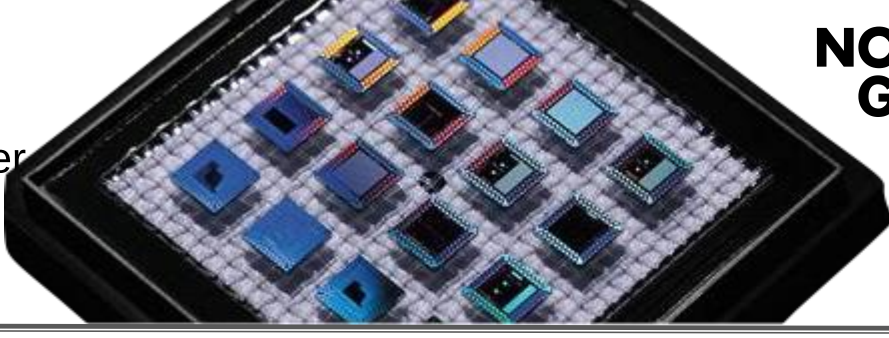
# APN229

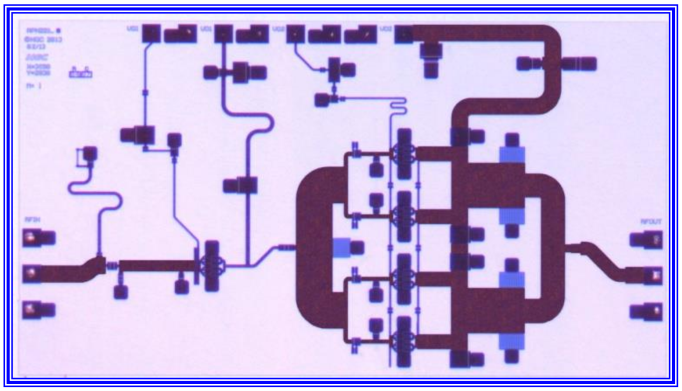
27 – 31 GHz

GaN Power Amplifier



NORTHROP GRUMMAN

Revision 2022-1



**x=3.65mm; y=2.03 mm**

## Product Description

The APN229 monolithic GaN HEMT amplifier is a broadband, two-stage power device, designed for use in SATCOM Terminals and point-to-point digital radios. To ensure rugged and reliable operation, HEMT devices are fully passivated. Both bond pad and backside metallization are Au-based that is compatible with epoxy and eutectic die attach methods.

## Applications

- Point-to-Point Digital Radios
- Point-to-Multipoint Digital Radios
- SATCOM Terminals

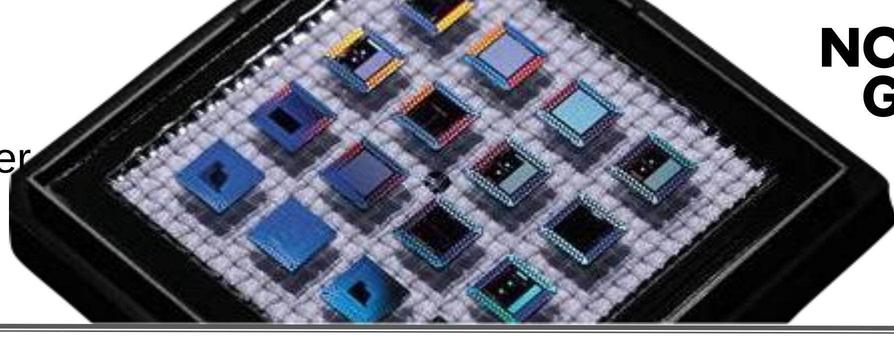
## Product Features

- RF frequency: 27 to 31 GHz
- Linear Gain: 20 dB typ.
- Psat: 39 dBm typ.
- Die Size: 7.41 sq. mm.
- 0.2um GaN HEMT Process
- 4 mil SiC substrate
- DC Power: 28 VDC @ 600 mA

**Export Information**

ECCN: **3A001.b.2.c**

HTS (Schedule B) code: **8542.33.0001**





### Absolute Maximum Ratings

| Parameter | Value | Unit |
|---|---|---|
| Drain Voltage | 28 | V |
| Gate Voltage Range | -8 to 0 | V |
| Drain Current | 750 | mA |
| Gate Current | 0.3 | mA |
| Power Dissipation* | 21 | W |
| Soldering Temperature | 320 | ºC |

*7W/mm of gate periphery

### Recommended Operating Conditions

| Parameter | | Unit |
|---|---|---|
| Drain Voltage Range | 20 - 26 | V |
| Gate Voltage Range | -5 to -3 | V |
| Stg 1 Drain Current (Idq) | 120 | mA |
| Stg 2 Drain Current (Idq) | 120 – 480 | mA |

### Electrical Specifications

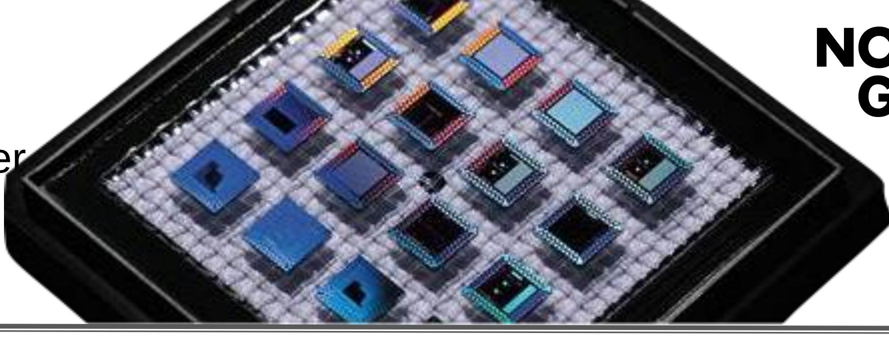
| Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|
| Operational Frequency | 27 | | 30 | GHz |
| **Small Signal at 28V** | | | | |
| Small Signal Linear Gain | 20 | 21.2 | 20.7 | dB |
| Input Return Loss | --30.1 | | -11 | dB |
| Output Return Loss | -30.8 | | -5.5 | dB |
| **On-Wafer Pulsed Power at 28V** | | | | |
| Psat (at 26 dBm) | 37.7 | 38.6 | 39.3 | dBm |
| Power Gain (at 26 dBm) | 11 | 12.6 | 13.3 | dB |
| P1db | 35 | 35.8 | 36.6 | dBm |
| PAE (at 26 dBm) | 24.2 | 29.1 | 31.7 | % |
| Max PAE | 35.7 | 29.9 | 31.7 | % |
| **Fixtured CW at 24V, 25ºC Case Temp** | | | | |
| Psat (at 26 dBm) | 37.4 | 38.1 | 39.3 | dBm |
| Power Gain (at 26 dBm) | 11.5 | 12.2 | 13.4 | dB |
| PAE (at 26 dBm) | 22.2 | 26 | 32.9 | % |
| Max PAE | 24 | 28.3 | 33.8 | % |
| Drain Voltage | | 28 | | V |
| Stage 1 Gate Voltage | | -4.060 | | V |
| Stage 2 Gate Voltage | | -4.125 | | V |
| Stage 1 Idq | | 120 | | mA |
| Stage 2 Idq | | 480 | | mA |



**Web: http://www.yeswegan.com**

Phone: (310) 814-5000 • Fax: (310) 812-7011 • E-mail: as-mps.sales@ngc.com

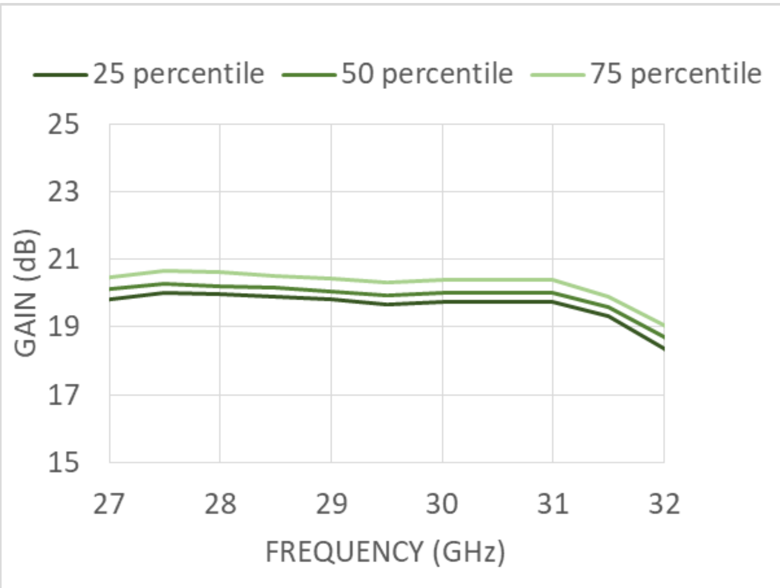
# APN229
27 – 31 GHz
GaN Power Amplifier



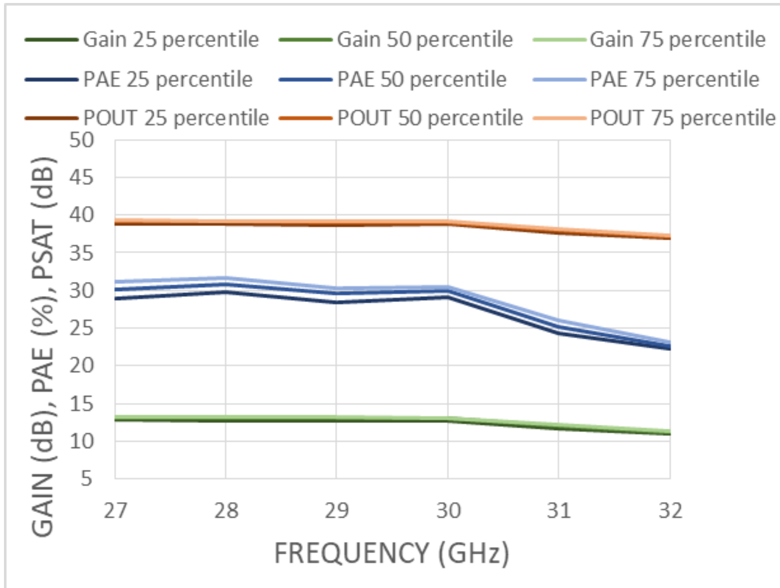
Revision 2022-1

## On wafer measured Performance Characteristics (Typical Performance at 25°C)
## Vd = 28.0 V, Id1 + Id1a = 120mA, Id2 + Id2a =480 mA

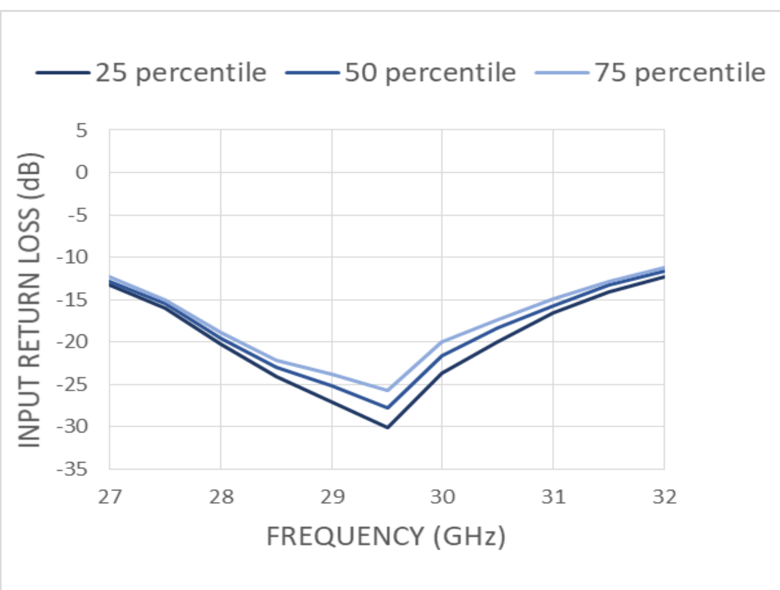
Small Signal GAIN vs. Frequency



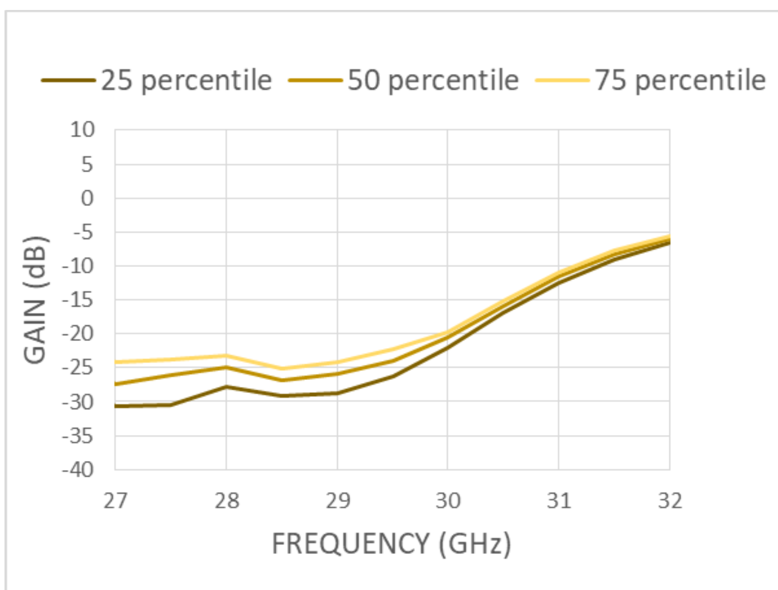

Large Signal PAE, GAIN, PSAT vs. Frequency




Input Return Loss vs. Frequency




Output Return Loss vs. Frequency

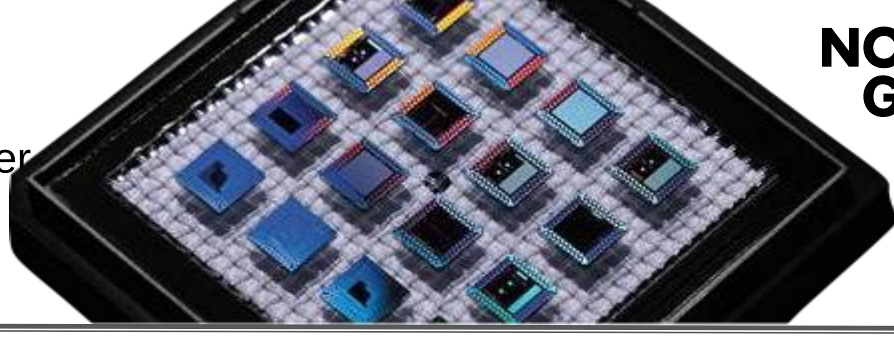





**Web: http://www.yeswegan.com**

Phone: (310) 814-5000 • Fax: (310) 812-7011 • E-mail: as-mps.sales@ngc.com

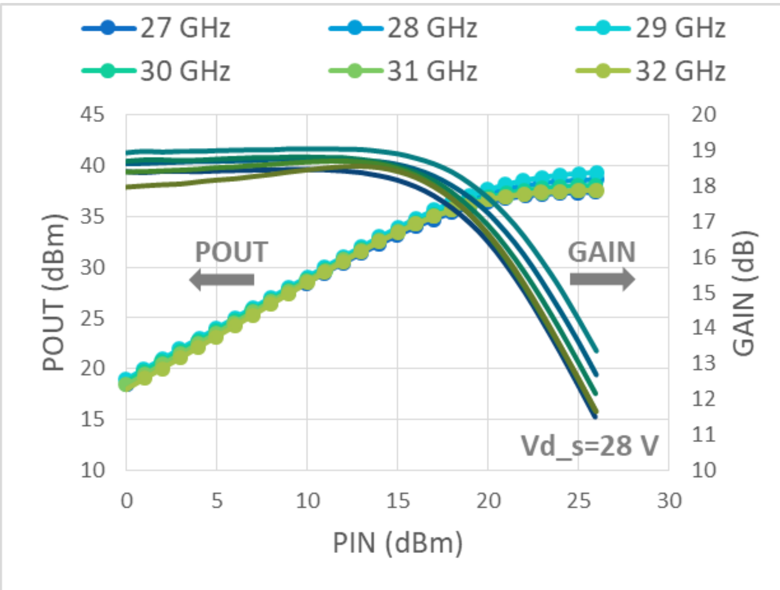
# APN229
27 – 31 GHz
GaN Power Amplifier



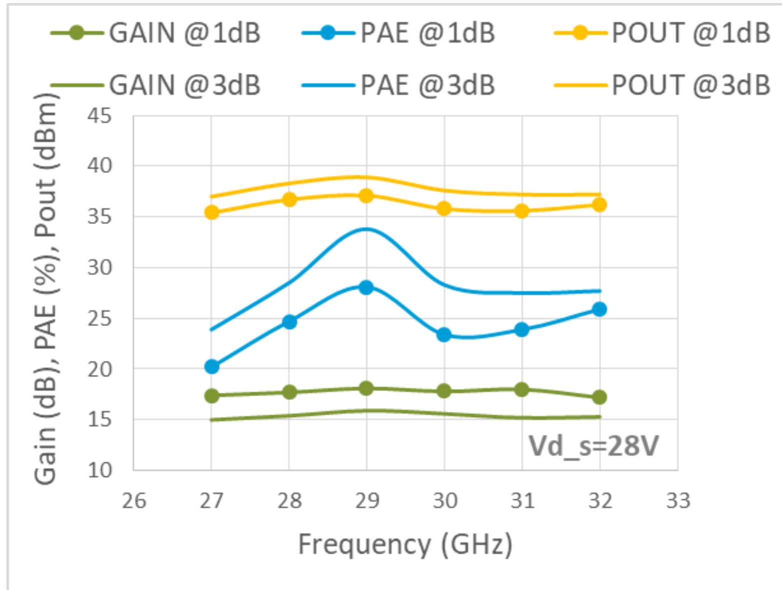
Revision 2022-1

## Fixture measured Performance Characteristics (Typical Performance at 25°C)
## Vd = 28.0 V, Id1 + Id1a =120 mA, Id2 + Id2a = 480 mA

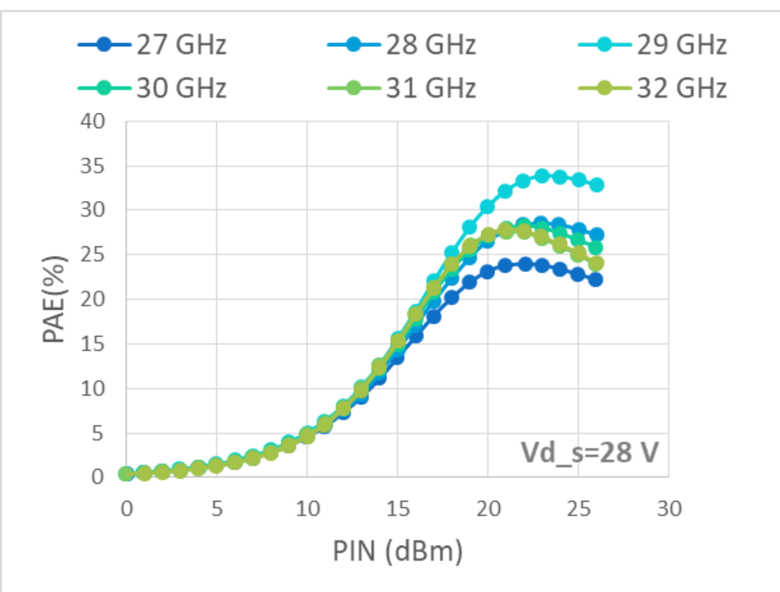
POUT and GAIN vs. PIN



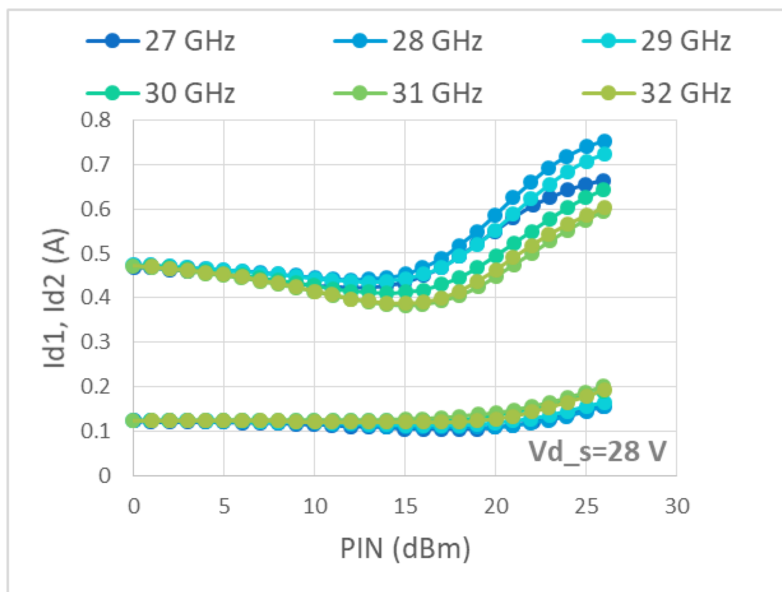

PAE, GAIN, POUT vs. FREQUENCY




PAE vs PIN



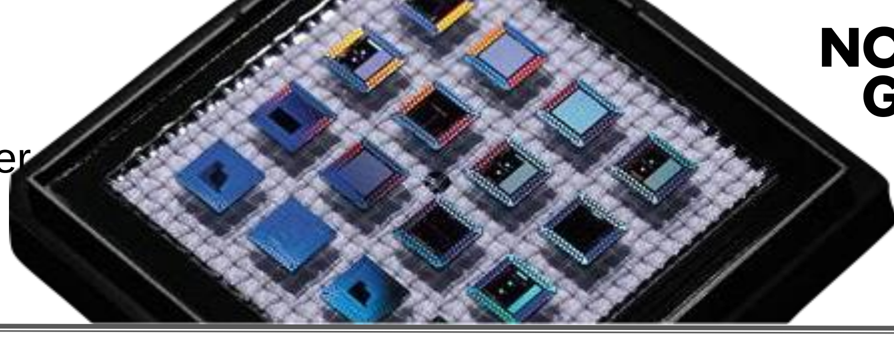

Id1, Id2 vs PIN








Phone: (310) 814-5000 • Fax: (310) 812-7011 • E-mail: as-mps.sales@ngc.com



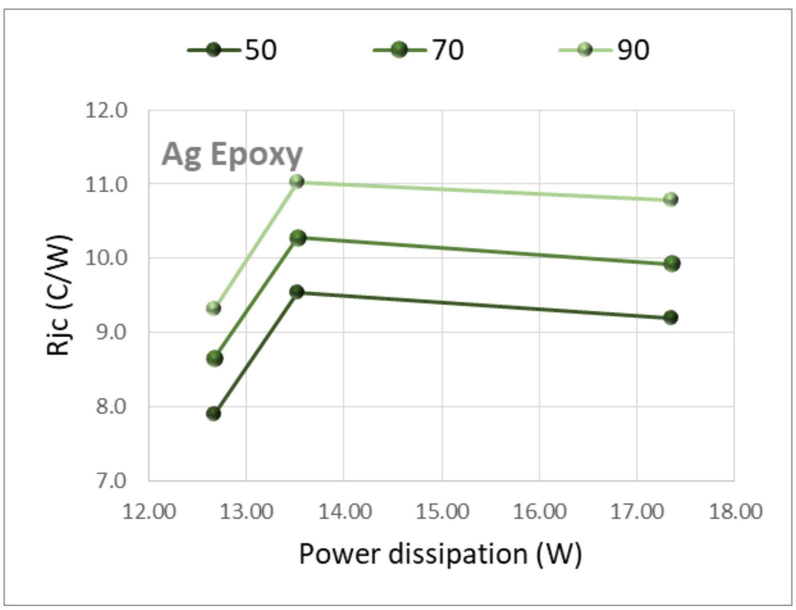
NORTHROP GRUMMAN

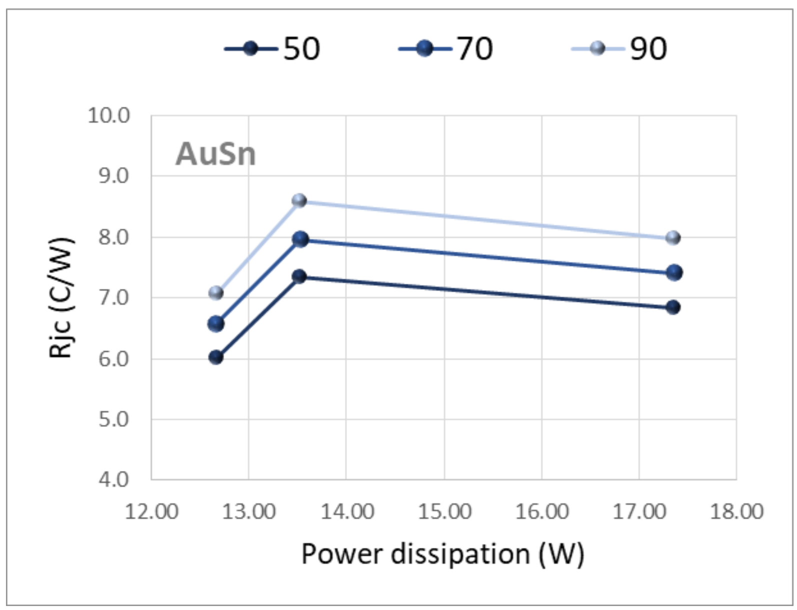
Revision 2022-1

**Preliminary Thermal Properties with die mounted with 25um 80/20 AuSn Eutectic to: 10mil Cu10W Shim.**

** Vd = 28.0 V, Idq1 = 120 mA, Id2q = 480mA

| Shim | Mounting Material | Average Backside Die Temperature | Hottest Junction Temperature Tjc | RF Output | Power Dissipation (W) | Thermal Resistance Rjc (ºC/W) |
|---|---|---|---|---|---|---|
| 10 mil CuW | AuSn Eutectic | 50 ºC | 126.1 | 32.98 | 12.67 | 6.0 |
| | | | 149.2 | 36.4 | 13.52 | 7.3 |
| | | | 168.8 | 39.25 | 17.36 | 6.8 |
| | | 70 ºC | 153.2 | 32.98 | 12.67 | 6.6 |
| | | | 177.6 | 36.4 | 13.52 | 8.0 |
| | | | 198.6 | 39.25 | 17.36 | 7.4 |
| | | 90 ºC | 179.5 | 32.98 | 12.67 | 7.1 |
| | | | 206.1 | 36.4 | 13.52 | 8.6 |
| | | | 228.3 | 39.25 | 17.36 | 8.0 |
| 10 mil CuW | Ag Epoxy | 50 ºC | 149.9 | 32.98 | 12.67 | 7.9 |
| | | | 179.0 | 36.4 | 13.52 | 9.5 |
| | | | 209.4 | 39.25 | 17.36 | 9.2 |
| | | 70 ºC | 179.6 | 32.98 | 12.67 | 8.7 |
| | | | 208.9 | 36.4 | 13.52 | 10.3 |
| | | | 242.2 | 39.25 | 17.36 | 9.9 |
| | | 90 ºC | 239.1 | 33.2 | 12.67 | 9.3 |
| | | | 208.1 | 36.4 | 13.52 | 11.0 |
| | | | 277.1 | 39.25 | 17.36 | 10.8 |



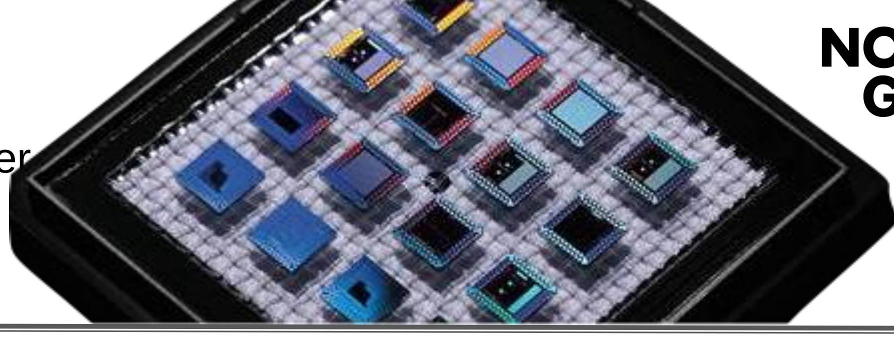








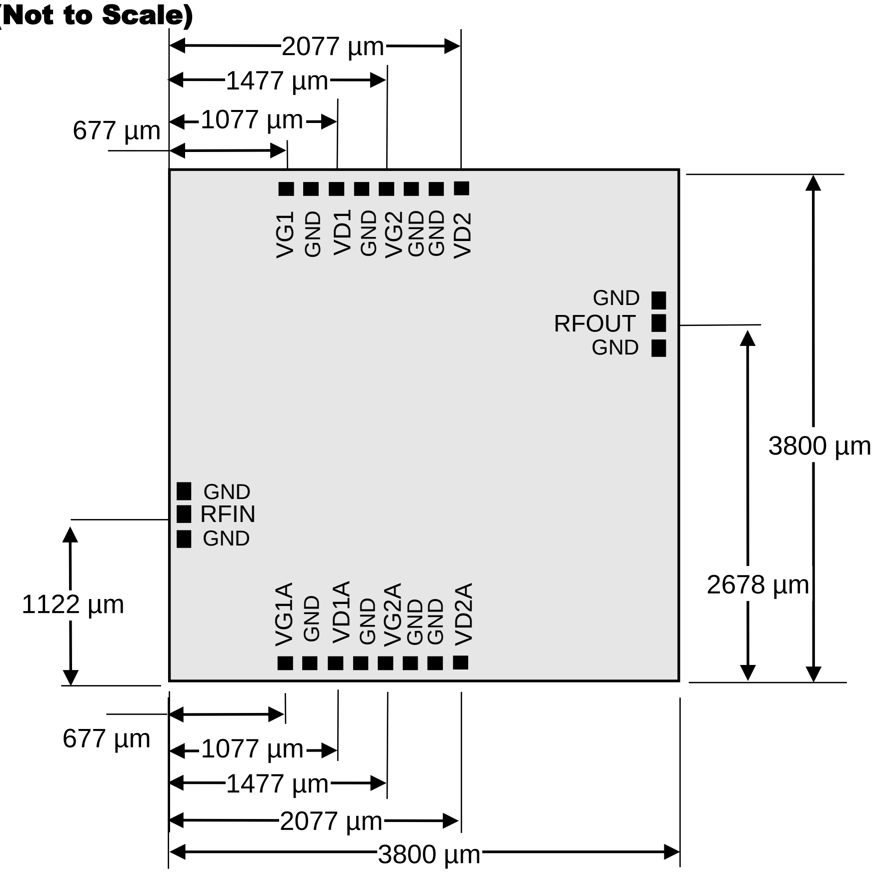
Phone: (310) 814-5000 • Fax: (310) 812-7011 • E-mail: as-mps.sales@ngc.com





### Die Size and Bond Pad Locations (Not to Scale)

X = 3800 µm ± 25 µm
Y = 3800 ± 25 µm
DC Bond Pad = 100 x 100 ± 0.5 µm
RF Bond Pad = 100 x 100 ± 0.5 µm
Chip Thickness = 101 ± 5 µm




### Biasing/De-Biasing Details:

Bias for 1st stage is from top. The 2nd stages must bias up from both sides.

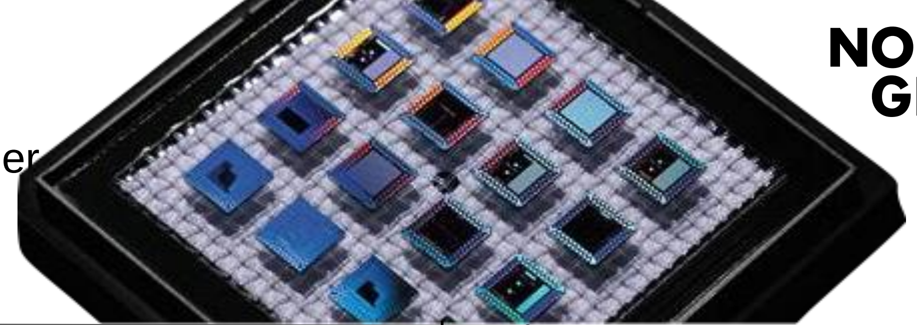
Listed below are some guidelines for GaN device testing and wire bonding:

a. Limit positive gate bias (G-S or G-D) to < 1V
b. Know your devices' breakdown voltages
c. Use a power supply with both voltage and current limit.
d. With the power supply off and the voltage and current levels at minimum, attach the ground lead to your test fixture.
    i. Apply negative gate voltage (-5 V) to ensure that all devices are off
    ii. Ramp up drain bias to ~10 V
    iii. Gradually increase gate bias voltage while monitoring drain current until 20% of the operating current is achieved
    iv. Ramp up drain to operating bias
    v. Gradually increase gate bias voltage while monitoring drain current until the operating current is achieved
e. To safely de-bias GaN devices, start by debiasing output amplifier stages first (if applicable):
    i. Gradually decrease drain bias to 0 V.
    ii. Gradually decrease gate bias to 0 V.
    iii. Turn off supply voltages
f. Repeat de-bias procedure for each amplifier stage



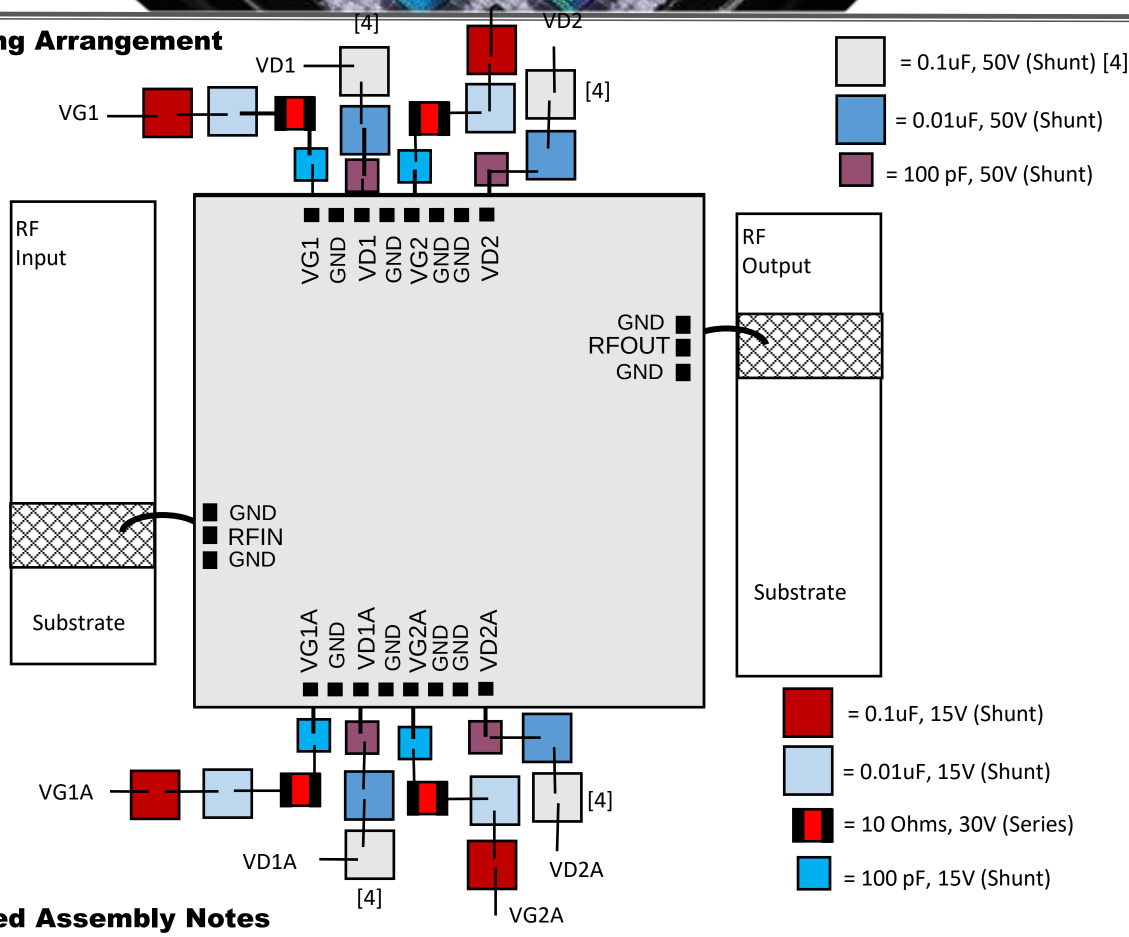


Phone: (310) 814-5000 • Fax: (310) 812-7011 • E-mail: as-mps.sales@ngc.com





### Suggested Bonding Arrangement




### Recommended Assembly Notes

1. Bypass caps should be 100 pF (approximately) ceramic (single-layer) placed no farther than 30 mils from the amplifier.
2. Best performance obtained from use of <10 mil (long) by 3 by 0.5 mil ribbons on input and output.
3. Part must be biased from both sides as indicated.
4. The 0.1uF, 50V capacitors are not needed if the drain supply line is clean. If Drain Pulsing of the device is to be used, do **NOT** use the 0.1uF , 50V Capacitors.

### Mounting Processes

Most NGSS GaN IC chips have a gold backing and can be mounted successfully using either a conductive epoxy or AuSn attachment. NGSS recommends the use of AuSn for high power devices to provide a good thermal path and a good RF path to ground. Maximum recommended temp during die attach is 320ºC for 30 seconds.

**Note**: Many of the NGSS parts do incorporate airbridges, so caution should be used when determining the pick up tool.

**CAUTION**: THE IMPROPER USE OF AuSn ATTACHMENT CAN CATASTROPHICALLY DAMAGE GaN CHIPS.



**Web: http://www.yeswegan.com**

Phone: (310) 814-5000 • Fax: (310) 812-7011 • E-mail: as-mps.sales@ngc.com