GaN High Power Amplifier, 25 W 27 - 31 GHz



CMPA2H3B025D Rev. V1

Features

Saturated Power: 25 W
Power Added Efficiency: 26%
Large Signal Gain: 21 dB
Small Signal Gain: 25 dB
Input Return Loss: <-10 dB
Output Return Loss: <-10 dB

IM3: <-25 dBc @ 40 dBm PoutCW operation

Applications

· Ka-Band Satcom Uplink

Description

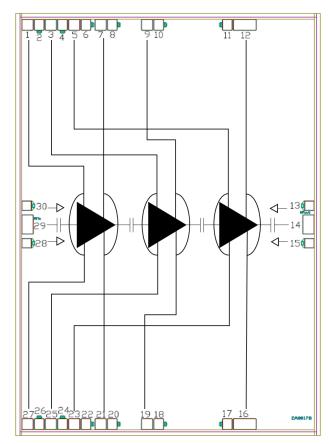
The CMPA2H3B025D is a 25 W, MMIC HPA utilizing MACOM's high performance, 0.15 μ m GaN-on-SiC production process. This amplifier operates from 27 – 31 GHz and targets both defense and commercial satellite communications applications. Under saturation, this amplifier achieves 25 W of typical output power with 21 dB of large signal gain and > 25% power-added efficiency. Targeting an IM3 level of -25 dBc or better, this HPA delivers 10 W of output power with 26 dB of gain and 20% power-added efficiency.

The bare die solution provides peak performance while minimizing required board space.

Ordering Information

| Part Number | Package (MOQ/ Mult) |
|------------------|---------------------|
| CMPA2H3B025D | Gel Pack (10/10) |
| CMPA2H3B025D-AMP | Sample Board (1/1) |

Functional Schematic



Pin Configuration¹

| i iii Goinigaradon | |
|--------------------|-------------------|
| Pin# | Name |
| 13, 15, 28, 30 | GND |
| 1, 27 | VG1 |
| 3, 25 | VG2 |
| 5, 23 | VG3 |
| 7, 21 | VD1 |
| 9, 19 | VD2 |
| 12, 16 | VD3 |
| 14 | RF _{OUT} |
| 29 | RF _{IN} |

^{1.} The backside of the MMIC must be connected to RF, DC and thermal ground.



RF Electrical Specifications: V_D = 28 V, I_{DQ} = 300 mA, CW, T_C = 25°C, Z_0 = 50 Ω

| Parameter | Test Conditions | Frequency (GHz) | Units | Min. | Тур. | Max. |
|------------------------|---|--------------------|-------|----------------------|----------------------|------|
| Output Power | | 27 29 31 | dBm | 42.9 43.1 42.7 | 44.0 44.2 43.8 | _ |
| Power Added Efficiency | P _{IN} = 23 dBm | 27 29 31 | % | 23 21 22 | 26 27 25 | _ |
| Large Signal Gain | | 27 29 31 | dB | _ | 21.0 21.2 20.8 | _ |
| Small Signal Gain | P _{IN} = -20 dBm | 27 29 31 | dB | _ | 25.0 25.0 25.0 | _ |
| Input Return Loss | - FIN20 apm | 27-31 | dB | _ | -10 | _ |
| Output Return Loss | | 27-31 | dB | _ | -10 | _ |
| IM3 | P _{OUT} /Tone = 37 dBm Tone/Spacing = 300 MHz | 27 29 31 | dBc | _ | -25 -25 -25 | _ |

DC Electrical Specifications:

| Parameter | | Min. | Тур. | Max. |
|-------------------------|---|------|------|------|
| Drain Voltage | V | _ | 28 | _ |
| Gate Voltage | V | _ | -1.8 | _ |
| Quiescent Drain Current | | _ | 300 | _ |
| Saturated Drain Current | Α | _ | 3.4 | _ |



Recommended Operating Conditions

| Parameter | Symbol | Unit | Min. | Тур. | Max. |
|-------------------------|-----------------|------|------|------|------|
| Input Power | P _{IN} | dBm | _ | 23 | _ |
| Drain Voltage | V _D | V | _ | 28 | _ |
| Gate Voltage | V _G | V | _ | -1.8 | _ |
| Quiescent Drain Current | I _{DQ} | mA | _ | 300 | _ |
| Operating Temperature | T _C | °C | -40 | _ | +85 |

Absolute Maximum Ratings^{2,3}

| Parameter | Symbol | Unit | Min. | Max. |
|---------------------------------------|-------------------|-------|------|--------|
| Input Power | P _{IN} | dBm | _ | 25 |
| Drain to Source Voltage | V _{DS} | V | _ | 84 |
| Drain Voltage | V _D | V | _ | 28 |
| Gate Voltage | V _G | V | -8 | +2 |
| Drain Current | I _D | Α | _ | 5.5 |
| Gate Current | I _G | mA | _ | 10 |
| Dissipated Power @ +85° | P _{DISS} | W | _ | 66 |
| VSWR | _ | Ratio | _ | 5:1 |
| Junction Temperature (MTTF > 1E6 Hrs) | TJ | °C | _ | +225°C |
| Storage Temperature | T _{STG} | °C | -65 | +150 |
| Mounting Temperature (30 seconds) | T _M | °C | | +320 |

^{2.} Exceeding any one or combination of these limits may cause permanent damage to this device.

Handling Procedures

Please observe the following precautions to avoid damage:

Static Sensitivity

These electronic devices are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these HBM Class 1A devices.

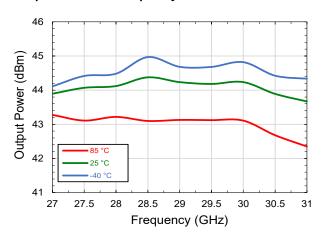
^{3.} MACOM does not recommend sustained operation near these survivability limits.



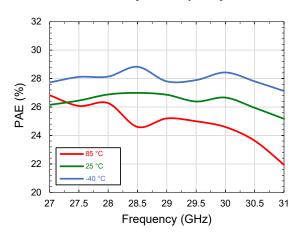
Typical Performance Curves - Large Signal over Temperature:

 $V_D = 28 \text{ V}, I_{DQ} = 300 \text{ mA}, CW, P_{IN} = 23 \text{ dBm}$

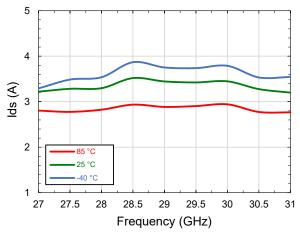
Output Power vs. Frequency



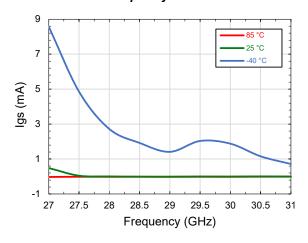
Power Added Efficiency vs. Frequency



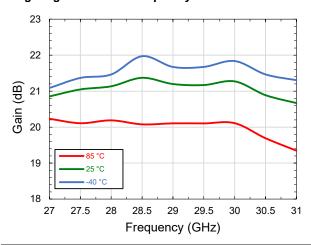
Drain Current vs. Frequency



Gate Current vs. Frequency



Large Signal Gain vs. Frequency

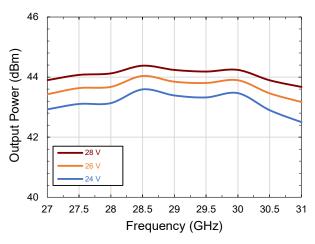




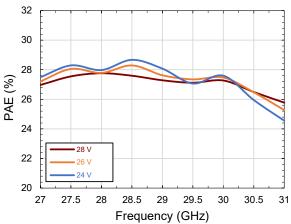
Typical Performance Curves - Large Signal over V_D:

 I_{DQ} = 300 mA, CW, P_{IN} = 23 dBm, T_{C} = 25°C

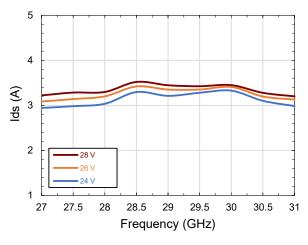
Output Power vs. Frequency



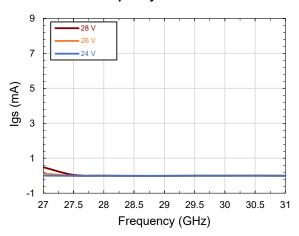
Power Added Efficiency vs. Frequency



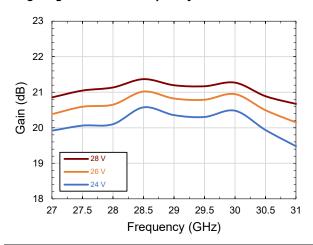
Drain Current vs. Frequency



Gate Current vs. Frequency



Large Signal Gain vs. Frequency

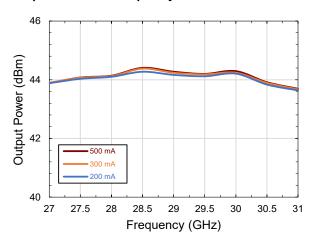




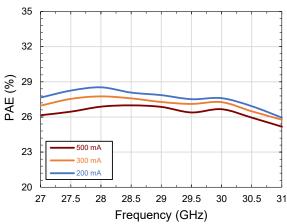
Typical Performance Curves - Large Signal over IDQ:

 V_D = 28 V, CW, P_{IN} = 23 dBm, T_C = 25°C

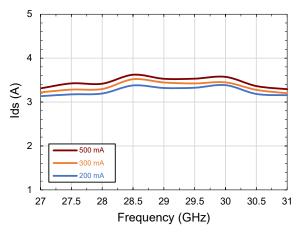
Output Power vs. Frequency



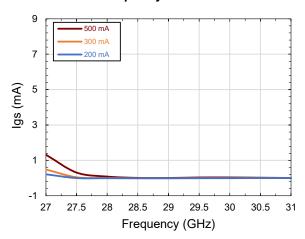
Power Added Efficiency vs. Frequency



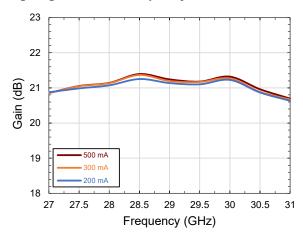
Drain Current vs. Frequency



Gate Current vs. Frequency



Large Signal Gain vs. Frequency

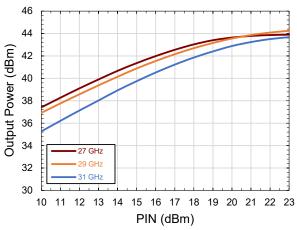




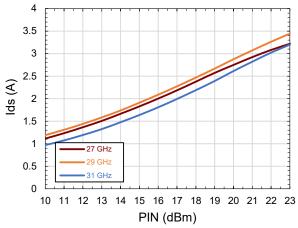
Typical Performance Curves - Drive-Up over Frequency:

 $V_D = 28 \text{ V}, I_{DQ} = 300 \text{ mA}, CW, T_C = 25^{\circ}\text{C}$

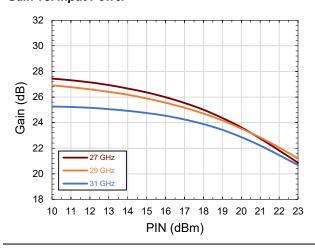
Output Power vs. Input Power



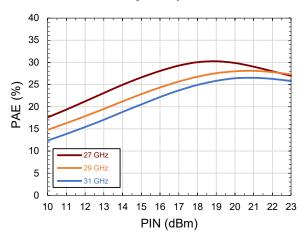
Drain Current vs. Input Power

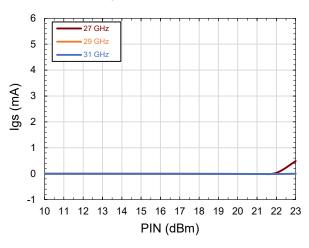


Gain vs. Input Power



Power Added Efficiency vs. Input Power



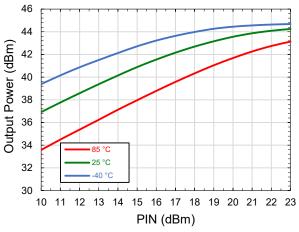




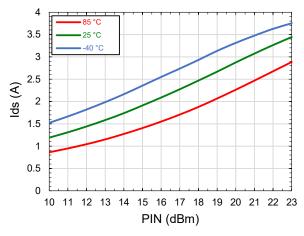
Typical Performance Curves - Drive-Up over Temperature:

 $V_D = 28 \text{ V}$, $I_{DQ} = 300 \text{ mA}$, CW, Frequency = 29 GHz

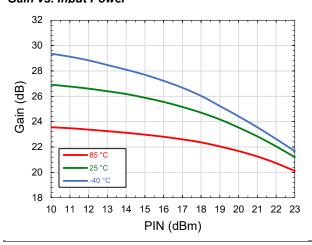
Output Power vs. Input Power



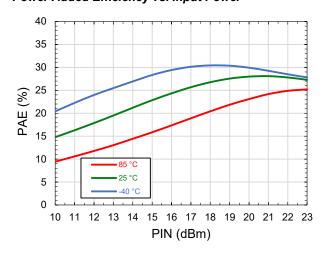
Drain Current vs. Input Power

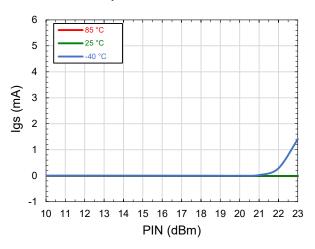


Gain vs. Input Power



Power Added Efficiency vs. Input Power



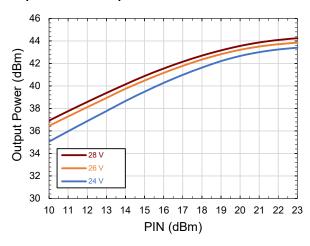




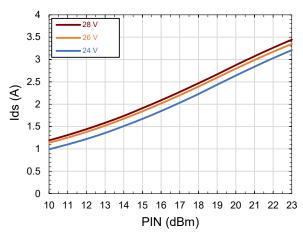
Typical Performance Curves - Drive-Up over V_D:

 I_{DQ} = 300 mA, CW, Frequency = 29 GHz, T_{C} = 25°C

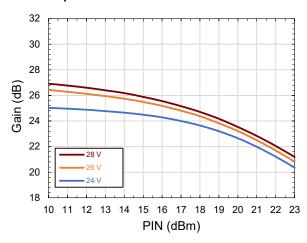
Output Power vs. Input Power



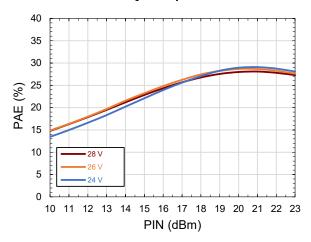
Drain Current vs. Input Power

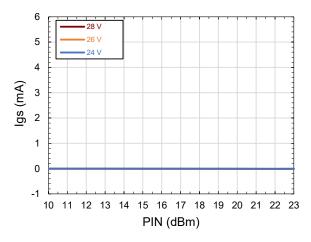


Gain vs. Input Power



Power Added Efficiency vs. Input Power



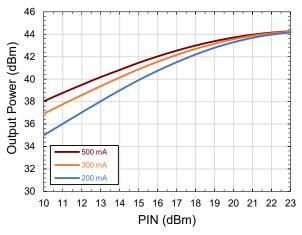




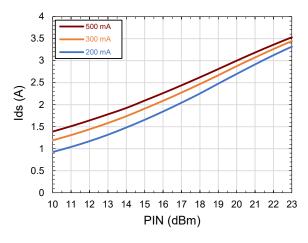
Typical Performance Curves - Drive-Up over IDQ:

 V_D = 28 V, CW, Frequency = 29 GHz, T_C = 25°C

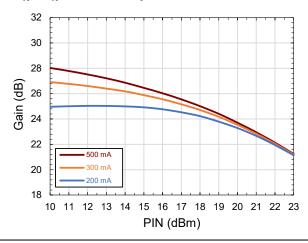
Output Power vs. Input Power



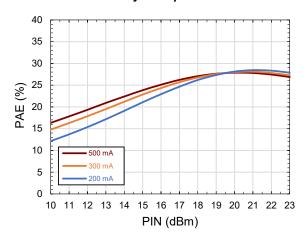
Drain Current vs. Input Power

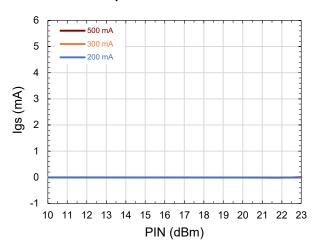


Large Signal Gain vs. Input Power



Power Added Efficiency vs. Input Power



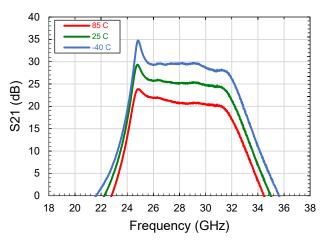




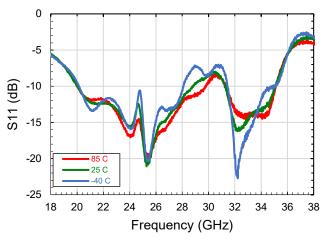
Typical Performance Curves - Small Signal over Temperature and V_D:

 I_{DQ} = 300 mA, CW, P_{IN} = -30 dBm

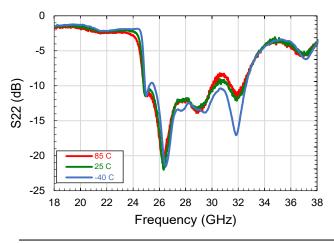
S21 vs. Frequency over Temperature @ V_D = 28 V



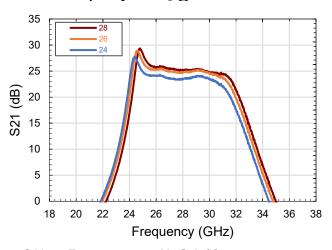
S11 vs. Frequency over Temperature @ V_D = 28 V



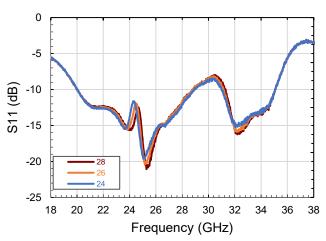
S22 vs. Frequency over Temperature @ V_D = 28 V



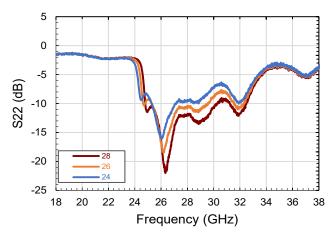
S21 vs. Frequency over V_D @ 25°C



S11 vs. Frequency over V_D @ 25°C



S22 vs. Frequency over V_D @ 25°C



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Small-Signal vs Idq

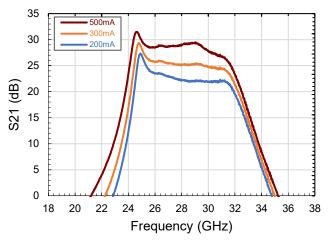
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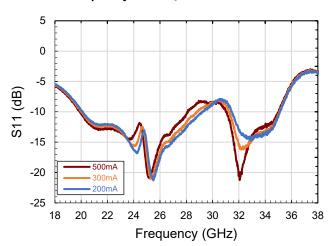
Typical Performance Curves - Small Signal over IDQ:

 $V_D = 28 \text{ V}, \text{ CW}, P_{IN} = -20 \text{ dBm}, T_C = 25^{\circ}\text{C}$

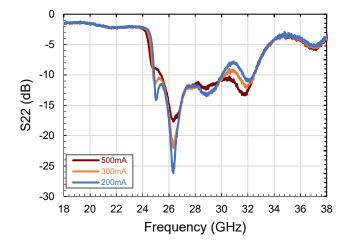
S21 vs. Frequency over IDQ



S11 vs. Frequency over IDQ



S22 vs. Frequency over IDQ

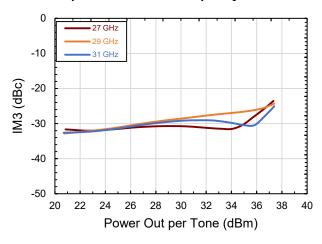




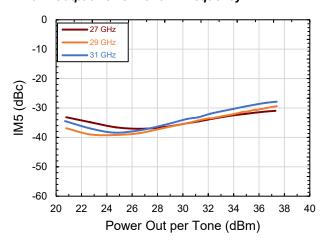
Typical Performance Curves - Linearity (IM3 and IM5)

 V_D = 28 V, I_{DQ} = 300 mA, CW, Frequency = 29 GHz, Tone Spacing = 300 MHz, T_C = 25°C (unless otherwise stated)

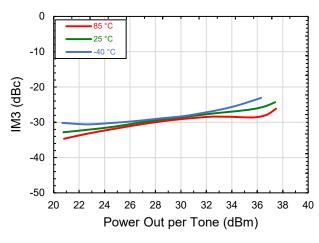
IM3 v. Output Power/Tone v. Frequency



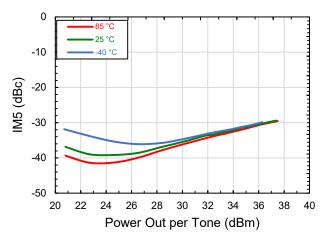
IM5 v. Output Power/Tone v. Frequency



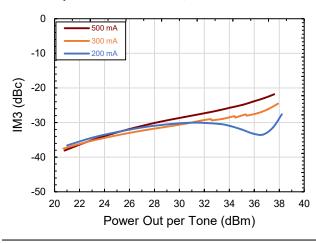
IM3 v. Output Power/Tone v. Temperature



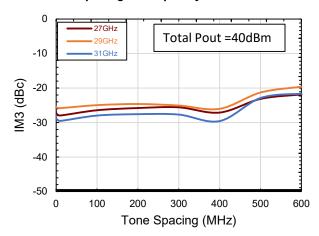
IM5 v. Output Power/Tone v. Temperature



IM3 v. Output Power/Tone v. IDQ



IM3 v. Tone Spacing v. Frequency



GaN High Power Amplifier, 25 W 27 - 31 GHz

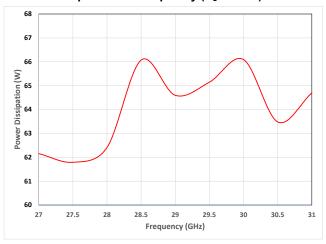


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Thermal Characteristics

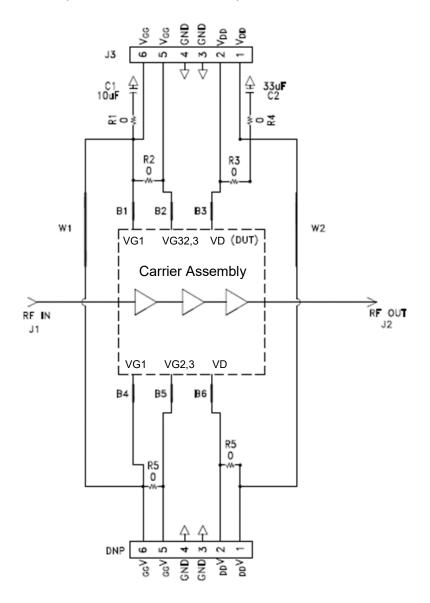
| Parameter | Operating Conditions | Value |
|--|---|----------|
| Operating Junction Temperature (T _J) | Freq = 29 GHz, V _D = 28 V, I _{DQ} = 300 mA, I _{DRIVE} = 3.1 A, | 170°C |
| Thermal Resistance, Junction to Case ($R_{\theta JC}$) | P_{IN} = 24 dBm, P_{OUT} = 43 dBm, P_{DISS} = 65 W, T_{CASE} = 85°C, CW | 1.31°C/W |

Power Dissipation vs. Frequency (T_C = 85°C)





Evaluation Board Schematic (CMPA2H3B025D-AMP)

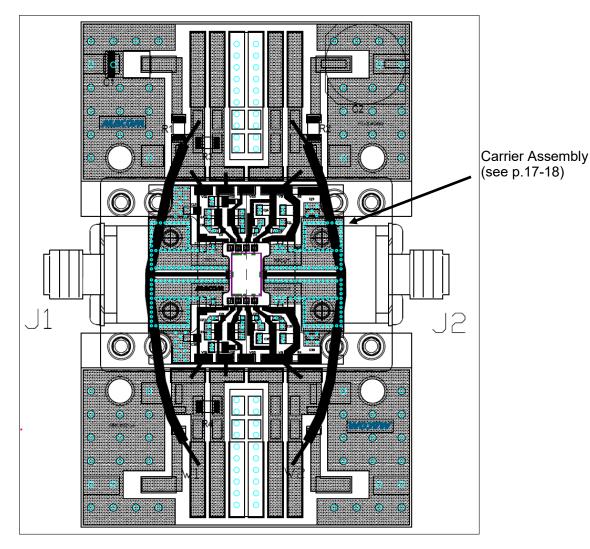


Parts List

| Part | Value | Qty. |
|--------|---|------|
| C1 | 10 μF Tantalum Capacitor | 1 |
| C2 | 33 μF Electrolytic Capacitor | 1 |
| B1-B6 | Jumper Wire | 6 |
| W1, W2 | WIRE, BLACK, 22 AWG (~2") | 2 |
| J1, J2 | SMA Female End Launch RF Connector, .007" Pin, .048" Coax | 2 |
| J3 | 6-Pin DC Header, Right Angle | 1 |
| R1-R6 | 0 Ohm Resistors, 1206 | 6 |



Evaluation Board Assembly Drawing (CMPA2H3B025D-AMP)



Note: Gate and drain should be biased on both sides of the die in order to achieve optimum video bandwidth performance.

Bias On Sequence

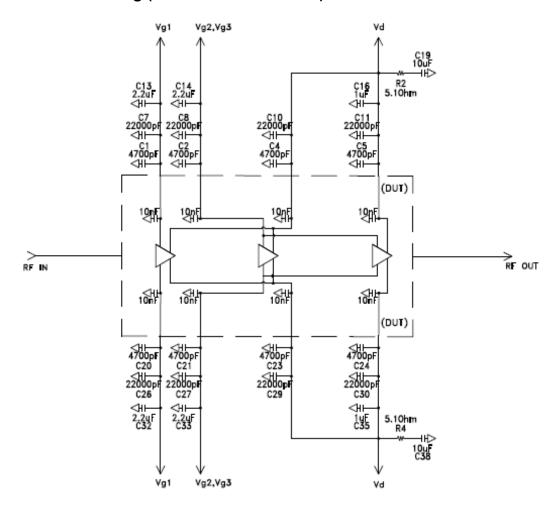
- 1. Ensure RF is turned-off
- 2. Apply pinch-off voltage of -5 V to the gate (V_G)
- 3. Apply nominal drain voltage (V_D)
- Adjust Vg to obtain desired quiescent drain current (I_{DQ})
- 5. Apply RF

Bias Off Sequence

- 1. Turn RF off
- 2. Apply pinch-off to the gate $(V_G = -5 V)$
- 3. Turn off drain voltage (V_D)
- 4. Turn off gate voltage (V_G)



Carrier Schematic Drawing (CMPA2H3B025D-AMP)

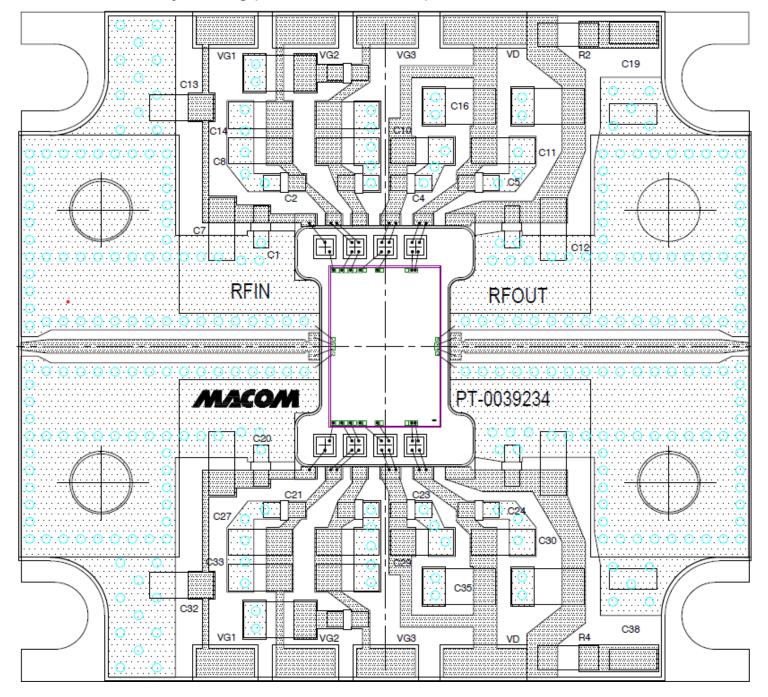


Parts List

| Part | Value | Qty. |
|-------------------------------|---|------|
| C1, 2, 4, 5, 20, 21, 23, 24 | CAPACITOR, 0402, 4700 pF, 50V | 8 |
| C7, 8, 10, 11, 26, 27, 29, 30 | CAPACITOR, 0603, 0.022 μF, 50V | 8 |
| C13, C14, C32, C33 | CAPACITOR, 0603, 2.2 μF, 50V | 4 |
| C19, C38 | CAPACITOR, 1206, 10 μF, 50V | 2 |
| C41-C48 | CAPACITOR, Single Layer 0303, 10 nF, 100V | 8 |
| C16, C35 | CAPACITOR, 0805, 1 μF, 50V | 2 |
| R2, R4 | RESISTOR, 0603, 5.1 Ω | 2 |

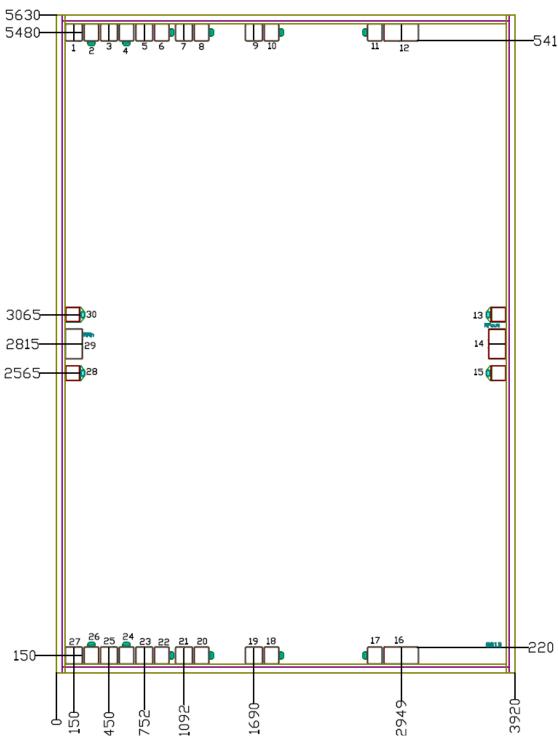


Carrier Assembly Drawing (CMPA2H3B025D-AMP)





Mechanical Information

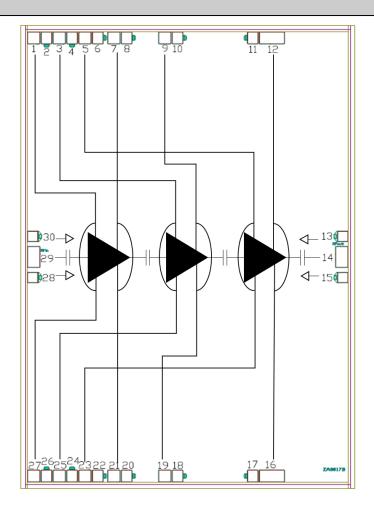


Notes

- 1) Die size: 3920 μm x 5630 μm (+0/-50 μm)
- 2) Die thickness: 75 μm (+/- 10 μm)
- 3) Unless otherwise specified, all dimensions shown are μm with a tolerance of +/- 5 μm .

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Pin Description

| Pin# | Name | Description | Pad Size (µm) |
|---|-------------------|--|---------------|
| 2,4,6,8,10,11,13,15,17, 18,20,22,24,26,28,30 | GND | RF and DC ground. | 120 x 140 |
| 1, 27 | VG1 | Gate bias for stage 1. Both pins must be connected. | 140 x 140 |
| 3, 25 | VG2 | Gate bias for stage 2. Both pins must be connected. | 140 x 140 |
| 5, 23 | VG3 | Gate bias for stage 3. Both pins must be connected. | 140 x 140 |
| 7, 21 | VD1 | Drain bias for stage 1. Both pins must be connected. | 140 x 140 |
| 9, 19 | VD2 | Drain bias for stage 2. Both pins must be connected. | 140 x 140 |
| 12, 16 | VD3 | Drain bias for stage 3. Both pins must be connected. | 140 x 290 |
| 14 | RF _{OUT} | RF Output. 50-ohm matched. Internally DC blocked. | 140 x 240 |
| 29 | RF _{IN} | RF Input. 50-ohm matched. Internally DC blocked. | 140 x 240 |
| MMIC backside | GND | RF and DC ground. | NA |

GaN High Power Amplifier, 25 W 27 - 31 GHz



CMPA2H3B025D Rev. V1

Revision History

| Rev | Date | Change Description |
|-----|-----------|---------------------|
| V1 | 06/242025 | Production release. |
| | | |

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GaN High Power Amplifier, 25 W 27 - 31 GHz



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