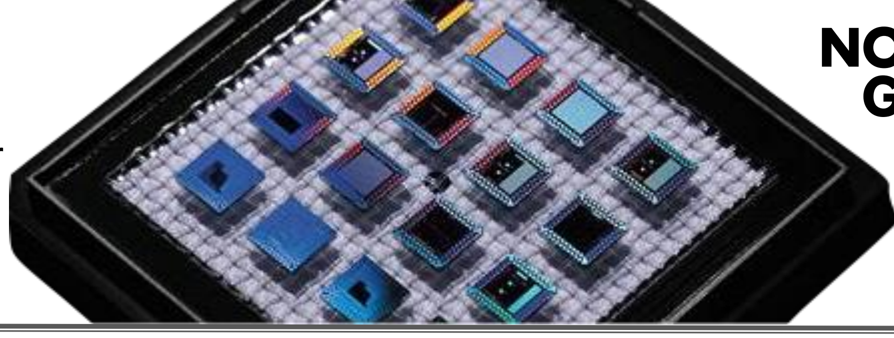
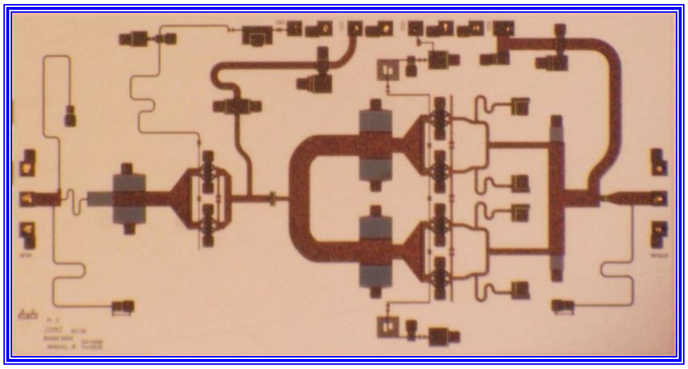
APN149

18–23 GHz

GaN Power Amplifier



Revision 2022-1



X = 4.4 mm Y = 2.28 mm

Product Description

The APN149 monolithic GaN HEMT amplifier is a broadband, two-stage power device, designed for use in Point-to-Point and Multipoint Digital Radios, Military SatCom and Radar Applications. 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

- Military SatCom
- Phased-Array Radar Applications
- Point-to-Point Radio
- Point-to-Multipoint Communications
- Terminal Amplifiers

Product Features

- RF frequency: 18 to 23 GHz
- Linear Gain: 20 dB typ.
- Psat: 38 dBm typ.
- Efficiency @ P3dB > 30 %
- Die Size: < 10.032 sq. mm.
- 0.2um GaN HEMT
- 4 mil SiC substrate
- DC Power: 28 VDC @ 544 mA

Export Information

ECCN: **3A611.x**

HTS (Schedule B) code: **8542.33.0000**

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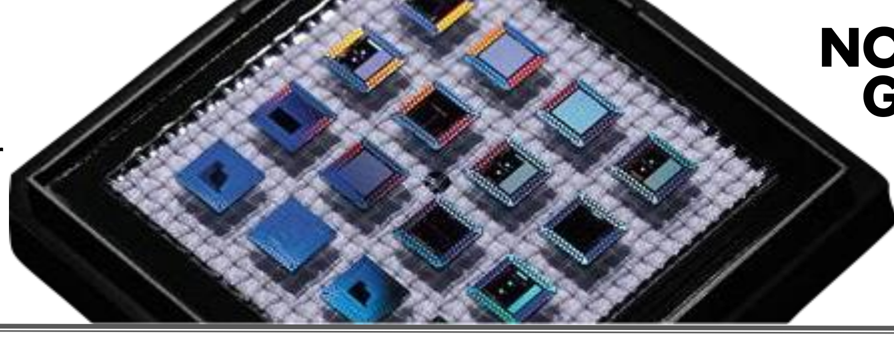

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Absolute Maximum Ratings

Parameter	Value	Unit
Drain Voltage	28	V
Gate Voltage Range	-8 to 0	V
Drain Current	700	mA
Gate Current	0.3	mA
Soldering Temperature	320	ºC

Recommended Operating Conditions

Parameter	Value	Unit
Drain Voltage Range	20 - 28	V
Gate Voltage Range	-5 to -3	V
Stg 1 Drain Current (Idq)	144	mA
Stg 2 Drain Current (Idq)	400	mA

Electrical Specifications

Parameter	Min	Typ	Max	Unit
Operational Frequency	18		23	GHz
Small Signal at 28V				
Small Signal Linear Gain	19	22	23.3	dB
Input Return Loss	-30		-4.2	dB
Output Return Loss	-26		-7.5	dB
On-Wafer Pulsed Power at 28V				
Psat (at 25 dBm)	37	38.6	40.3	dBm
Power Gain (at 25 dBm)	12	13.6	15.3	dB
P1db	32.5	33	34.2	dBm
PAE (at 25 dBm)	18	27	35	%
Max PAE	18.8	28.5	35.3	%
Fixtured CW at 28V, 25ºC Case Temp				
Psat (at 25 dBm)	38.4	39.1	39.5	dBm
Power Gain (at 25 dBm)	19.5	21.8	23.3	dB
PAE (at 25 dBm)	22	25.8	30	%
Max PAE	28.7	32	34	%
Drain Voltage		28		V
Stage 1 Gate Voltage		-4.220		V
Stage 2 Gate Voltage		-4.230		V
Stage 1 Idq		144		mA
Stage 2 Idq		400		mA

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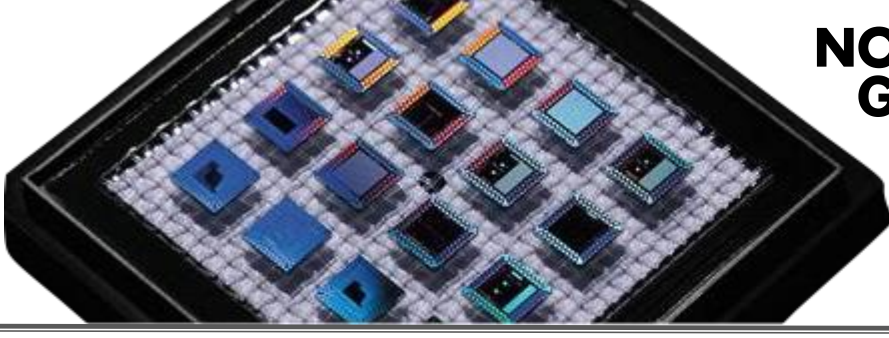
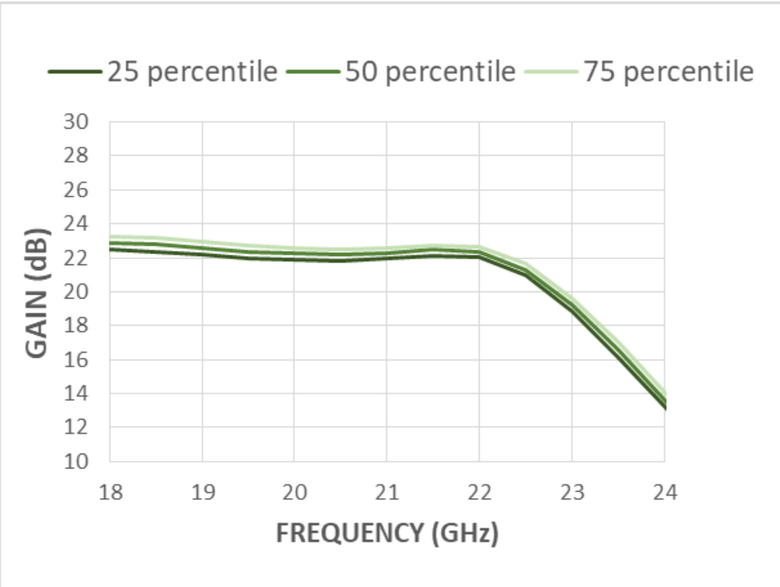
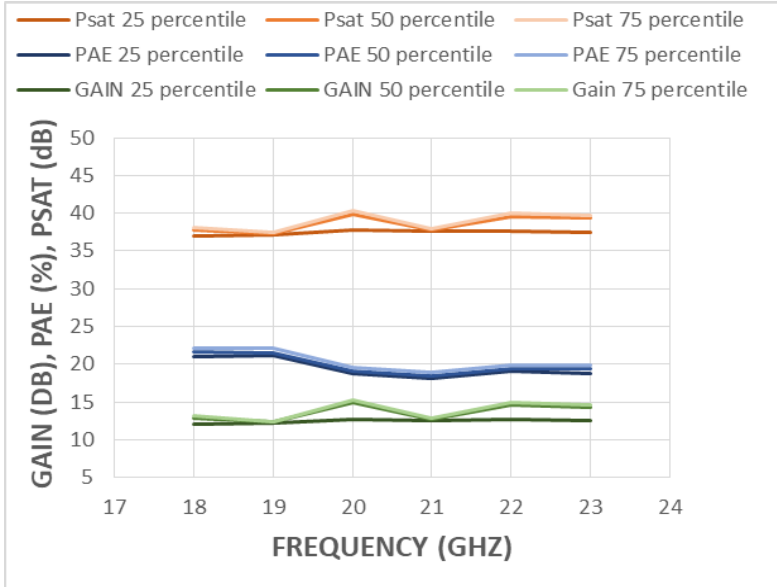


On wafer measured Performance Characteristics (Typical Performance at 25°C) Vd = 28 V, Id1 = 140 mA, Id2 = 400 mA. *

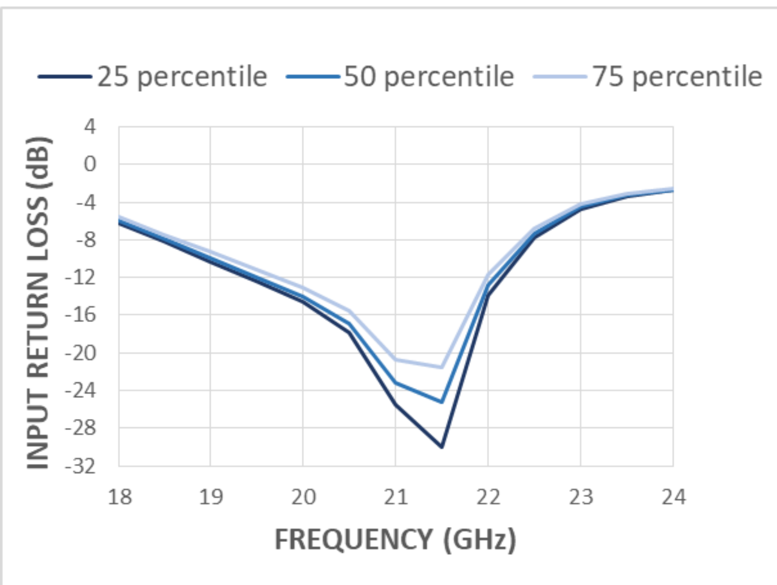
Small Signal GAIN vs. Frequency



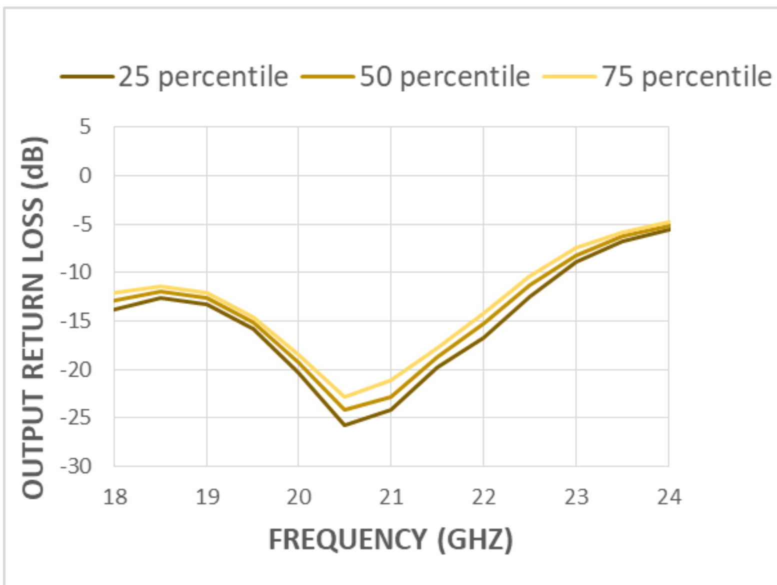
Large Signal PAE, GAIN, Pout vs. Frequency



Input Return Loss vs. Frequency



Output Return Loss vs. Frequency



*Pulsed-power on-wafer

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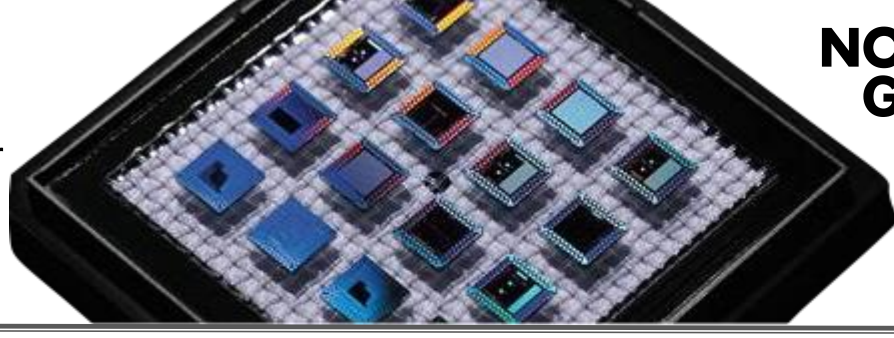
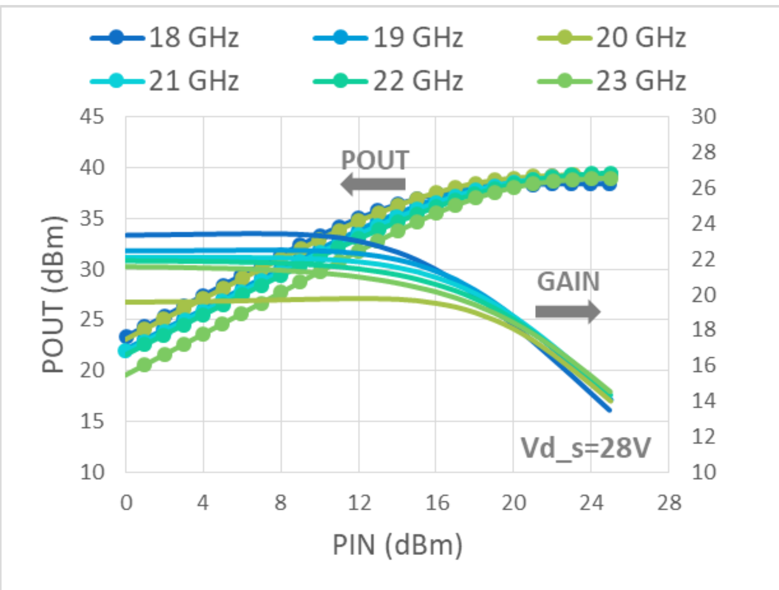
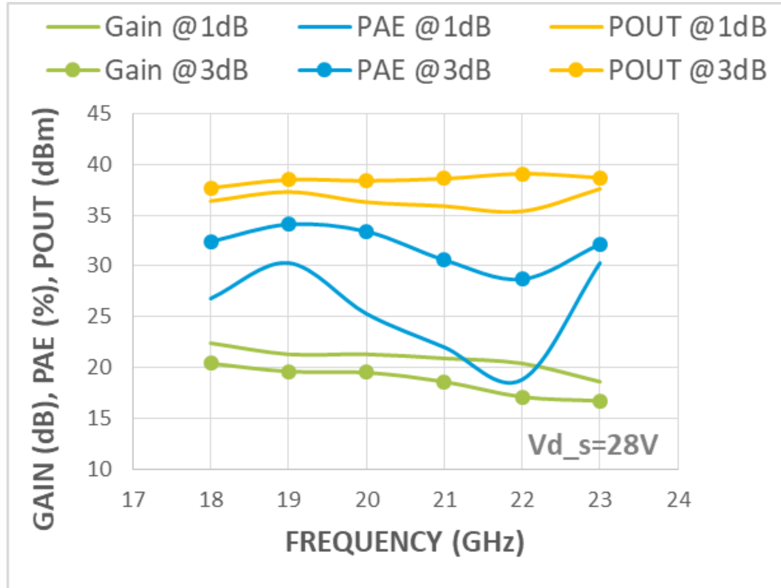


Fixture measured Performance Characteristics (Typical Performance at 25°C)
Vd = 28.0 V, Id1 = 144 mA, Id2 = 400 mA

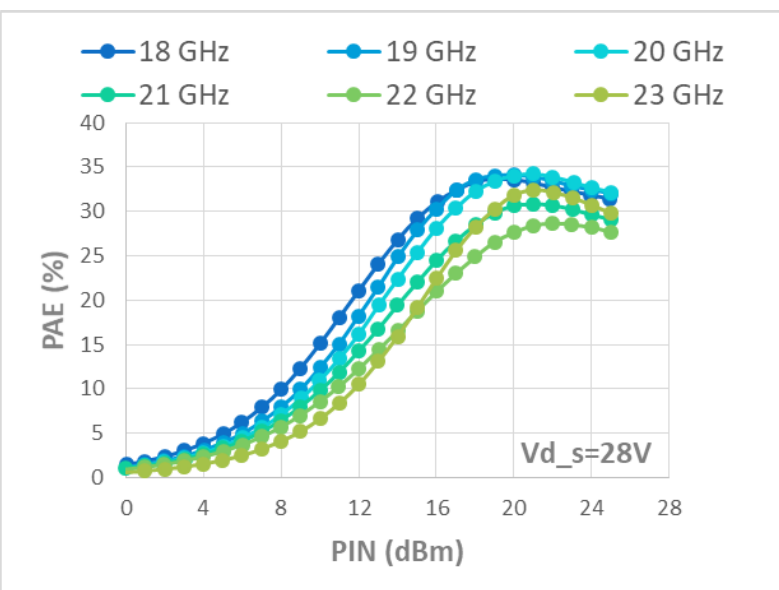
POUT and GAIN vs. PIN



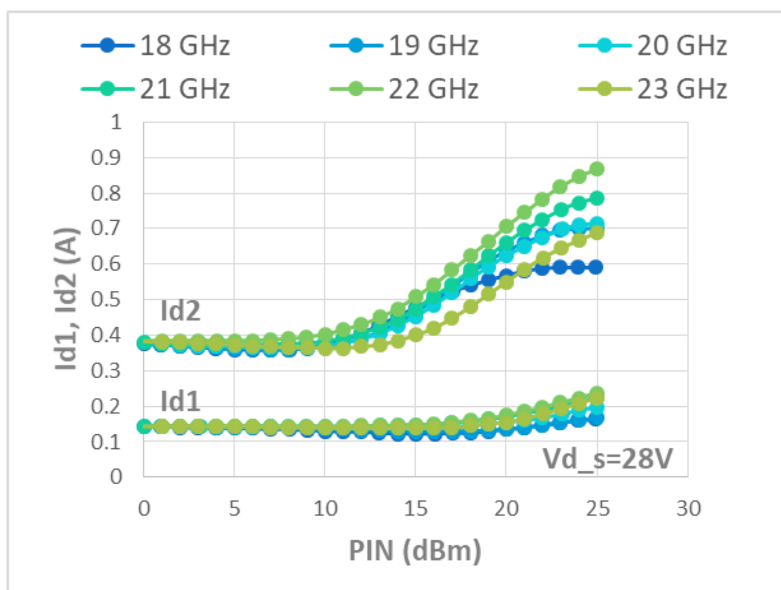
PAE, GAIN, POUT vs. FREQUENCY



PAE vs PIN



Id1, Id2 vs PIN



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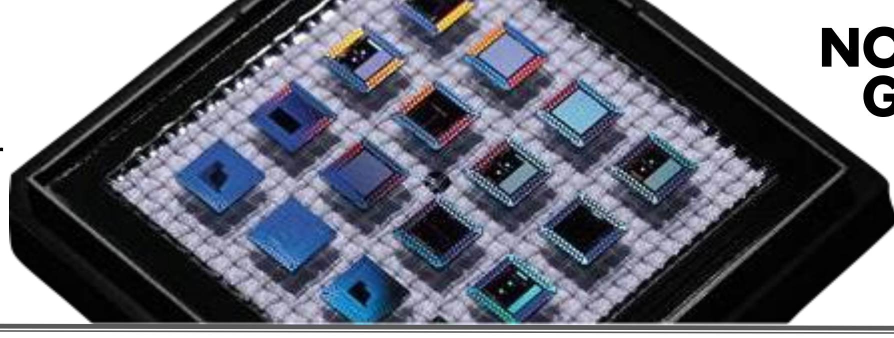

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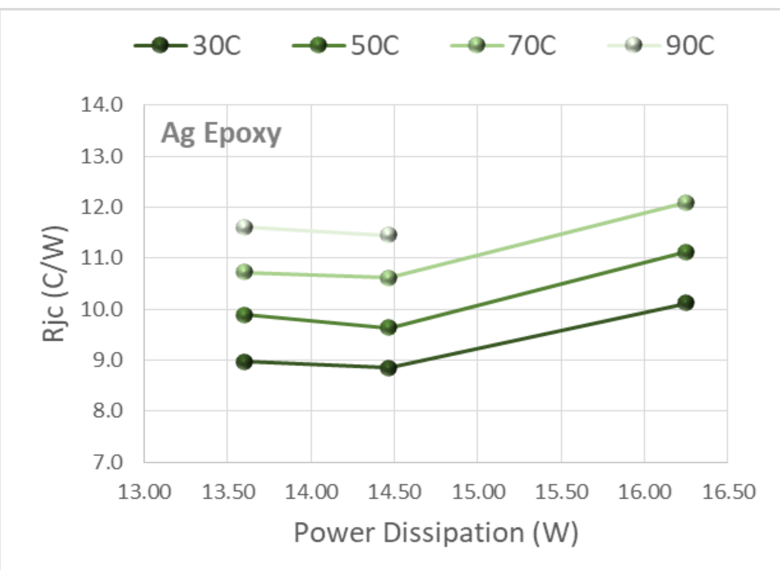
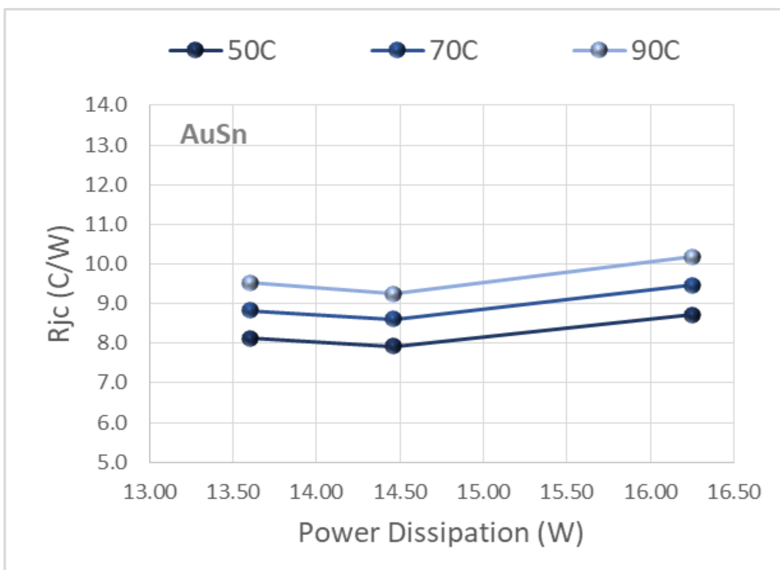
Preliminary Thermal Properties with die mounted with 25um 80/20 AuSn Eutectic to: 10mil Cu10W Shim.

** Vd = 28.0 V, Idq1 = 143 mA, Id2q = 375mA

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	161	33.2	13.6	8.1
			164	36.4	14.5	7.9
			192	39.1	16.3	8.7
		70 ºC	190	33.2	13.6	8.8
			194	36.4	14.5	8.6
			224	39.1	16.3	9.5
		90 ºC	220	33.2	13.6	9.5
			224	36.4	14.5	9.2
			255	39.1	16.3	10.2
10 mil CuW	Ag Epoxy	30 ºC	152	33.2	13.6	9
			158	36.4	14.5	8.8
			194	39.1	16.3	10.1
		50 ºC	184	33.2	13.6	9.9
			189	36.4	14.5	9.6
			231	39.1	16.3	11.1
		70 ºC	216	33.2	13.6	10.7
			223	36.4	14.5	10.6
			266	39.1	16.3	12.1
		90 ºC	248	33.2	13.6	11.6
			257	36.4	14.5	11.5





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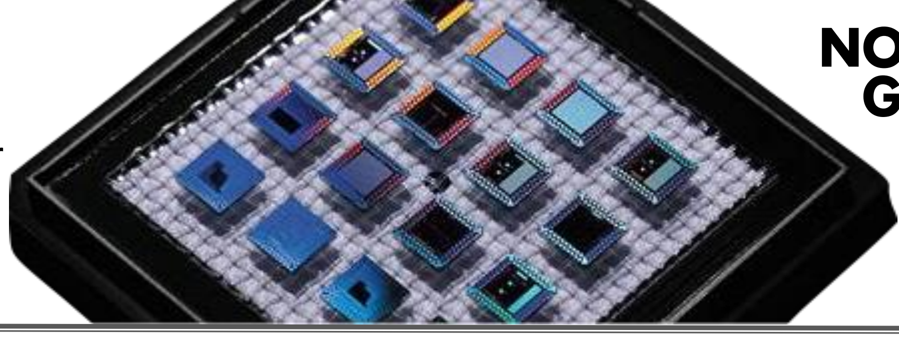
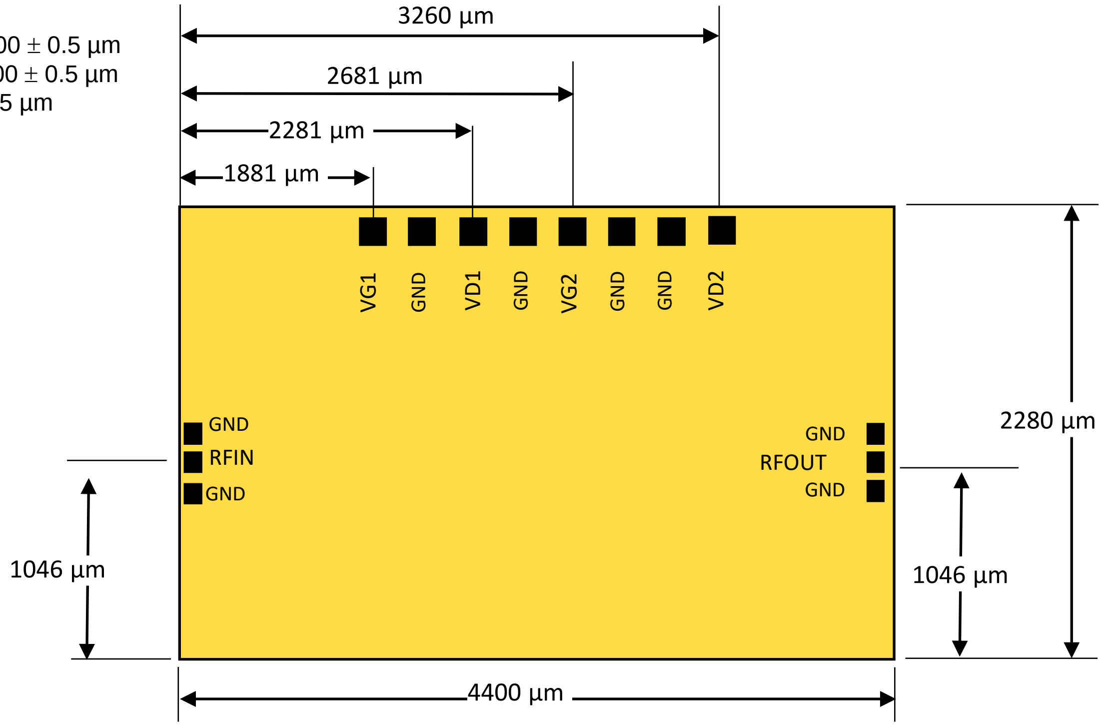


Die Size and Bond Pad Locations (Not to Scale)

X = 4400 µm ± 25 µm
Y = 2280 ± 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

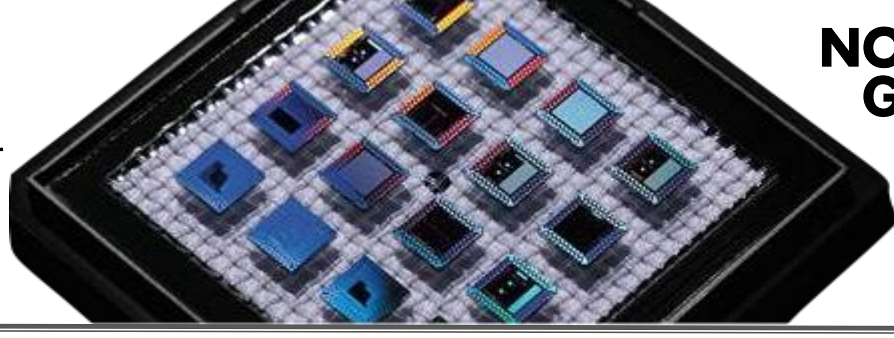


Biasing/De-Biasing Details:

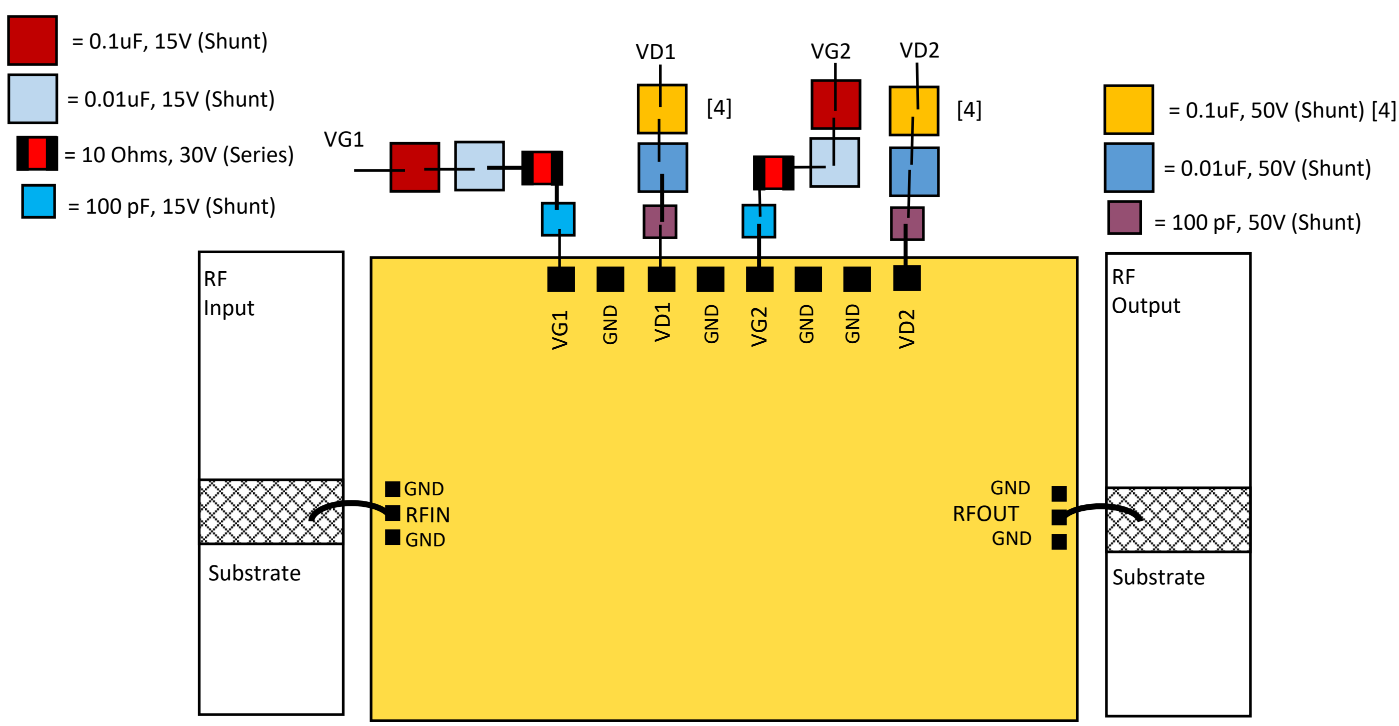
Bias for 1st stage is from top. The 2nd stages must bias up from both sides.

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



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.

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