7.9-11GHz 25W BARE DIE GaN POWER AMPLIFIER

ICP1044

Product Overview

MICROCHIP's ICP1044 is a 3 stage MMIC power amplifier in bare die form, fabricated in GaN on SiC technology. ICP1044 operates from 7.9-11GHz with 44dBm output power, 38% typical PAE and 34dB small signal gain. ICP1044 is well suited to commercial and defense applications.

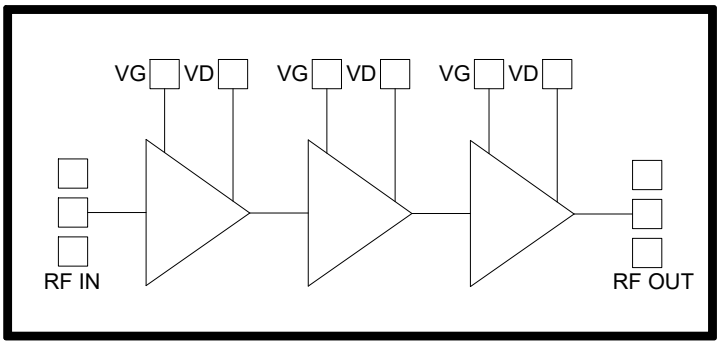
Key Features

- **Frequency Range: 7.9-11GHz**
- **Pout: 44dBm Pulsed (100µs, 10%)**
- **PAE: 38%**
- **Small Signal Gain: 34dB**
- **Bias: V_D=28V, I_{DQ}=220mA**
- **Technology: GaN on SiC**
- **Lead-free and RoHS compliant**
- **Pulsed or CW operation**
- **Dimensions: 3.56mm x 1.81mm**
- **Integrated Power Detector**

Applications

- Commercial Radar
- Satellite Communications
- Aerospace & Defence

Functional Block Diagram



Electrical Specifications

Parameter	Min.	Typ.	Max.	Units	Conditions(1)
Frequency	7.9		11	GHz	
Output Power		44		dBm	P_{in}=14dBm
Power Added Efficiency, PAE		38		%	P_{in}=14dBm
Small Signal Gain, S_{21}		34		dB	
Input Return Loss		-15		dB	
Output Return Loss		-5.5		dB	

(1) Test Conditions unless otherwise stated: V_D=28V, I_{DQ}=220mA, T_A=25°C, Pulsed 10% (100us/1ms)

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Table of Contents

Product Overview 1

1. Electrical Specification 3
   - 1.1. Absolute Maximum Ratings 3
   - 1.2. Small Signal Performance 4
   - 1.3. Large Signal Performance 5

2. Mechanical Drawing 11

3. Application Circuit 12

4. Evaluation Board 13

5. Other considerations 14

6. Ordering, Shipping, and Handling 15

Microchip Information 16

- The Microchip Website 16
- Product Change Notification Service 16
- Customer Support 16
- Microchip Devices Code Protection Feature 16
- Legal Notice 16
- Trademarks 17
- Quality Management System 18
- Worldwide Sales and Service 19

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1. Electrical Specification

1.1. Absolute Maximum Ratings

Parameter	Absolute Maximum
Drain Voltage (V_D)	32V
Drain - Source Breakdown Voltage	120V
Gate Voltage range (V_G)	-8V to 1.5V
Gate Current (I_G), continuous 25°C	3.75 mA
Channel Temperature	275°C
Storage Temperature	-65°C to +150°C
Reflow temperature	320 °C

Note:
Exceeding any one or combination of these limits may cause permanent damage to this device.

Microchip Technology Inc. does not recommend sustained operation near these survivability limits.

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1.2. Small Signal Performance

Typical Data

Test conditions: V_D=24V and 28V, I_{DQ}=220mA

Figure 1-1. S_{21}

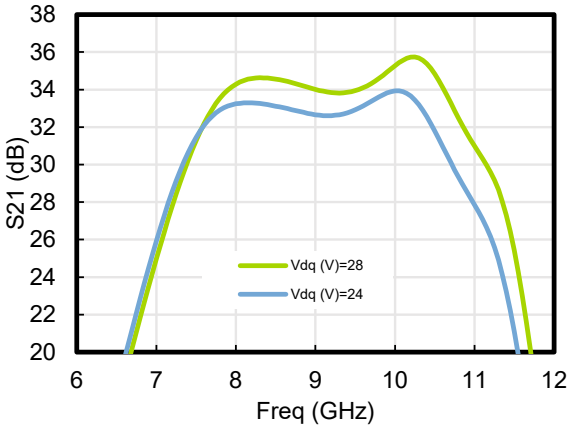


Figure 1-2. S_{11}

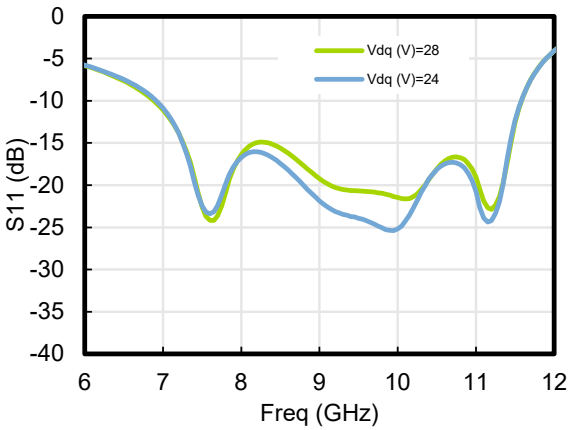
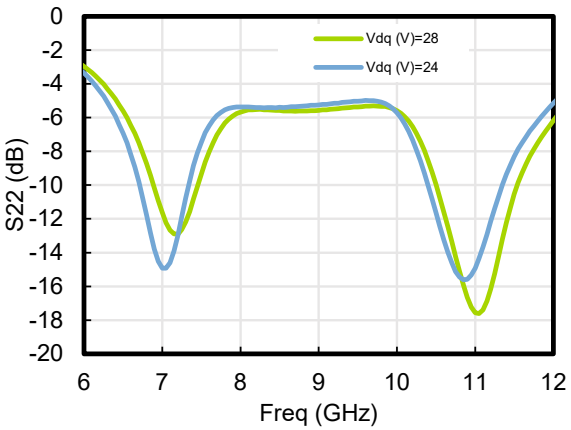


Figure 1-3. S_{22}



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1.3. Large Signal Performance

Typical Pulsed Power Data

Test conditions: V_D=28V, I_{DQ}=220mA, Pulsed 10% (100µs/1ms)

Figure 1-4. P_{out} vs. P_{in}

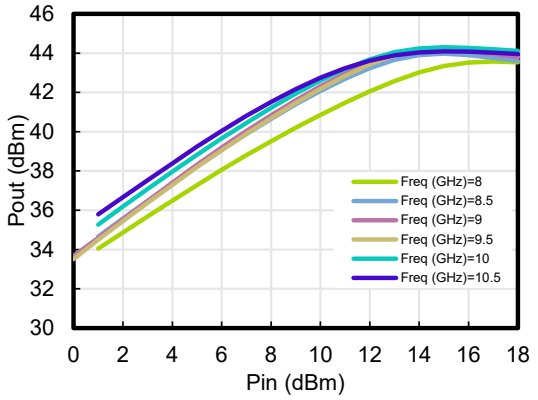


Figure 1-5. Gain vs. P_{out}

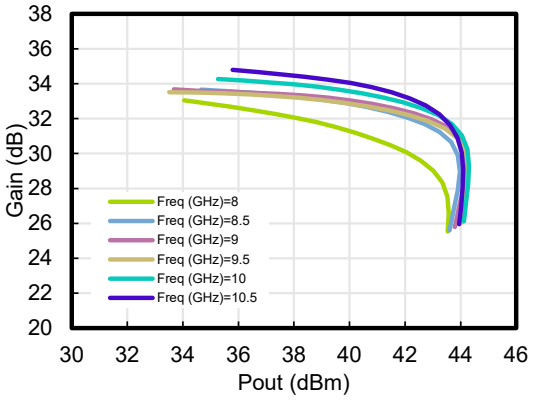


Figure 1-6. PAE vs. P_{out}

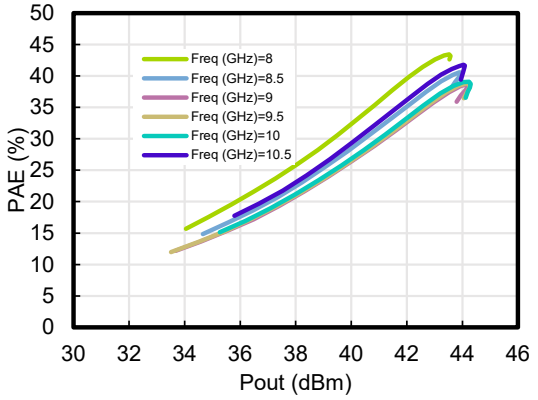


Figure 1-7. I_d vs. P_{out}

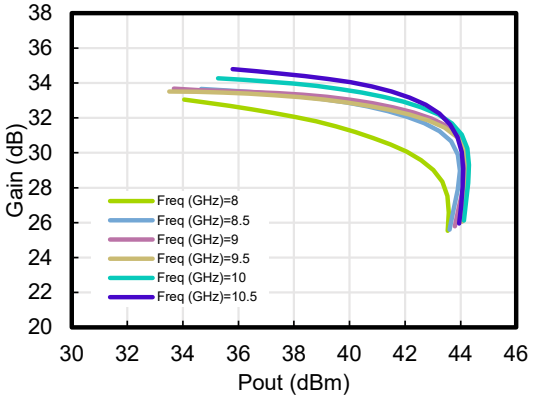


Figure 1-8. P_{out} vs. Freq

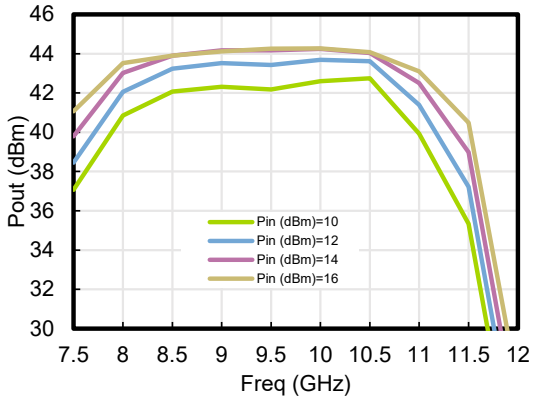
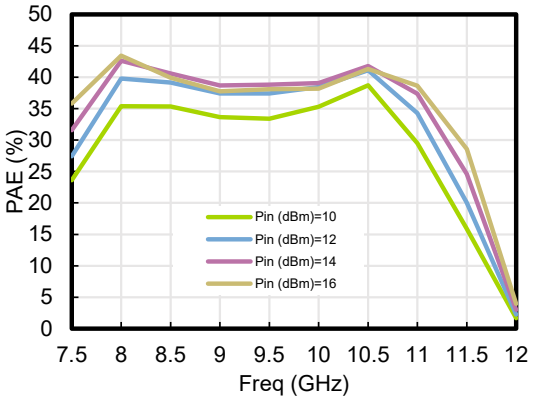


Figure 1-9. PAE vs. Freq



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Typical Pulsed Power Data

Test conditions: V_D=28V, I_{DQ}=220mA, Pulsed 20% (100µs/500µs)

Figure 1-10. P_{out} vs. P_{in}

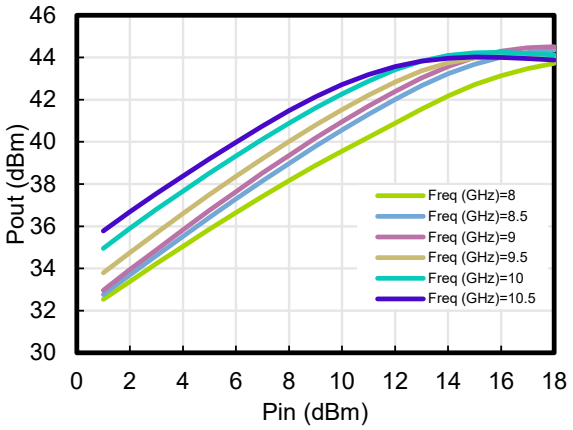


Figure 1-11. Gain vs. P_{out}

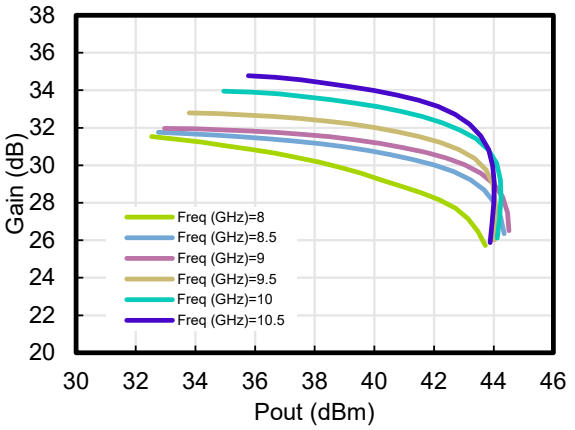


Figure 1-12. PAE vs. P_{out}

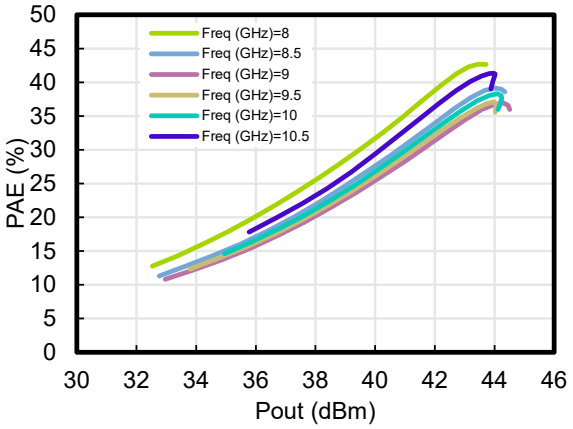


Figure 1-13. I_d vs. P_{out}

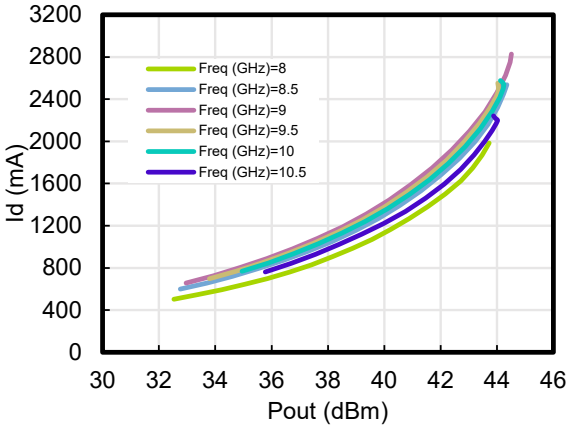


Figure 1-14. P_{out} vs. Freq

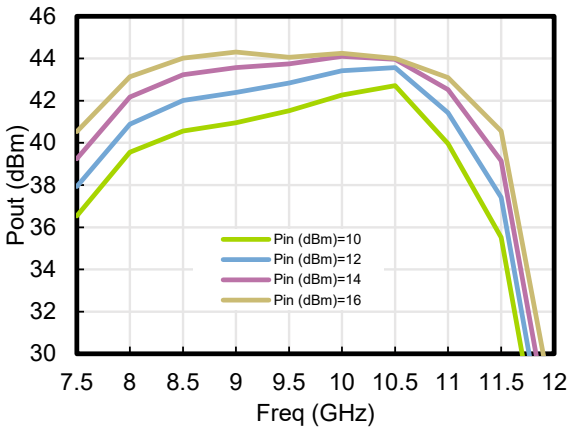
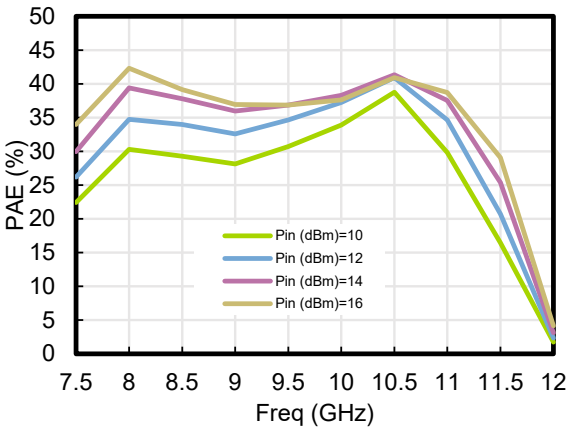


Figure 1-15. PAE vs. Freq



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Typical CW Power Data

Test conditions: V_D=28V, I_{DQ}=220mA, CW

Figure 1-16. P_{out} vs. P_{in}

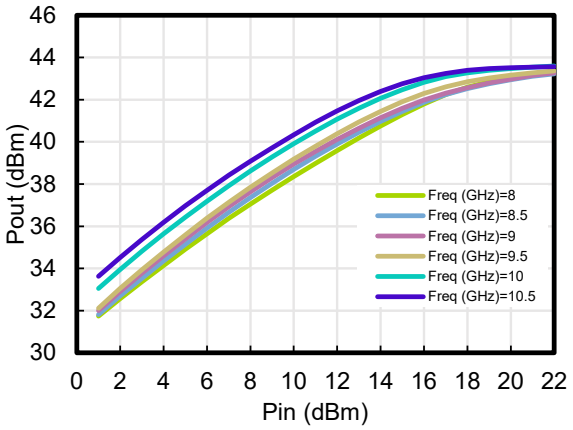


Figure 1-17. Gain vs. P_{out}

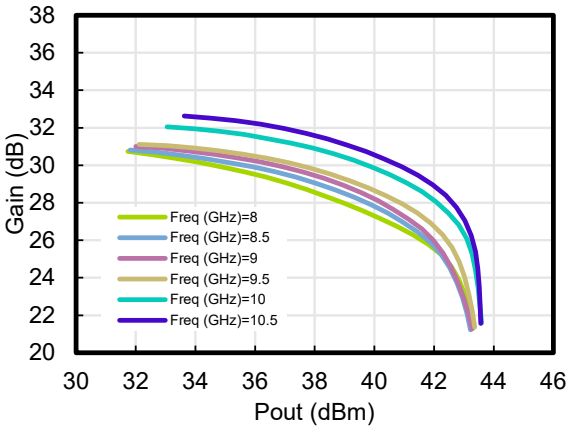


Figure 1-18. PAE vs. P_{out}

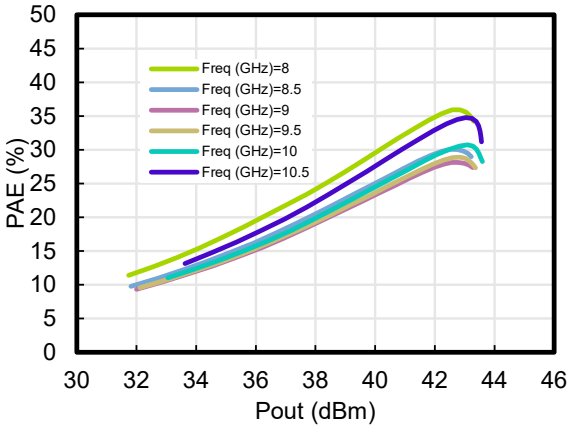


Figure 1-19. I_d vs. P_{out}

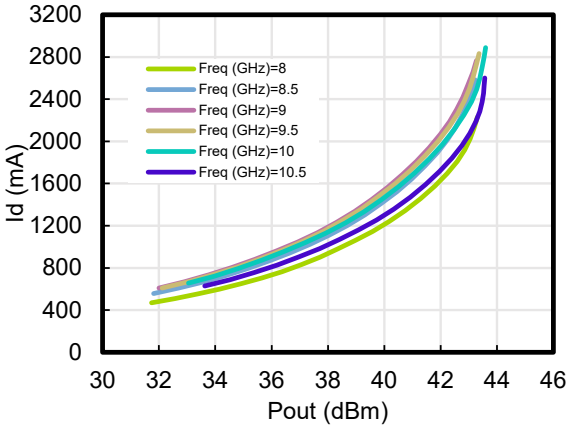


Figure 1-20. P_{out} vs. Freq

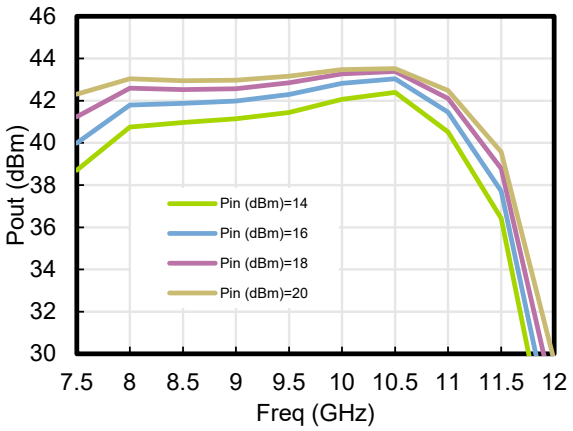
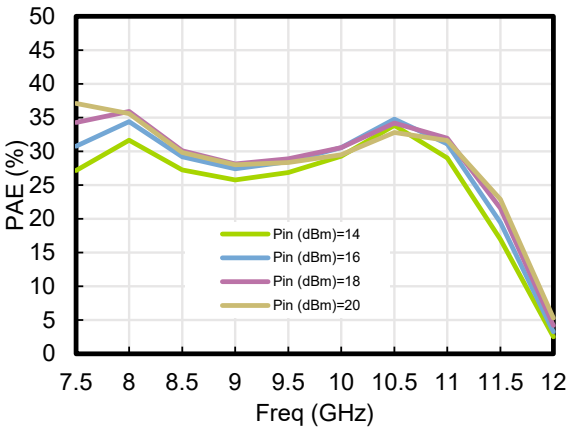


Figure 1-21. PAE vs. Freq



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Typical Pulsed Power Data

Test conditions: V_D=24V, I_{DQ}=220mA, Pulsed 10% (100µs/1ms)

Figure 1-22. P_{out} vs. P_{in}

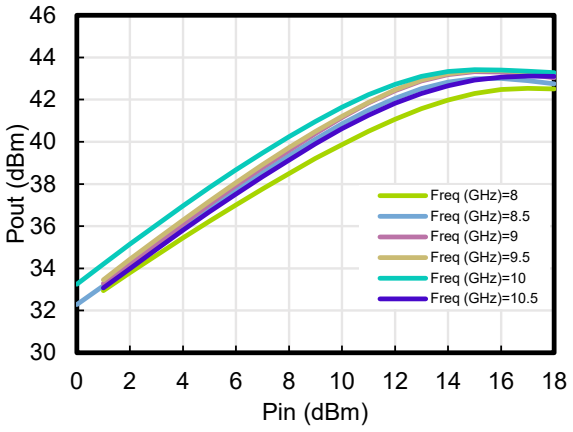


Figure 1-23. Gain vs. P_{out}

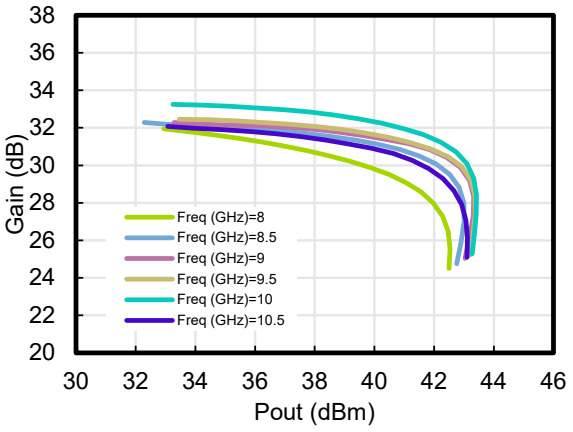


Figure 1-24. PAE vs. P_{out}

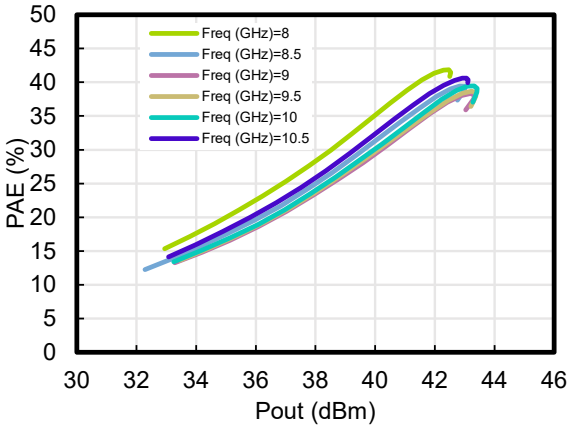


Figure 1-25. I_d vs. P_{out}

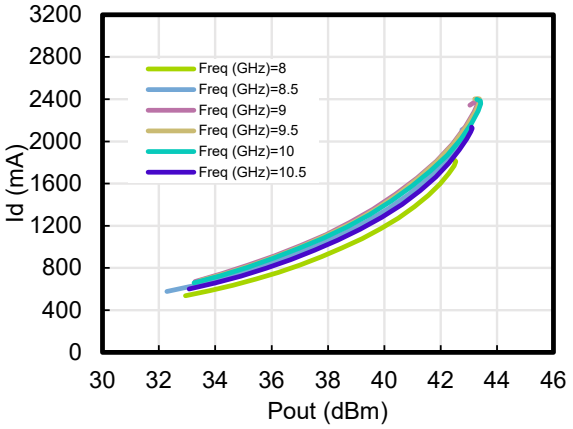


Figure 1-26. P_{out} vs. Freq

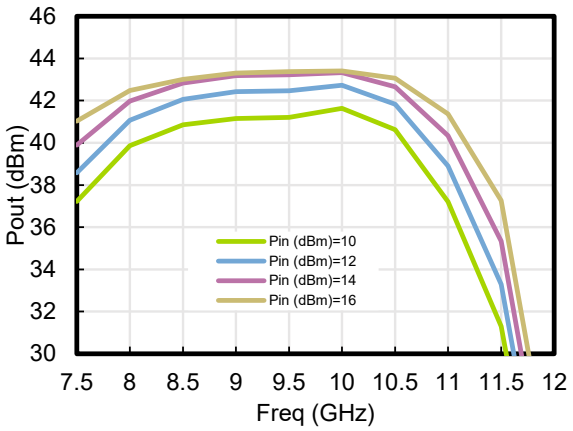
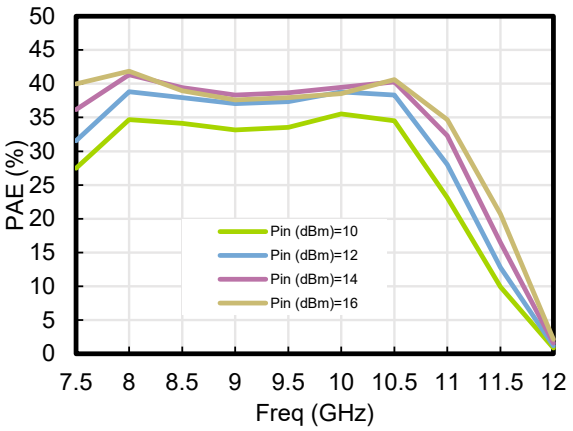


Figure 1-27. PAE vs. Freq



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Typical Pulsed Power Data

Test conditions: V_D=24V, I_{DQ}=220mA, Pulsed 20% (100µs/500µs)

Figure 1-28. P_{out} vs. P_{in}

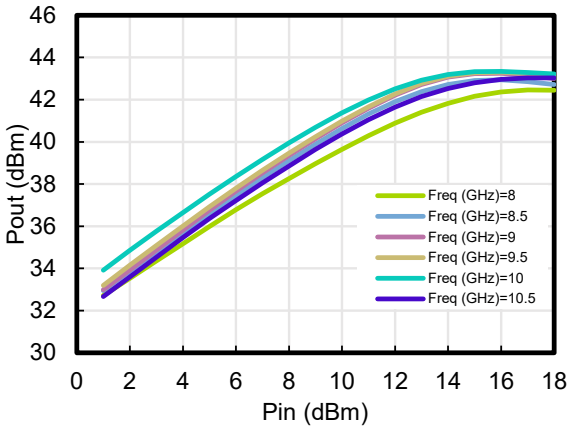


Figure 1-29. Gain vs. P_{out}

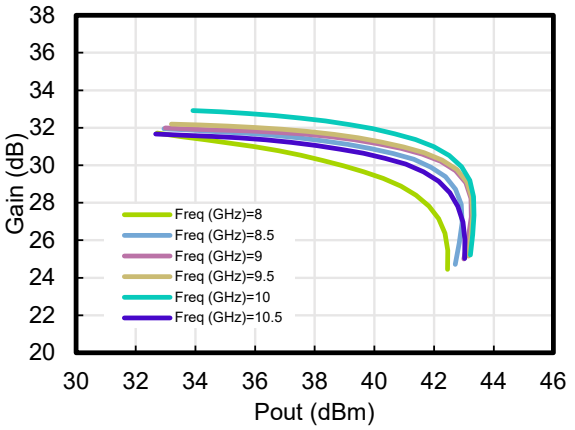


Figure 1-30. PAE vs. P_{out}

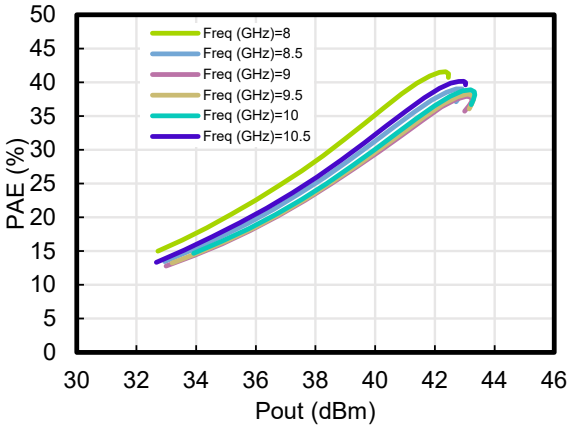


Figure 1-31. I_d vs. P_{out}

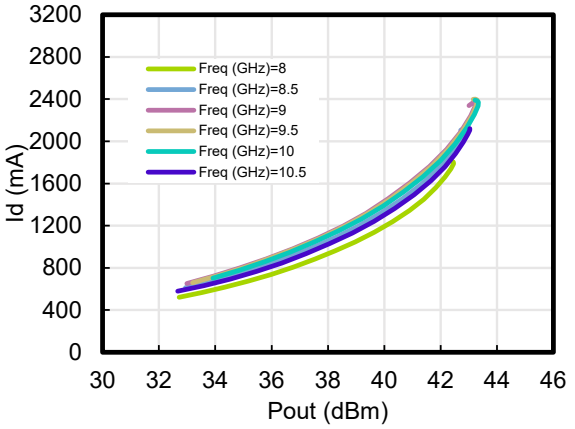


Figure 1-32. P_{out} vs. Freq

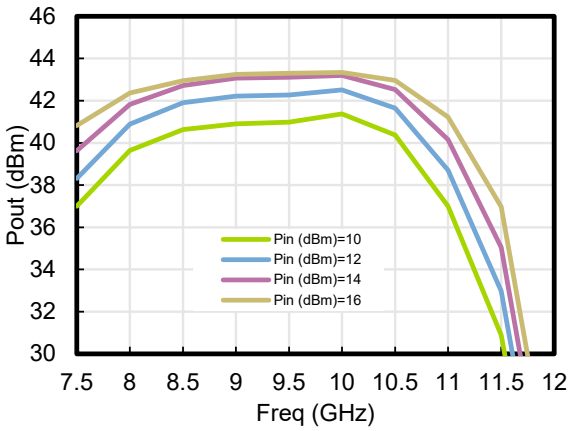
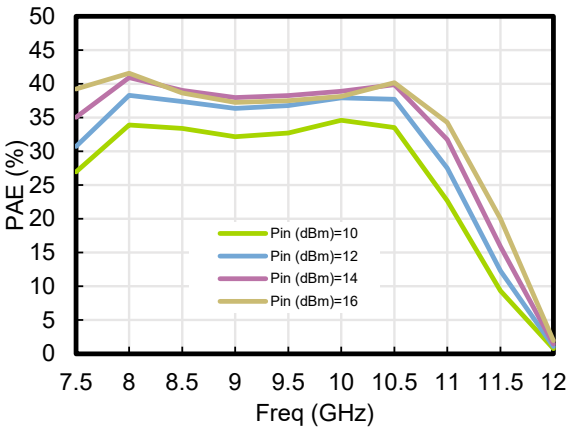


Figure 1-33. PAE vs. Freq



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Typical CW Power Data

Test conditions: V_D=24V, I_{DQ}=220mA, CW

Figure 1-34. P_{out} vs. P_{in}

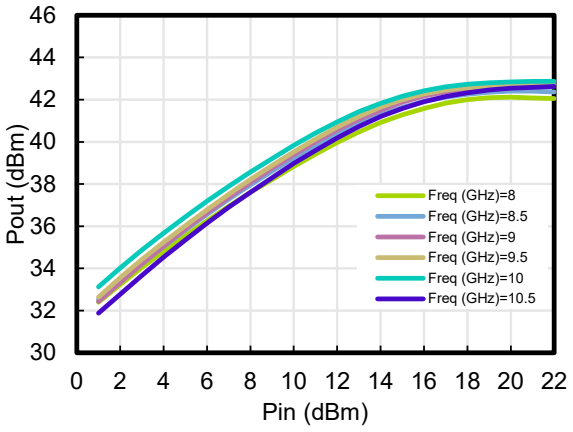


Figure 1-35. Gain vs. P_{out}

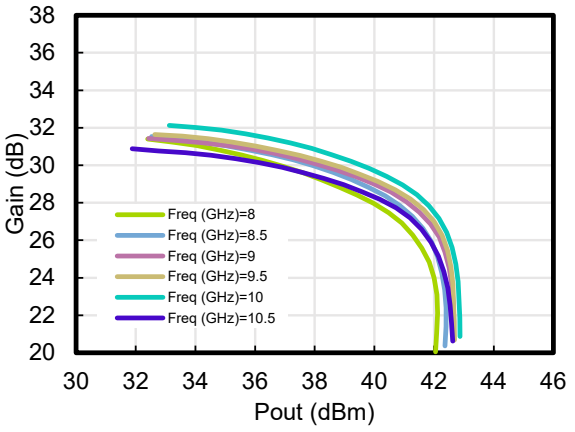


Figure 1-36. PAE vs. P_{out}

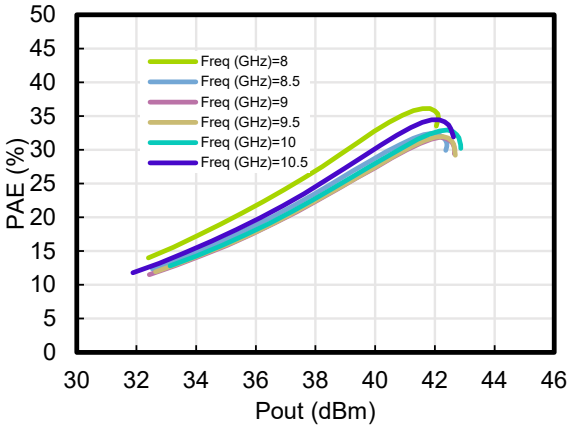


Figure 1-37. I_d vs. P_{out}

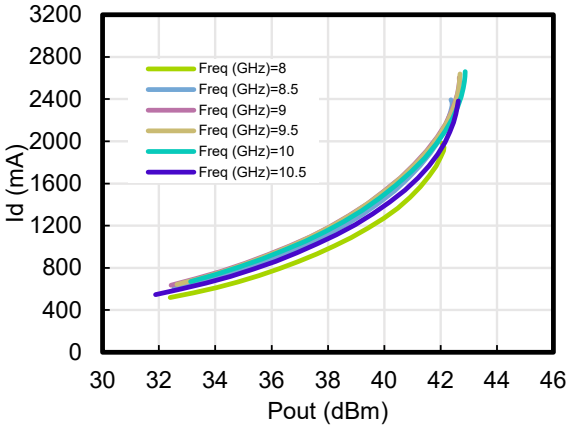


Figure 1-38. P_{out} vs. Freq

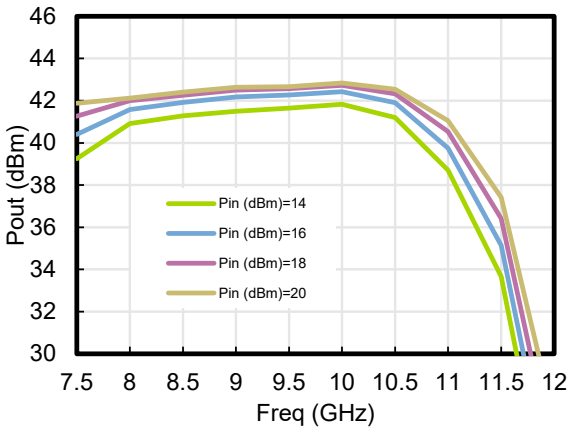
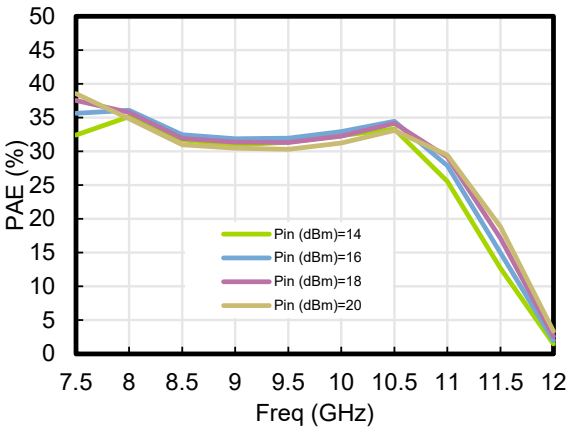
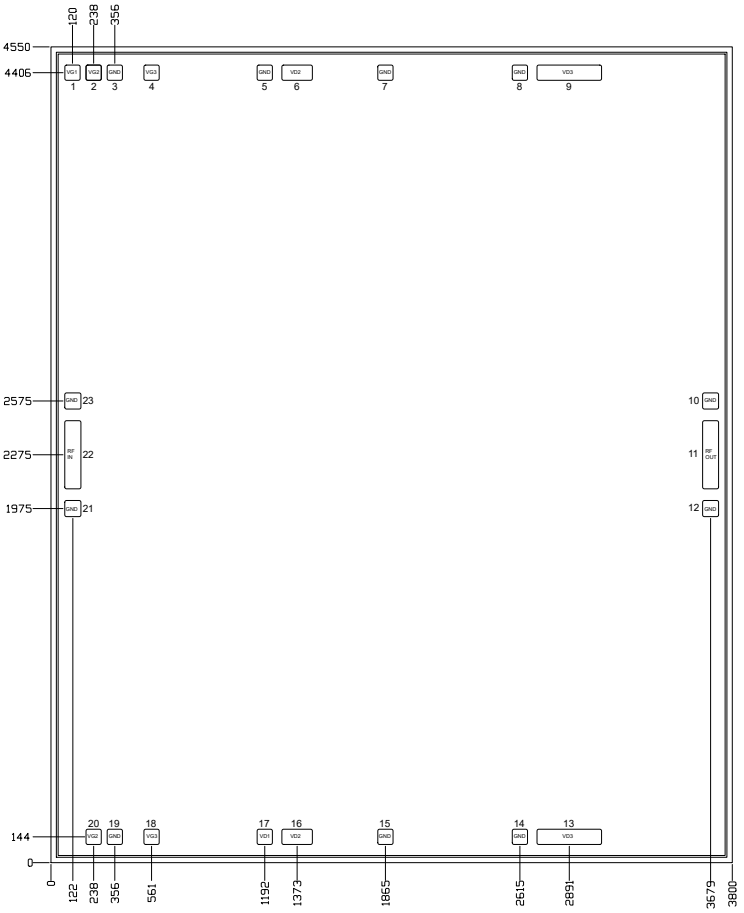


Figure 1-39. PAE vs. Freq



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2. Mechanical Drawing



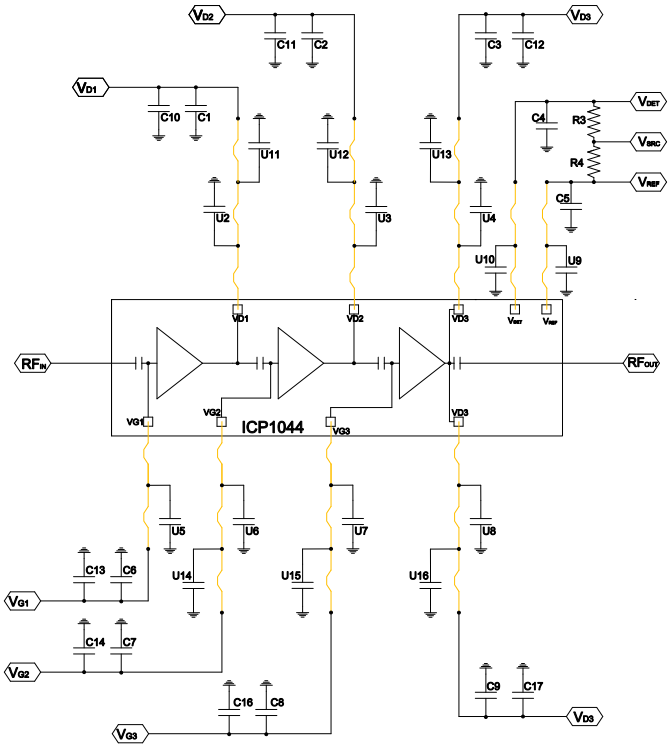
Units: mm | Thickness: | Backside of Die is RF and DC ground

Pad No.	Function	Description
1	V_{G1}(1)	First stage gate bias, decoupling and bypass caps required
2, 20	V_{G2}(1)	Second stage gate bias, decoupling and bypass caps required
3, 5, 7, 8, 14, 15, 19	NC	Pins can be connected to ground or left open circuit
4, 18	V_{G3}(1)	Third stage gate bias, decoupling and bypass caps required
6, 16	V_{D2}(2)	Second stage drain voltage, decoupling and bypass caps required
9, 13	V_{D3}(2)	Third stage drain voltage, decoupling and bypass caps required
10, 12, 21, 23	GND	Ground Connection
11	RF_{out}	RF output, 50ohm, DC blocked
17	V_{D1}(2)	First stage drain voltage, decoupling and bypass caps required
22	RF_{in}	RF input, 50ohm, DC blocked

1. V_{G1}, V_{G2} and V_{G3} can be connected together in application
2. V_{D1}, V_{D2} and V_{D3} can be connected together in application

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3. Application Circuit

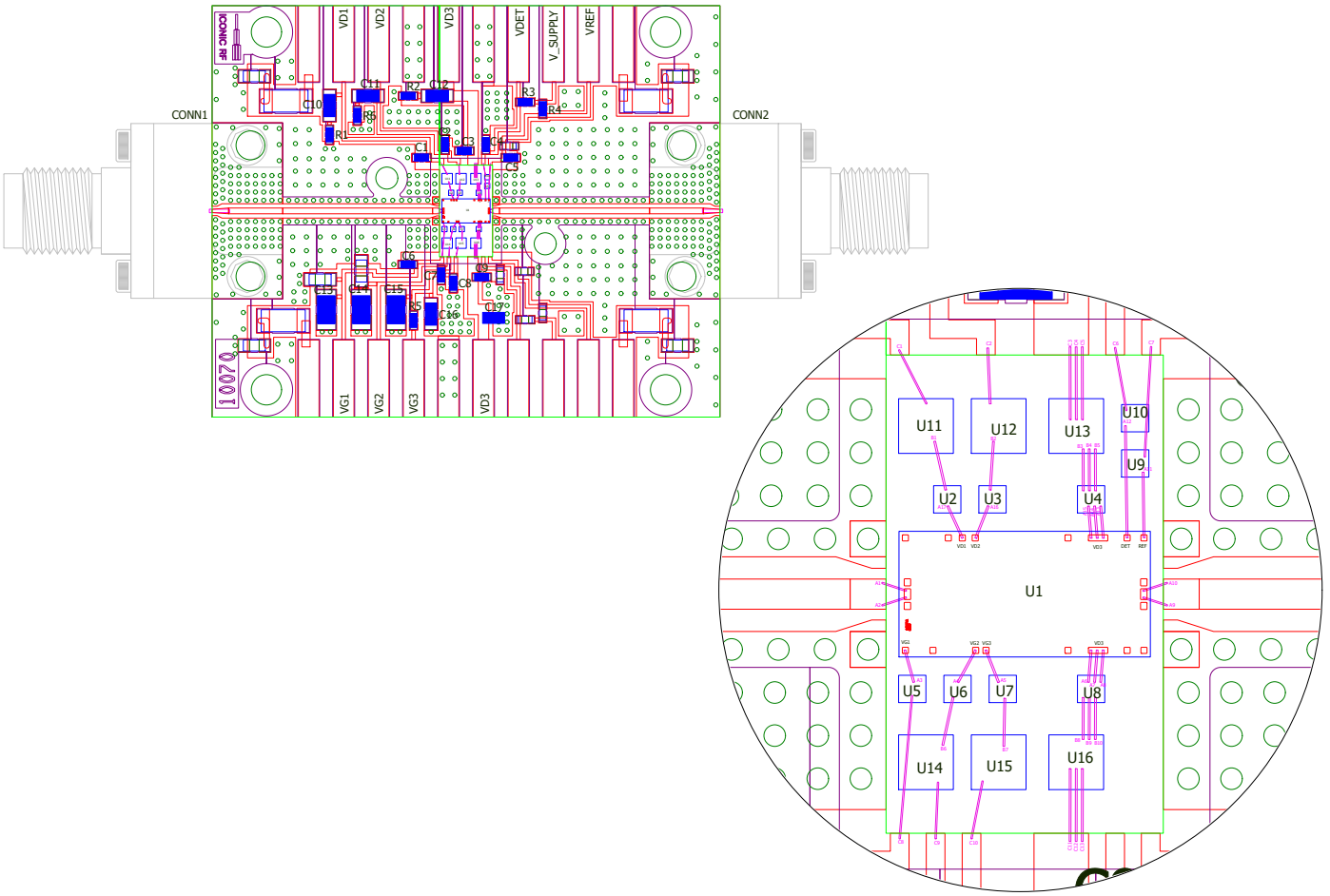


Bill of materials

Component ID	Value	Details	Qty	Manufacturer Part no
U2 - U10	100pF	Johanson 100pF SLC	9	500U01A101MT4W
U11- U16	10nF	Knowles 10nF SLC	6	V30BZ682M1SX
C1 - C9	10nF	10nF Capacitor, 10%, 50V, 0402	9	Various
C10 - C14,C16,C17	10µF	10µF Capacitor, 10%, 35V, 1206	6	Various
R3,R4	100kΩ	100kΩ Resistor, 0402	2	Various

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4. Evaluation Board



PCB Construction	Material	Dimensions
METAL_1_TOP	Cu + ENIG	1oz Copper plated Electroless Nickel 3-5µm Inmersion Gold 0.5µm
DIELECTRIC	RO4003C	8mils (203µm)
METAL2_BOTTOM	Cu + ENIG	1oz Copper plated Electroless Nickel 3-5µm Inmersion Gold 0.5µm

Key Features	Dimensions
VIA Drill	0.3mm
VIA Plating Thickness	50-70µm
50Ohm LINE WIDTH	420µm

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5. Other considerations

Bias-up procedure

1. Set V_G to -5V
2. Set V_D to 28V
3. Adjust V_G positive until I_D quiescent is 220mA
4. Limit I_D to 4A
5. Apply RF signal

Bias-down procedure

1. Turn off RF
2. Turn off V_D, allow drain capacitors to discharge
3. Turn off V_G

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6. Ordering, Shipping, and Handling

Handling Recommendations

Integrated circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. It is recommended to follow all procedures and guidelines outlined in the Microsemi application note AN01: GaAs MMIC Handling and Die Attach Recommendations.

Ordering Information

For additional ordering information, contact your Microchip sales representative.

Part Number	Standard Packing Format
ICP1044-1-110I	7.9-11GHz 25W Bare Die GaN Power Amplifier in Gelpak Format
EV27U88A	Dev Tool for ICP1044-1-110I, Fully Assembled Evaluation Board with RF Test Data

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