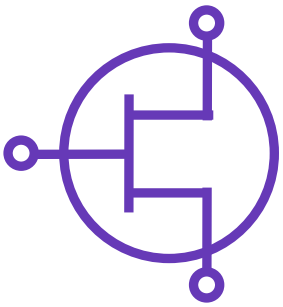
GaAs MESFET MODEL

MES-MWT-MWT3F-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-MWT3F-001
MwT-3F
Discrete GaAs MESFET

Model Description

The MES-MWT-MWT3F-001 is a non-linear model for the MwT-3F a discrete 300 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.

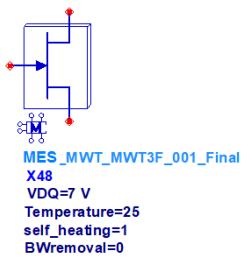
Technical Notes

- Model is optimized for 2, 4 and 7 V operation (26 mA (30% IDSS), 44 mA (50% IDSS) and 52 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.

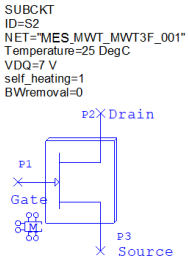
Model Simulation Settings

- **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

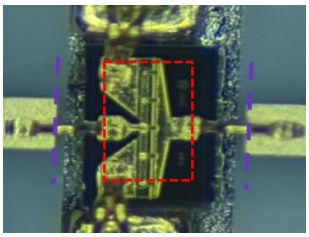


Keysight ADS



NI AWR

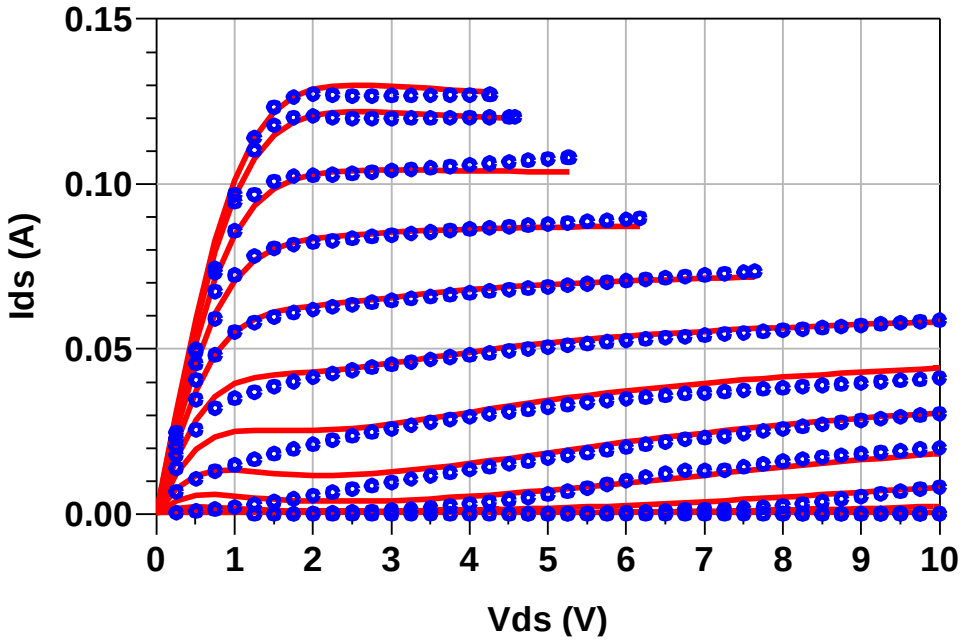
Reference Planes



Model and Measurement Reference Planes (BWremoval=1)

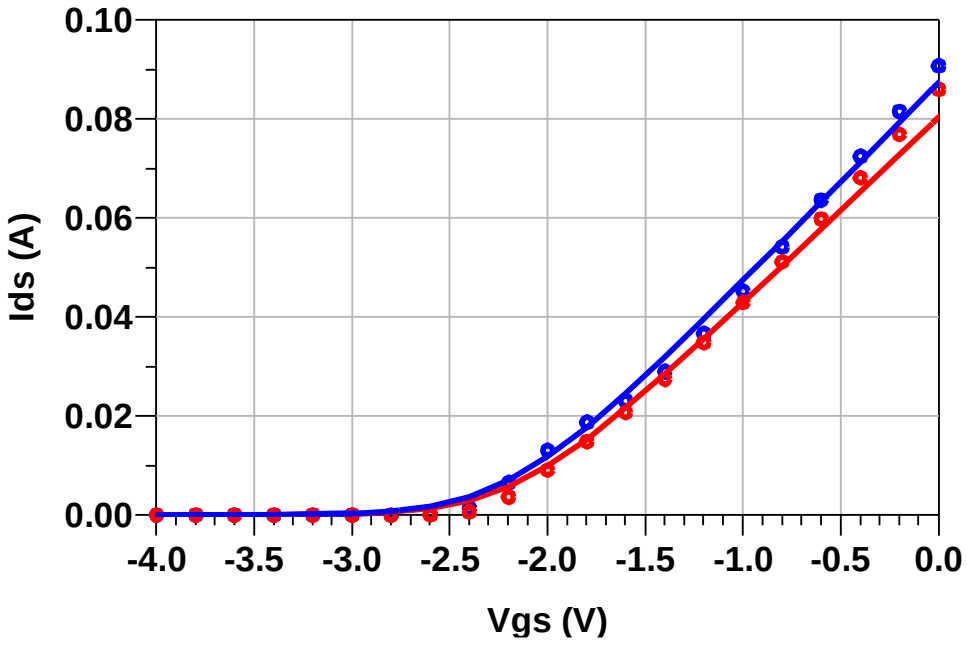
Model and Measurement Reference Planes (BWremoval=0)

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.

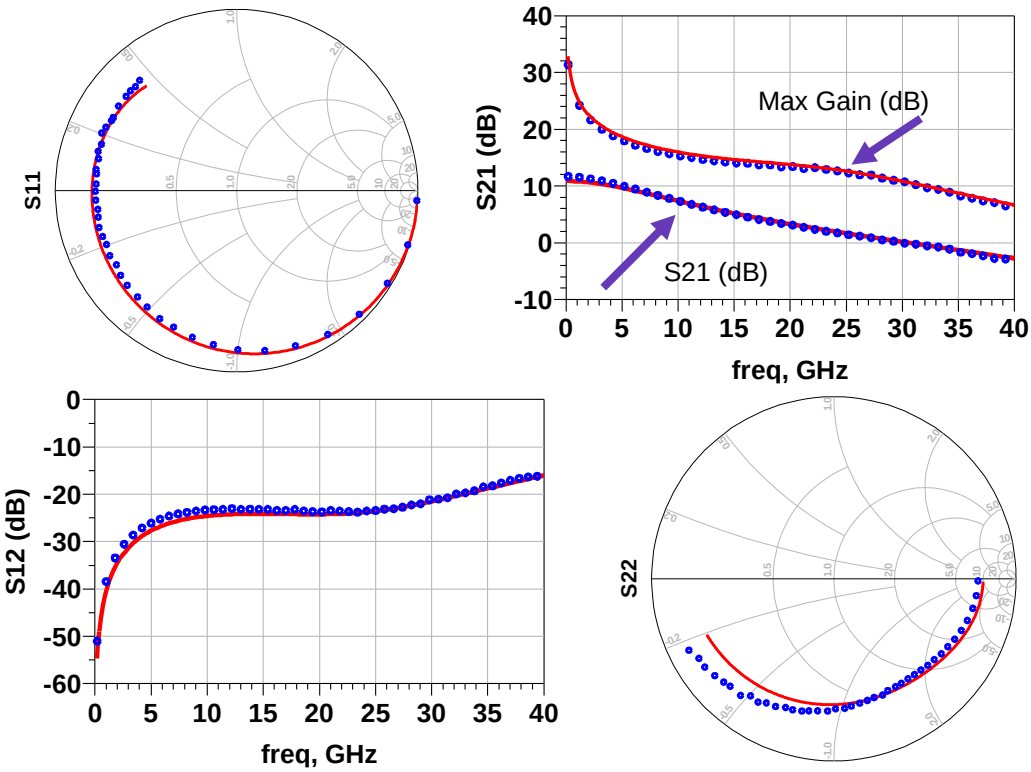
Model vs. Measurement Temperature IV Characteristics



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 = -0.81 V, IDS = 52.2 mA (60% IDSS), 25 C



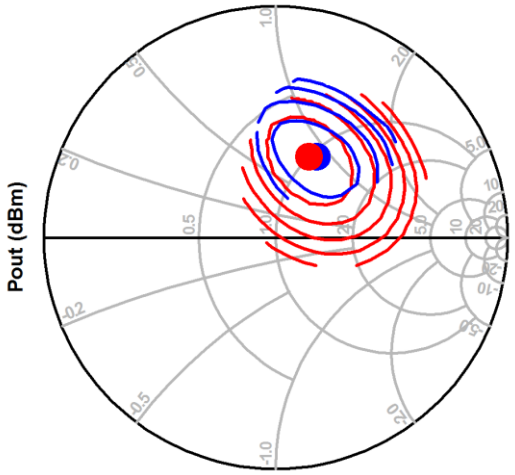
Legend: Red Solid lines - Model data, O Symbols - Measured data
Simulated at 25 C with the frequency range from 0.2 – 40 GHz. 50 Ω Smith Charts
BWremoval = 0

Load Pull Validation: Frequency = 12 GHz

VDS = 7 V, VGS = -0.81 V, IDS = 52.2 mA (60% IDSS),

Input Power = 11 dBm, Z0 = 50 Ω Center, 25 C

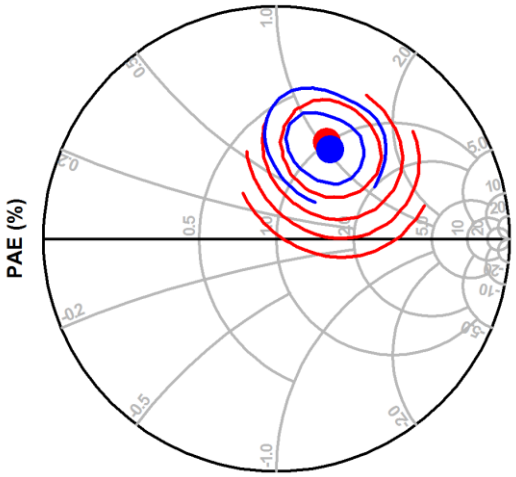
Power Tuning (0.5 dB contour step)



Test Bench Impedances (Ohms):

ZS = 9.9 + j*20.7
ZS2 = 97.2 - j*14.4
ZS3 = 81.9 - j*13.8
ZLoad2 = 45.9 - j*19.1
ZLoad3 = 16.9 + j*14.4

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	53.0 + j*43.8	23.0	53.8 + j*52.1	44.9
Model	50.0 + j*41.0	23.2	49.4 + j*53.0	48.2

Load pull data has been processed for contour display

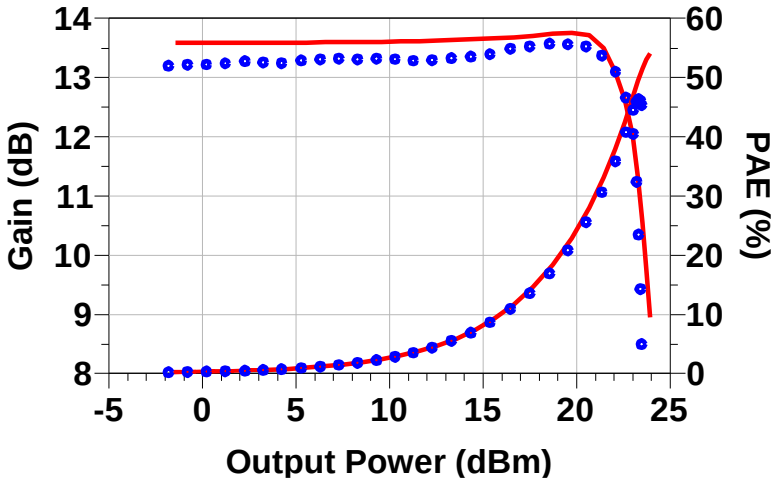
Single Tone Power Sweep: Frequency = 12 GHz
VDS = 7 V, VGS = -0.81 V, IDS = 52.2 mA (60% IDSS), 25 C

Load Condition: Measured Power Tuned

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

ZS = 9.9 + j*20.7
ZS2 = 97.2 - j*14.4
ZS3 = 81.9 - j*13.8
ZLoad = 53.0 + j*43.8
ZLoad2 = 59.1 + j*1.0
ZLoad3 = 31.2 + j*1.2

Transducer Gain and Power Added Efficiency (PAE)



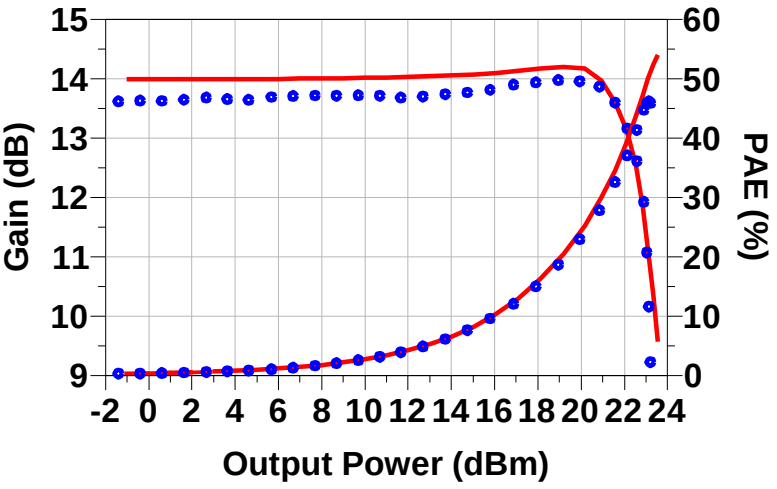
Legend: Red Solid lines - Model data, O Symbols - Measured data, BWremoval = 0

Load Condition: Measured PAE Tuned

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

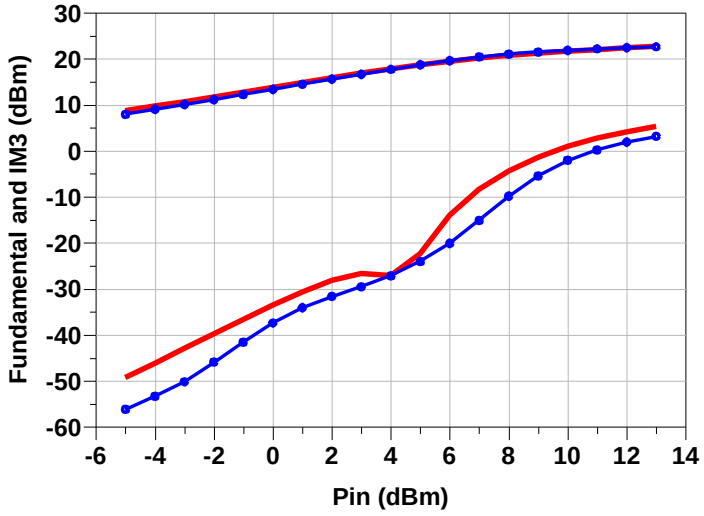
ZS = 9.9 + j*20.7
ZS2 = 97.2 - j*14.4
ZS3 = 81.9 - j*13.8
ZLoad = 53.8 + j*52.1
ZLoad2 = 59.7 - j*2.0
ZLoad3 = 27.2 + j*7.1

Transducer Gain and Power Added Efficiency (PAE)

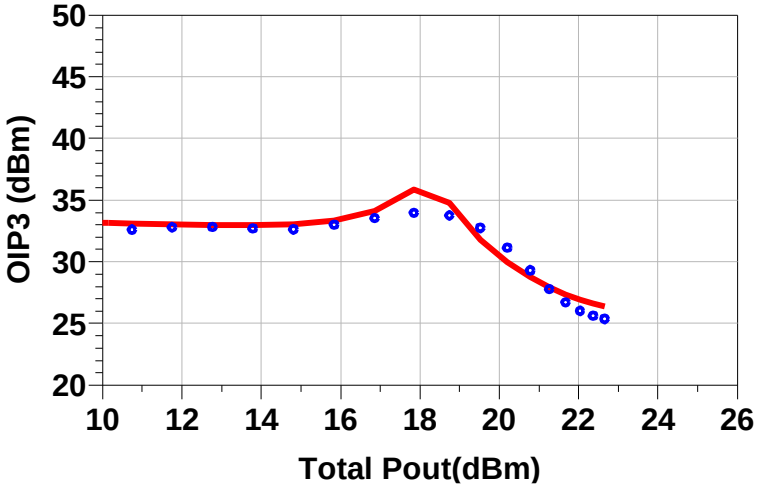


Legend: Red Solid lines - Model data, O Symbols - Measured data, BWremoval = 0

Two Tone Validation 12 GHz



Simulated (solid line) and measured (symbols) tuned for max Power.
Source impedance = (10.5 + j*21.3) Ohms, load impedance = (49.4 + j*44.6) Ohms.
Frequency =12 GHz, 5 MHz tone spacing, Vds = 7 V, 52.2 mA (60%Idss)

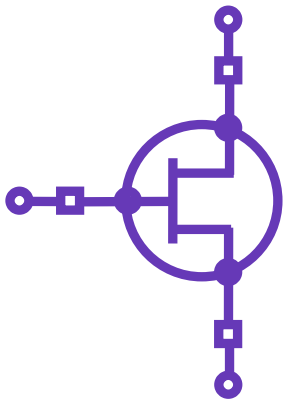


Simulated (solid line) and measured (symbols) tuned for max Power.
Source impedance = (10.5 + j*21.3) Ohms, load impedance = (49.4 + j*44.6) Ohms.
Frequency =12 GHz, 5 MHz tone spacing, Vds = 7 V, 52.2 mA (60%Idss)

Advanced Model Features:

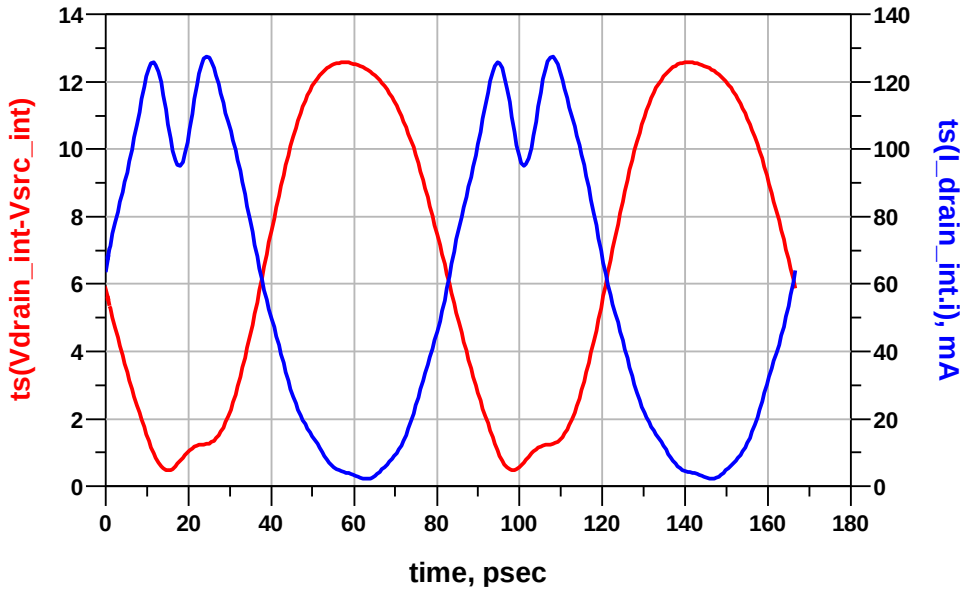
Intrinsic Voltage/Current Sensing

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



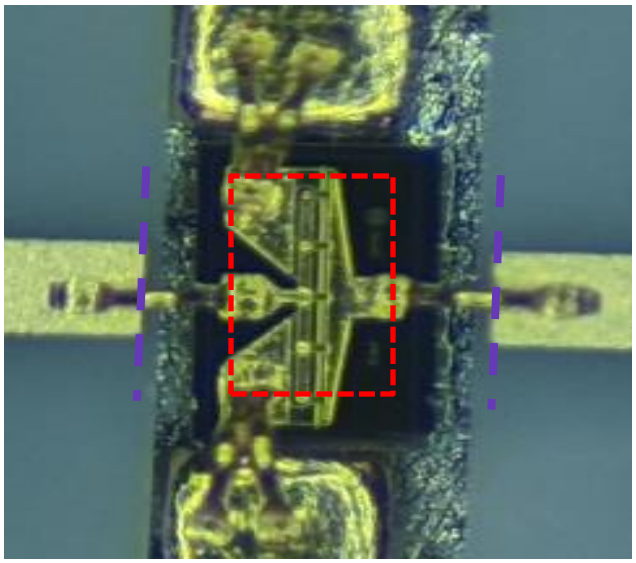
- External Model Planes
- Internal Model Planes for I/V waveform analysis
- Parasitic networks available separately from intrinsic I/V model

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 52.2 mA. ZS = (9.9 + j*20.7) Ohms, ZS2 = (97.2 - j*14.4) Ohms, ZS3 = (81.9 - j*13.8) Ohms, ZLoad = (53.0 + j*43.8) Ohms, ZLoad2 = (59.1 + j*1.0) Ohms, ZLoad3 = (31.2 + j*1.2) 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 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