NPA2001-DE

26.5 – 29.5 GHz GaN 35 W Power Amplifier

Product Description

The Nxbeam NPA2001-DE is a Ka-band high power amplifier MMIC fabricated in 0.2um GaN HEMT on SiC. The MMIC operates from 26.5 to 29.5 GHz and provides 35 W saturated output power, 31% PAE, and 25 dB of linear gain. The NPA2001-DE comes in die form with RF input and output matched to 50 Ω with DC blocking capacitors for easy system integration. The HEMT devices are fully passivated for reliable operation. Bond pad and backside metallization are Au-based for compatibility with eutectic die attachment methods.

Applications

- 5G mmWave (n257)
- Ka-band Satellite Communications
- Point-to-Point/Multipoint Digital Radios

Key Features

- Frequency: 26.5 – 29.5 GHz
- Linear Gain: 25 dB
- Psat: 35 W
- PAE: 31%
- Chip Dimensions: 5.0 x 4.0 x 0.1 mm

Electrical Specifications

Test Condition: Vd = 24 V , Idq = 2.18 A, CW Performance in Fixture, Typical Performance at 25°C

Parameter		Min	Typical	Max	Unit
Frequency		26.5		29.5	GHz
Gain (Small Signal)	27 GHz		25		dB
	28 GHz		25		
	29 GHz		25		
Output Power (at Psat, Pin=26 dBm)	27 GHz		45.6		dBm
	28 GHz		45.4		
	29 GHz		45.4		
PAE (at Psat, Pin=26 dBm)	27 GHz		32.5		%
	28 GHz		31.4		
	29 GHz		31.0		
Power Gain (at Psat, Pin=26 dBm)	27 GHz		20.5		dB
	28 GHz		20.3		
	29 GHz		19.7		
Input Return Loss	27 GHz		20		dB
	28 GHz		12		
	29 GHz		15		
Output Return Loss	27 GHz		14		dB
	28 GHz		14		
	29 GHz		13		

Maximum Quiescent Bias

Parameter	Max	Unit
Drain Voltage (Vd1, Vd2, Vd3)	28	V
Drain Current (Id1)	264	mA
Drain Current (Id2)	640	mA
Drain Current (Id3)	2560	mA

Maximum quiescent bias represents the operational bias used during reliability life testing. Biasing the part at or below this bias ensures reliability will be bound by the published reliability results.

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Absolute Maximum Ratings (Temp. = 25°C)

Parameter	Min	Max	Unit
Drain Voltage (Vd1, Vd2, Vd3)		28	V
Drain Current (Id1)		660	mA
Drain Current (Id2)		1600	mA
Drain Current (Id3)		6400	mA
Gate Voltage (Vg1, Vg2, Vg3)	-8	0	V

Absolute maximum ratings represent the maximum current under power saturation conditions.

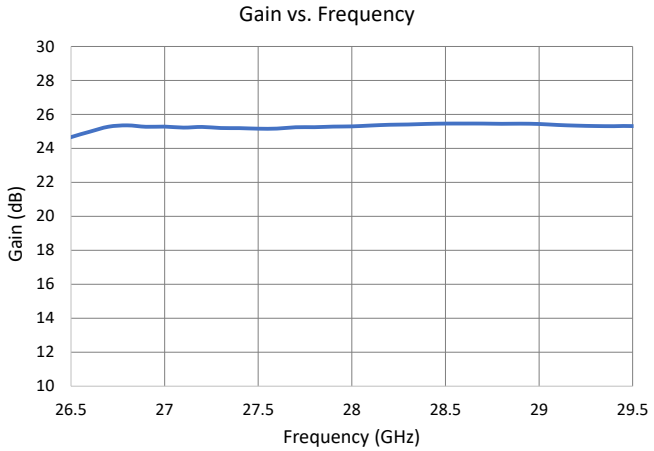
Recommended Quiescent Operating Condition

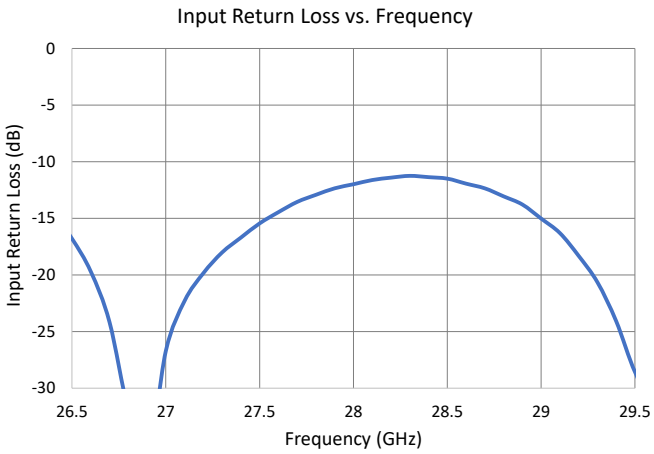
Parameter	Value	Unit
Drain Voltage (Vd)	20 - 28	V
Drain Current (Id1)	up to 264	mA
Drain Current (Id2)	up to 640	mA
Drain Current (Id3)	up to 2560	mA
Gate Voltage (Vg) (Typical Range)	-4	V

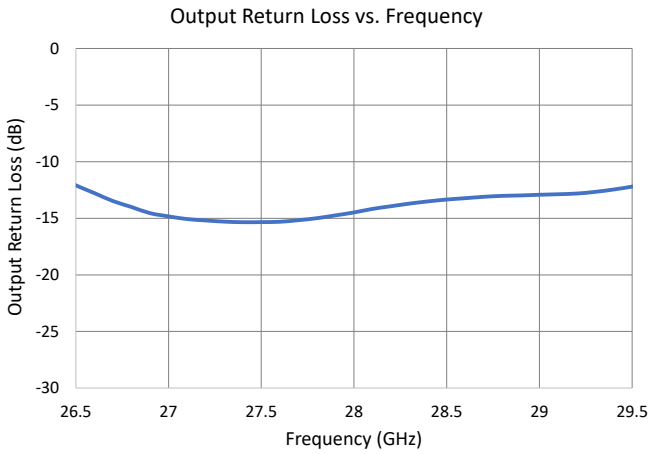
Gate voltage will vary based on desired current per stage

Small Signal Performance

Test Condition: Vd = 24 V, Idq = 2.18 A, (CW Performance in Fixture, Typical Performance at 25°C)







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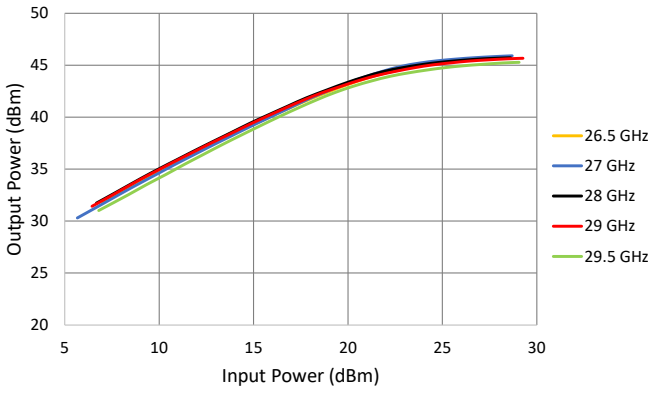
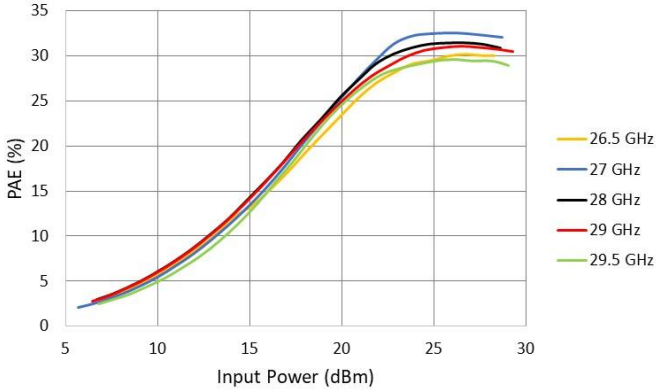
Large Signal Performance

Test Condition: Vd = 24 V, Idq = 2.18 A,
(CW Performance in Fixture, Typical Performance at 25°C)

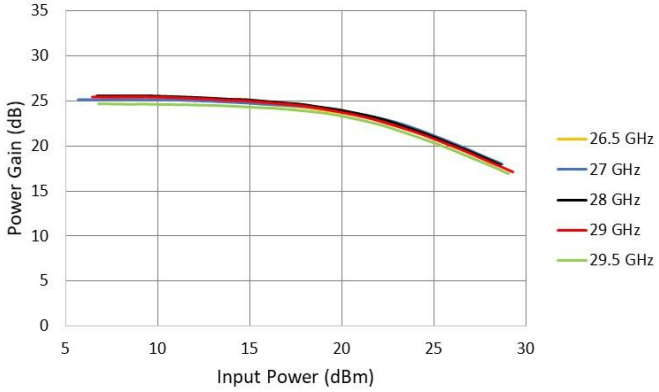
Output Power vs. Input Power vs. Frequency



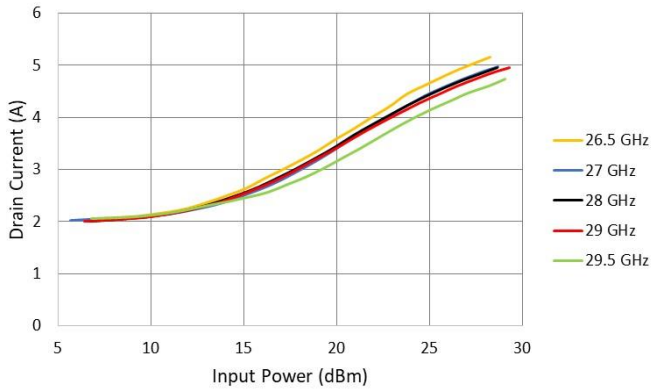
PAE vs. Input Power vs. Frequency



Power Gain vs. Input Power vs. Frequency



Drain Current vs. Input Power vs. Frequency



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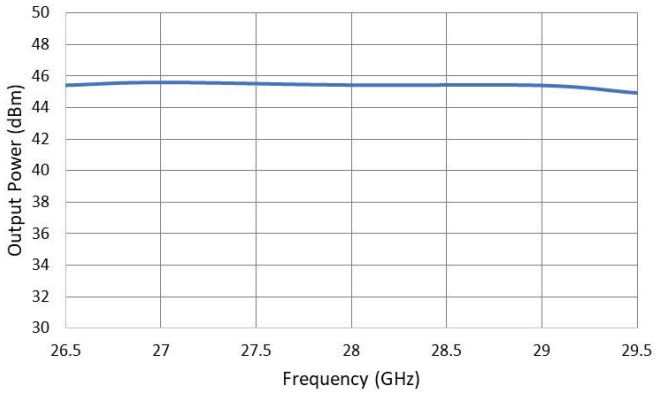
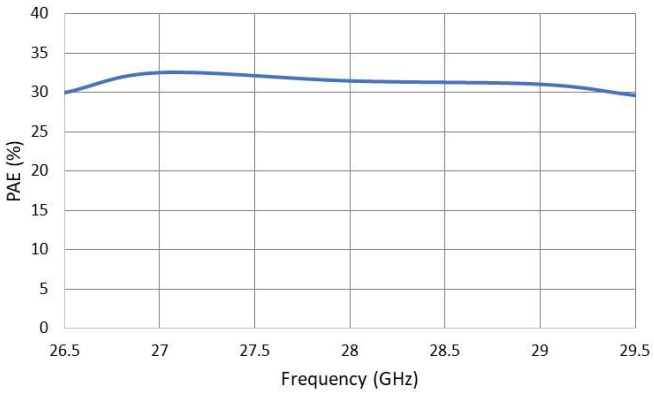
Large Signal Performance

Test Condition: Vd = 24 V, Idq = 2.18 A, Pin = 26 dBm (Psat)
(CW Performance in Fixture, Typical Performance at 25°C)

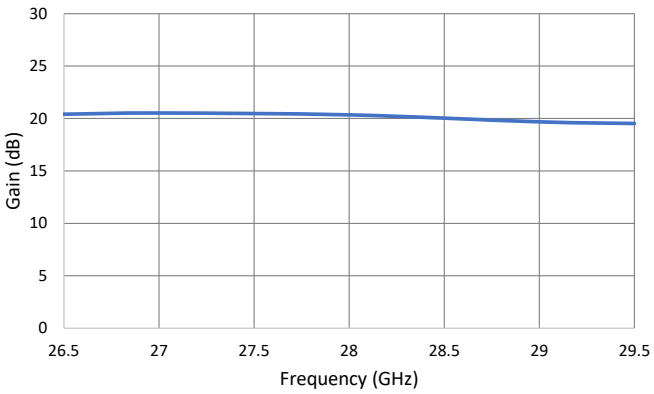
Output Power vs. Frequency (at 26 dBm Pin)



PAE vs. Frequency (at 26 dBm Pin)



Gain vs. Frequency (at 26 dBm Pin)



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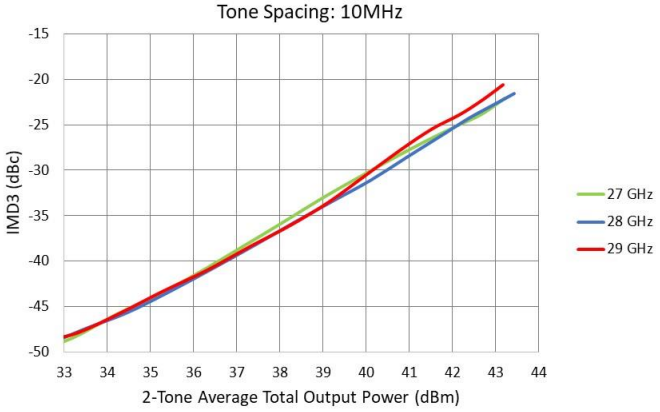
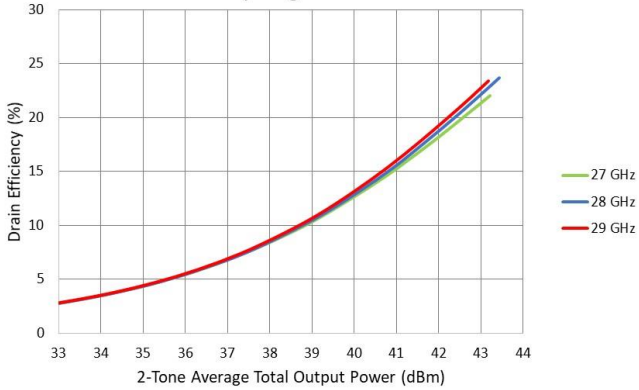
2-Tone Linearity Performance

CW Performance in Fixture, Typical Performance at 25°C,
Bias as Listed in Figure

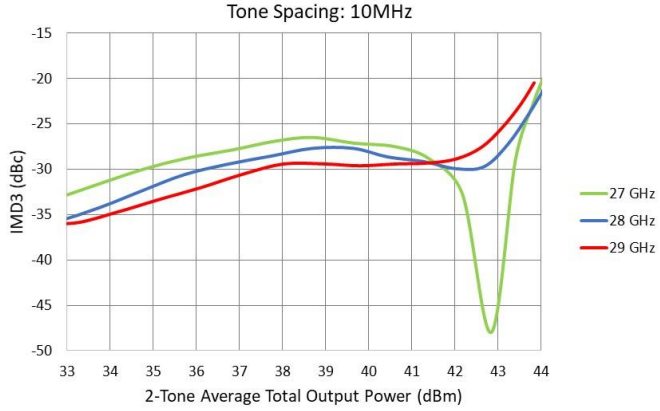
IMD3 vs. 2-Tone Output Power vs. Frequency
Vd = 26 V, Idq= 2.75 A (Vg1=Vg2=Vg3)
Tone Spacing: 10MHz



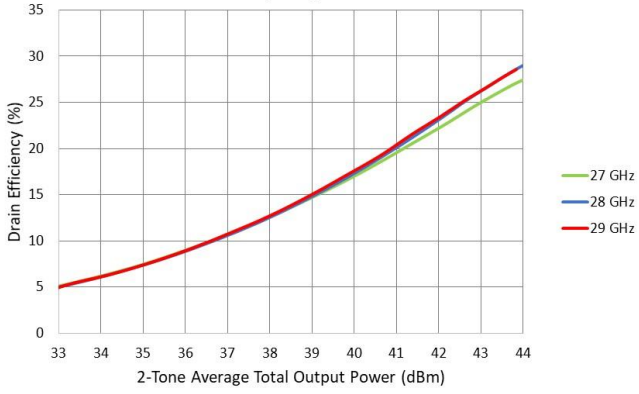
Drain Efficiency vs. 2-Tone Output Power vs. Frequency
Vd = 26 V, Idq= 2.75 A (Vg1=Vg2=Vg3)
Tone Spacing: 10MHz



IMD3 vs. 2-Tone Output Power vs. Frequency
Vd = 26 V, Idq= 1.3 A (Id1= 260mA, Id2=80mA, Id3=930mA)
Tone Spacing: 10MHz



Drain Efficiency vs. 2-Tone Output Power vs. Frequency
Vd = 26 V, Idq= v1.3 A (Id1= 260mA, Id2=80mA, Id3=930mA)
Tone Spacing: 10MHz



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Thermal Information

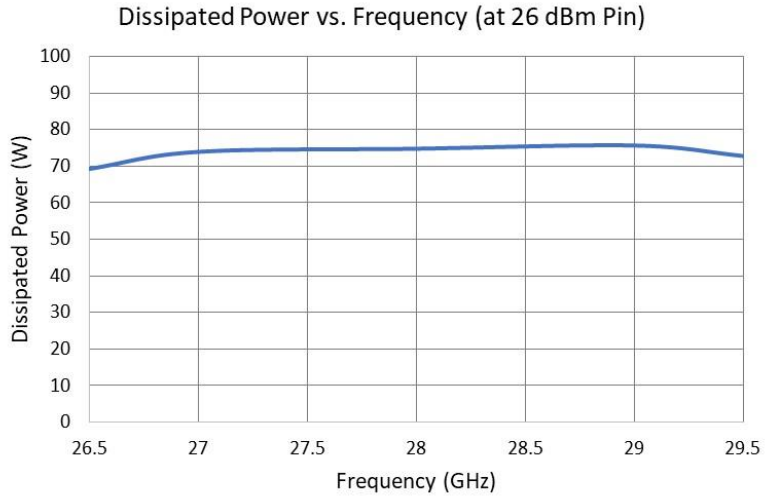
RF = Off

Parameter	Condition	Value	Unit
Thermal Resistance ($R_{\Theta JC}$)	RF=OFF	1.15	°C/W
Junction Temperature (Tj)	$T_{backside}$=85 °C, V_d=24 V, I_{dq}=2.18 A, P_{dis}=52.3 W	144.9	°C

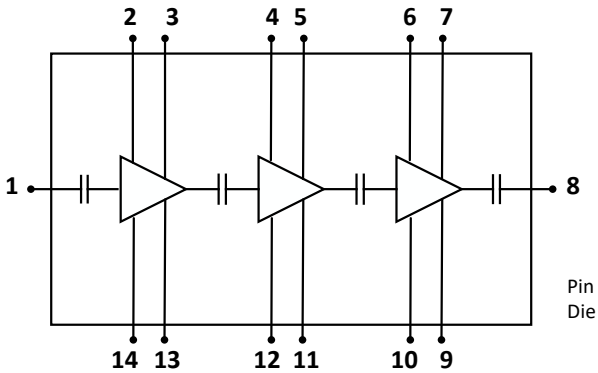
RF = On, Peak Junction Temperature at Pin = 26 dBm (Psat), CW Performance in Fixture

Parameter	Condition	Value	Unit
Thermal Resistance ($R_{\Theta JC}$)	P_{in}=26 dBm, Freq.=29 GHz	1.2	°C/W
Junction Temperature (Tj)	$T_{backside}$=85 °C, V_d=24 V, I_d=4.59 A, P_{dis}=75.7 W	175.6	°C

Note 1: Thermal resistance determined to the back of the chip.
Note 2: Mean time to failure per junction temperature information can be found in the following document: Nxbeam_GaN20MMIC_Reliability.pdf



Circuit Block Diagram



Pin number information detailed under Die Size and Bond Pad Information

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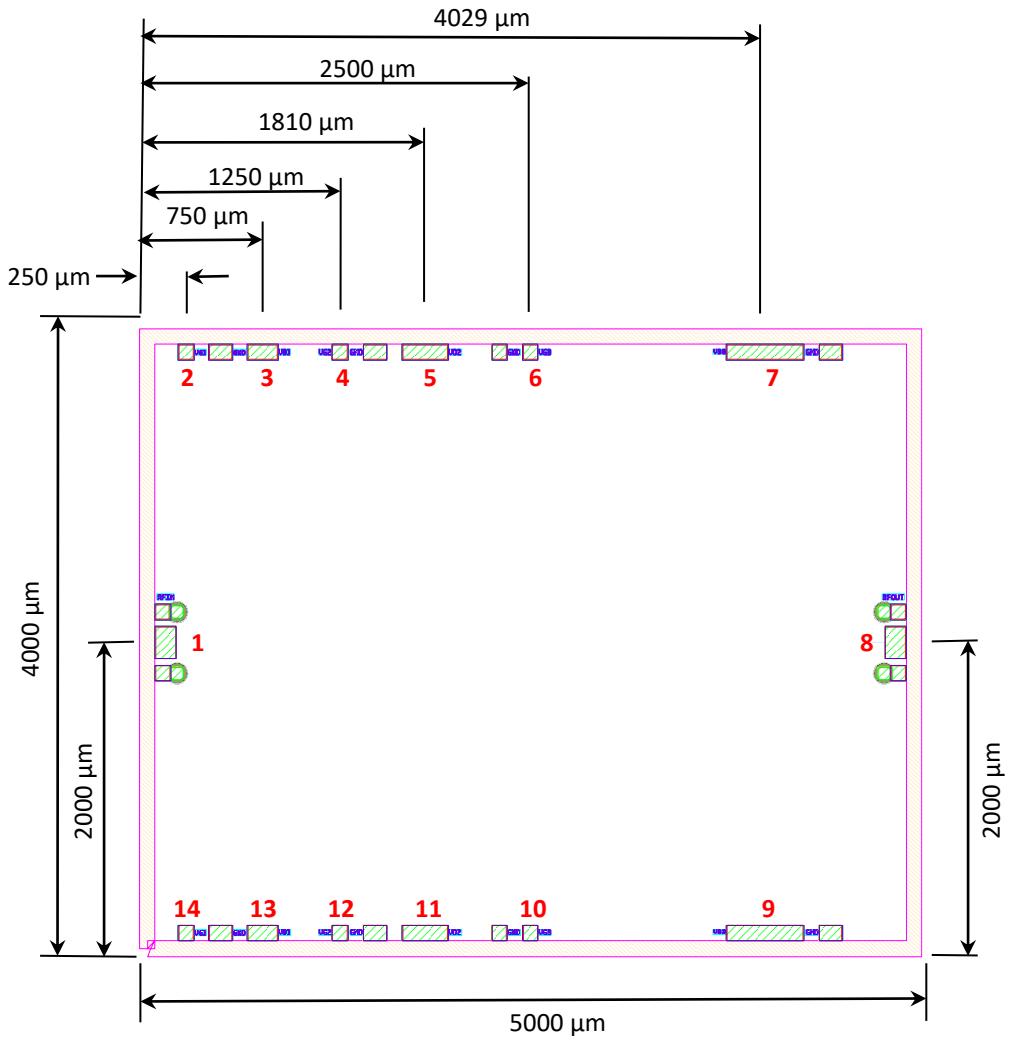
Die Size and Bond Pad Information

Chip Size = 5000 ±25 um x 4000 ±25 um
Chip Thickness = 100 um
Chip Backside metal is ground

RF Input/Output Pad Dimensions = 134 um x 208 um
DC Pad Dimensions:

- Vg1, Vg2, Vg3 = 100 um x 100 um
- Vd1 = 200 um x 100 um
- Vd2 = 290 um x 100 um
- Vd3 = 500 um x 100 um

Pad Num.	Function
1	RF in
2, 14	Vg1
3, 13	Vd1
4, 12	Vg2
5, 11	Vd2
6, 10	Vg3
7, 9	Vd3
8	RF out



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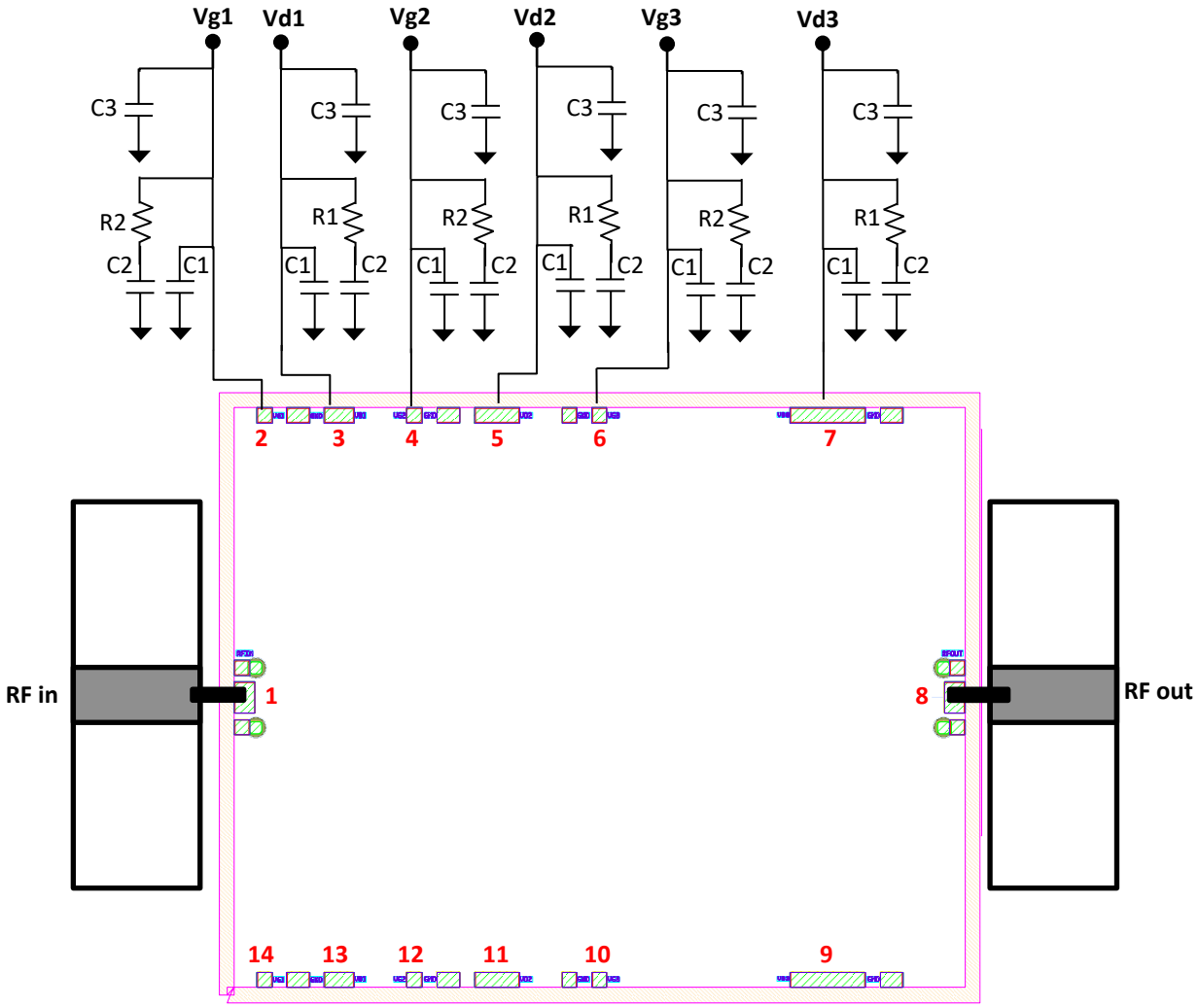
Suggested Off-Chip Components

The following diagram shows the recommended off-chip components. Bias must be applied from both sides of the chip for all drain connections and Vg3. The connection for Vg1 and Vg2 can be applied from either top or bottom. The off-chip components should be duplicated on the bottom side of the chip for connection required on both sides. All drain connections can be tied together to one source. All gate connections can be tied together to one source if desired.



Off-Chip Component Values

Capacitor	Value
C1	100 pF
C2	0.01 µF
C3	10 µF

Resistor	Value
R1	1 Ω
R2	10 Ω

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Assembly Process

- This product has gold backside metallization and can be mounted using either a high thermal conductive epoxy or AuSn eutectic die attachment.
- Nxbeam recommends the use of AuSn eutectic die attachment due to the high-power level of this product
- Maximum recommended temperature during die attachment is 320 °C for not more than 30 seconds.
- This product contains metal air bridges so caution should be taken when handling the die to avoid damage.

Bias Information

Bias-up Procedure:

1.) It is recommended that voltage and current limits are set on the voltage supply's prior to biasing the product.
2.) Ensure power supplies are properly grounded to the product test fixture.
3.) Apply a negative gate voltage of -6V to Vg1, Vg2, and Vg3 to ensure all devices are pinched off.
4.) Gradually increase the drain bias voltage (Vd1, Vd2, Vd3) to the desired bias level but not to exceed the maximum voltage of 28 V.
5.) Gradually increase the gate voltages (Vg1, Vg2, Vg3) while monitoring the drain current until the desired drain current in each stage is achieved.
6.) Apply RF signal.

Bias-down Procedure:

1.) Turn off RF signal.
2.) Gradually decrease Vg1, Vg2, and Vg3 down to -6 V.
3.) Gradually decrease the drain voltages (Vd1, Vd2, Vd3) down to 0 V.
4.) Gradually increase gate voltages (Vg1, Vg2, Vg3) to 0 V.
5.) Turn off supply voltages

ESD Sensitive Product

Important Information

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