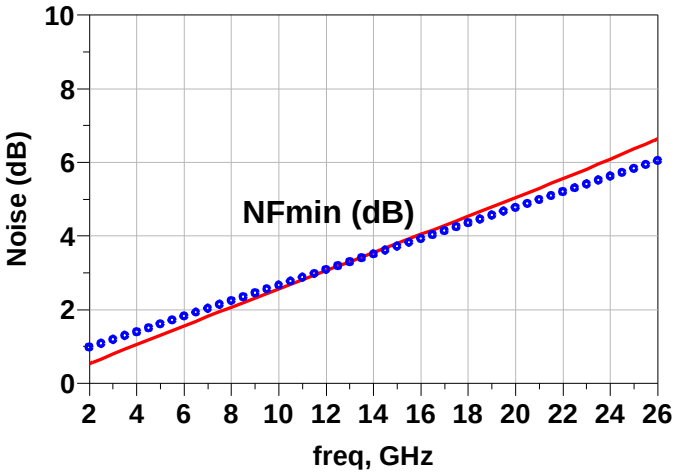
## VDS = 7V, VGS = -0.675V, IDS = 43.5mA (60% IDSS), 25C

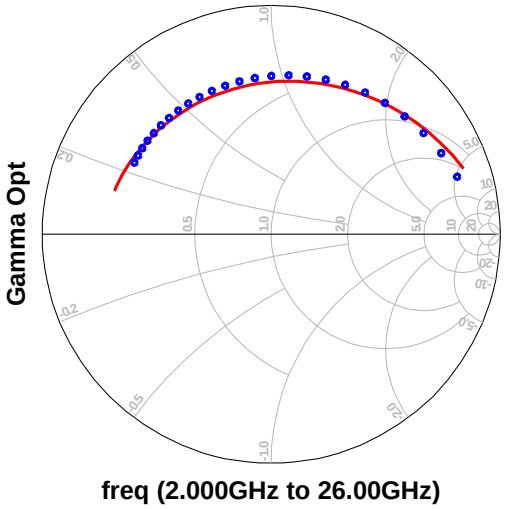



Legend: Red Solid lines - Model data, O Symbols - Measured data
Simulated at 25C with the frequency range from 0.2 – 40GHz. 50Ω Smith Charts
BWremoval = 0

## Noise Model vs. Measured:

### VDS = 4V, VGS = -1.1V, IDS = 50mA, 25C



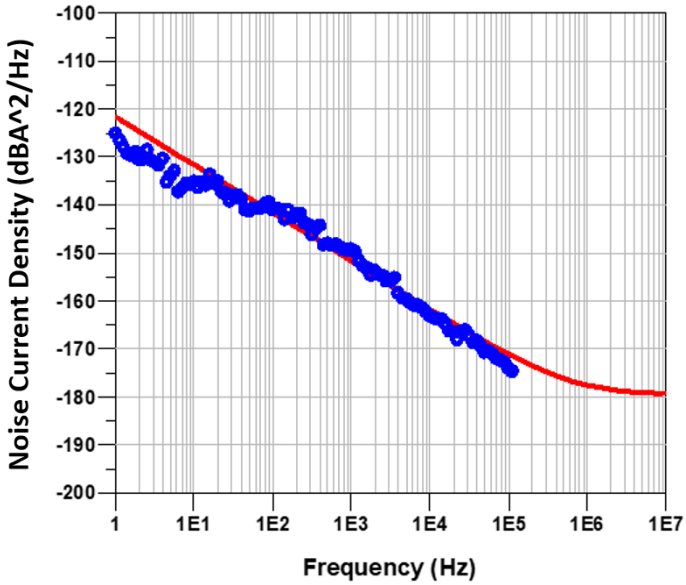

Legend: Red Solid lines - Model data, O Symbols - Measured data

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

50Ω Smith Chart.

## 1/f Noise Performance

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

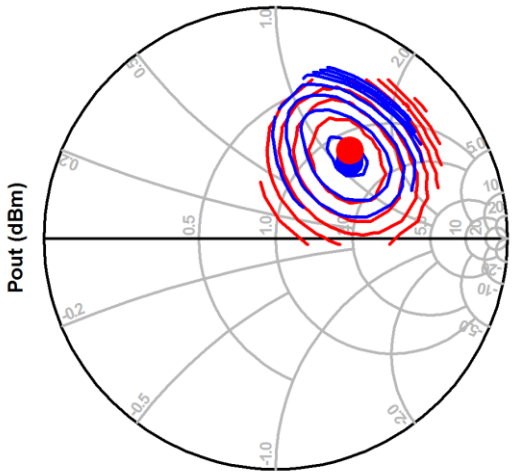



Legend: Red Solid lines - Model data simulated to 10 MHz offset, O Symbols - Measured data to 110 KHz

Simulated at 25C, BWremoval = 0

## Load Pull Validation: Frequency = 12GHz
## VDS = 7V, VGS = -0.675V, IDS = 43.5mA (60% IDSS),
## Input Power = 10dBm, Z0 = 50Ω Center, 25C

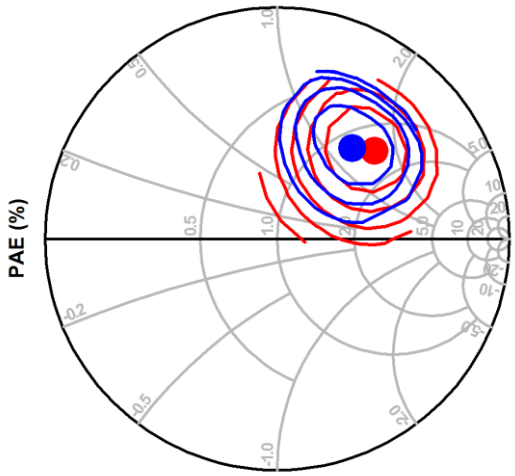
Power Tuning (0.5dB contour step)




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

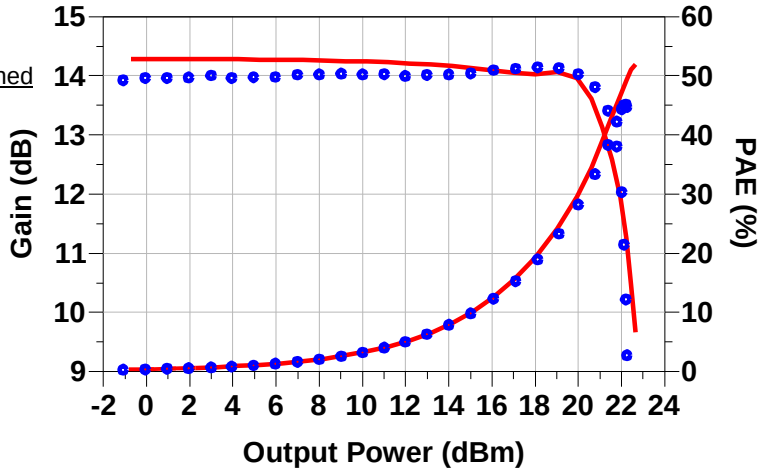
## Single Tone Power Sweep: Frequency = 12GHz
## VDS = 7V, VGS = -0.68V, IDS = 43.5 mA(60% IDSS), 25C

### 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



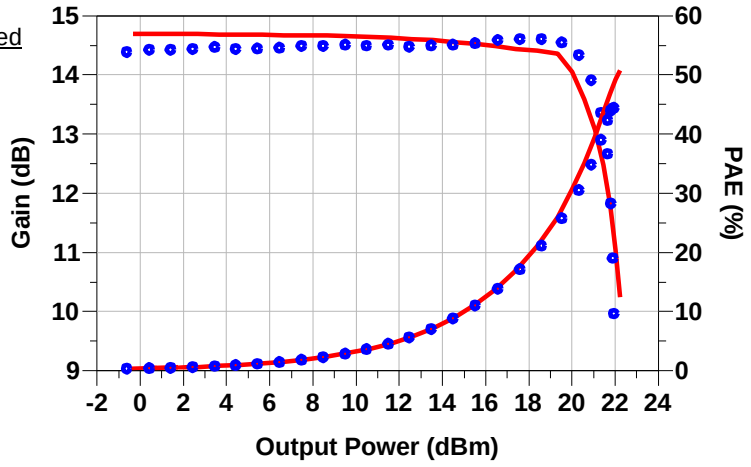

Legend: Red Solid lines - Model data, O Symbols - Measured data, BWremoval = 0

### 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

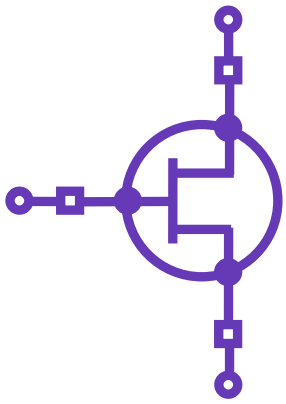



Legend: Red Solid lines - Model data, O Symbols - Measured data, BWremoval = 0

# Advanced Model Features:

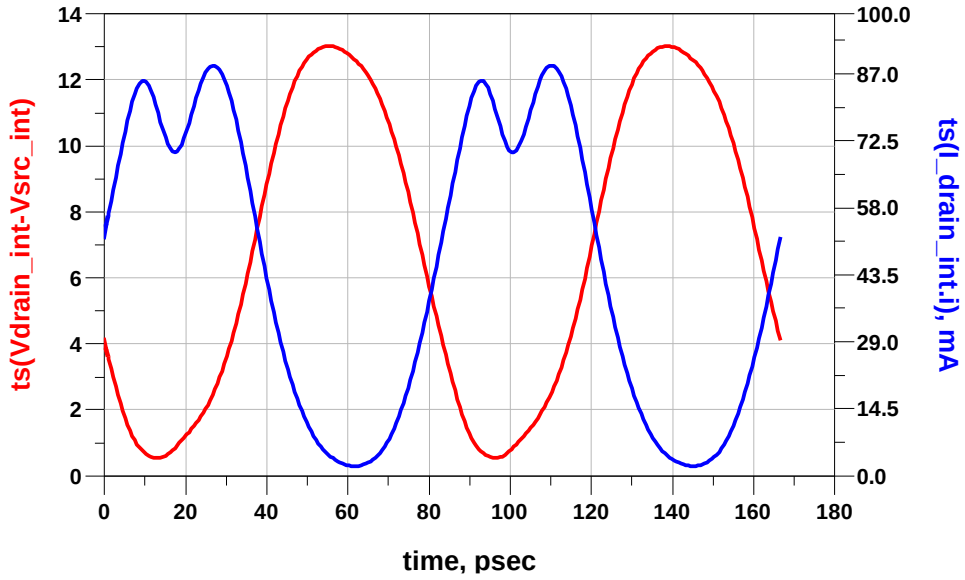
## Intrinsic Voltage/Current Sensing

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



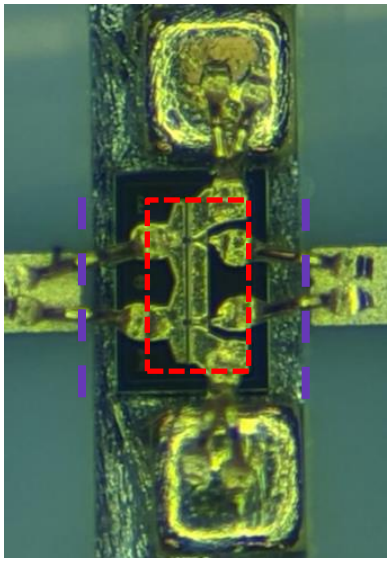
- External Model Planes
- Internal Model Planes for I/V waveform analysis
- Parasitic networks available separately from intrinsic I/V model

Example Plot of internal node Ids and Vds




Results based on harmonic balance simulation at 8dBm input power, PAE matched at 12GHz, 7V, and 43.5mA. ZS = 11.8 + j*29.6 Ohms, 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 Ohms

## Assembly Diagram



Test fixture details:

- Device thickness: 3.93 mil
- Test board thickness: 5 mils
- Bond-wire diameter: 1 mil gold
- Gate bond-wire length: 8 mils +/-2 (average)
- Drain bond-wire length: 6 mils +/-2 (average)
- Source bond-wire length (two wires per source pad): 6 mils +/-2 (average)
- Metal standoff external next to each source pad is 4 mils 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

| | |
|---|---|
| 12/27/2022 | Original model and datasheet development |