



## Description

ICONICRF's ICP1543 is a three stage MMIC power amplifier in bare die form, fabricated using GaN on SiC technology. ICP1543 operates from 12-18GHz with 43dBm output power, >30% PAE and 22dB small signal gain. ICP1543 is well suited to a variety of Test and Measurement and Aerospace & Defense applications.

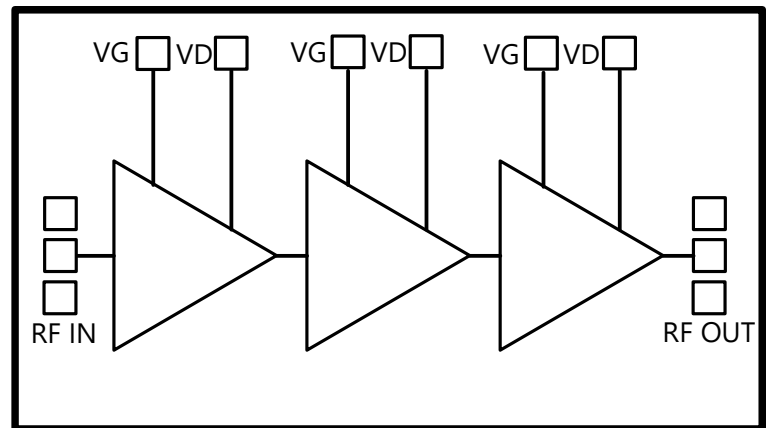
## Features

- Frequency Range: 12-18GHz
- Pout: 43 dBm @ 24dBm Pin
- PAE: >30 %
- Small Signal Gain: 22dB
- Bias: VD=24V IDQ=150mA
- Technology: GaN on SiC
- Lead-free and RoHS compliant
- Die Size = 3.75 mm x 3.45 mm

## Applications

- Test and Measurement
- Aerospace & Defense

## Functional Block Diagram



## Electrical Specifications | Test conditions unless otherwise stated | $V_D=24V$ , $I_{DQ}=150mA$ $T_A=25^\circ C$ , CW

| Parameter                | Conditions <sup>(1)</sup> | Min | Typ | Max | Units |
|--------------------------|---------------------------|-----|-----|-----|-------|
| Frequency                |                           | 12  |     | 18  | GHz   |
| Output Power @ $P_{sat}$ | Pin=25dBm                 |     | 43  |     | dBm   |
| PAE @ $P_{sat}$          | Pin=25dBm                 |     | 30  |     | %     |
| Small Signal Gain        |                           |     | 22  |     | dB    |
| Input Return Loss        |                           |     | 10  |     | dB    |
| Output Return Loss       |                           |     | 7   |     | dB    |

## Recommended Operating Conditions

| Parameter                            | Value       |
|--------------------------------------|-------------|
| Drain Voltage ( $V_D$ )              | 20V-24V     |
| Drain Quiescent Current ( $I_{DQ}$ ) | 150-300mA   |
| Gate Voltage Range ( $V_G$ )         | -2 to -1.5V |
| Operating Temperature ( $T_A$ )      | -40 to +85C |



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## 12-18GHz 20W GaN PA MMIC

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### Absolute Maximum Ratings

| Parameter                                      | Absolute Maximum |
|------------------------------------------------|------------------|
| Drain Voltage ( $V_{DG}$ )                     | 30V              |
| Gate Voltage Range ( $V_G$ )                   | -5V to 0V        |
| Drain Current ( $I_D$ ) $T_A=25^\circ\text{C}$ | 8A               |
| Gate Current ( $I_G$ )                         | 6.0mA            |
| Power Dissipation (CW) $T_A=25^\circ\text{C}$  | 180W             |
| Power Dissipation (CW) $T_A=85^\circ\text{C}$  | 125W             |
| CW Input Power                                 | +28dBm           |
| Channel Temperature                            | 275°C            |
| Eutectic Die Attach Temperature (30s)          | 320°C            |
| Storage Temperature                            | -65°C to +150°C  |

Exceeding any one or combination of the absolute maximum limits may cause permanent damage to this device. ICONICRF does not recommend sustained operation near these survivability limits.

### Thermal and Reliability

| Parameter          | Value   |
|--------------------|---------|
| Thermal Resistance | 1.1°C/W |

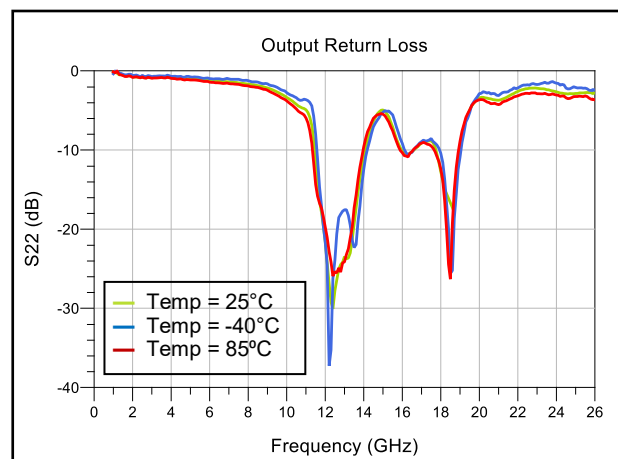
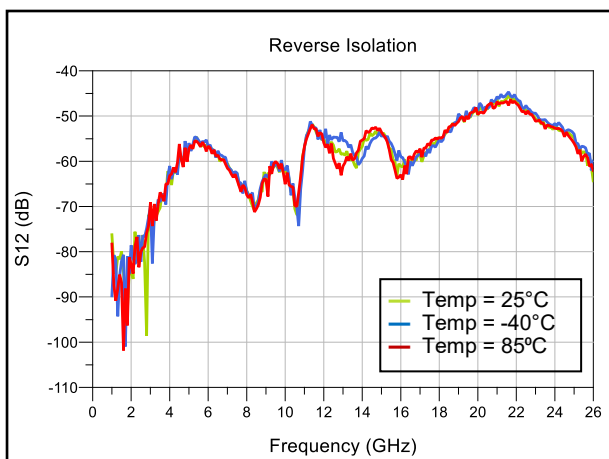
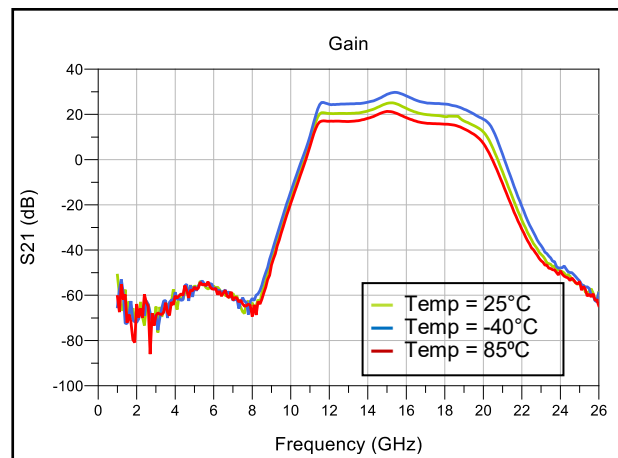
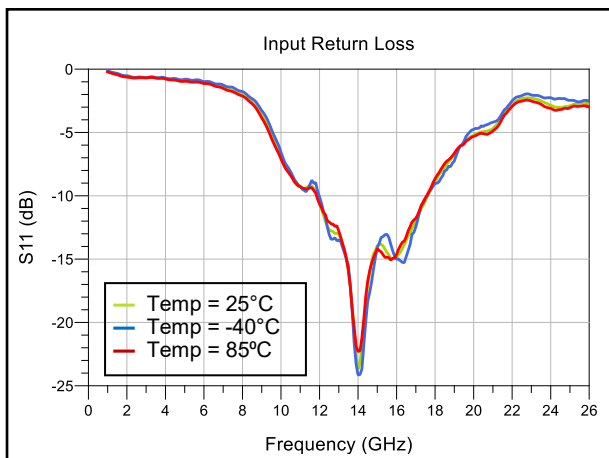
#### Notes

1. Assumes silver sintered epoxy attach (15um thick) mounted on CuMo carrier.
2. Base temperature is assumed at the top of the CuMo carrier
3. Thermal resistance calculated using IR measurement of the channel temperature.

### Ordering Information

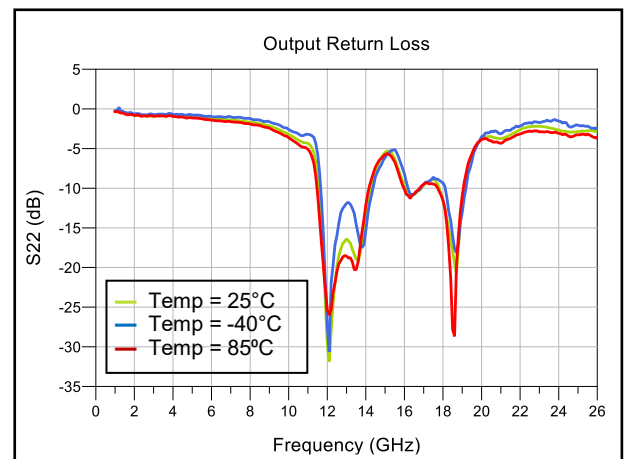
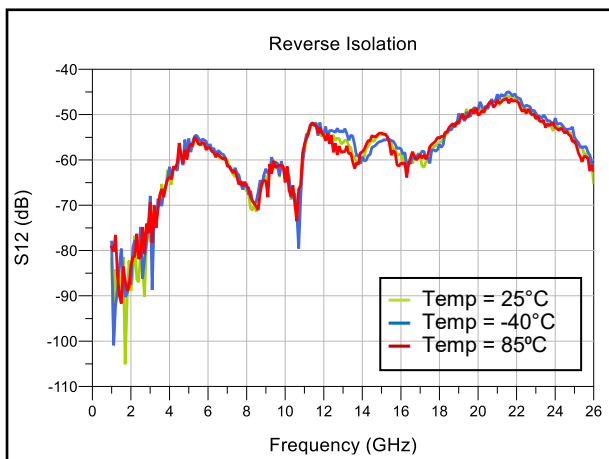
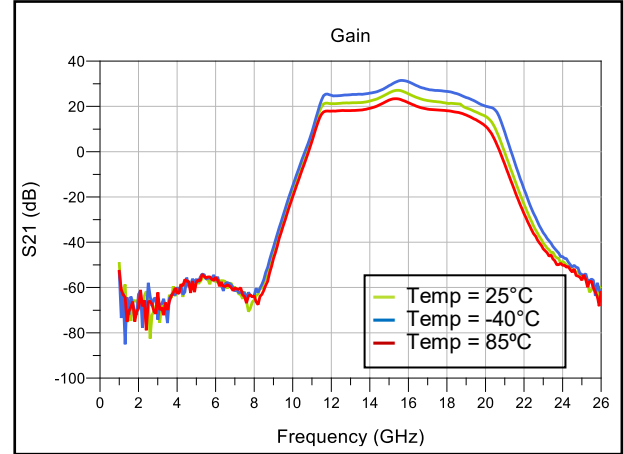
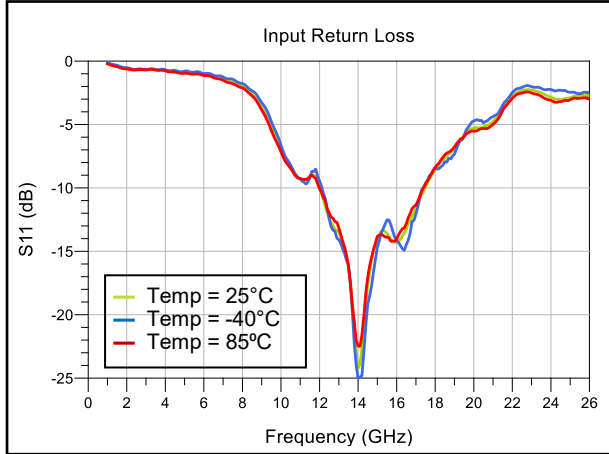
| Part No.       | Description                       |
|----------------|-----------------------------------|
| ICP1543-1-110I | Bare die in Gel-Pack trays        |
| EV83T37A       | ICP1543-1-501U EVB SMA connectors |

### Typical Small Signal Data | Test conditions unless otherwise stated $V_D=20V$ , $I_{DQ}=150mA$





### Typical Small Signal Data | Test conditions unless otherwise stated $V_D=24V$ , $I_{DQ}=150mA$





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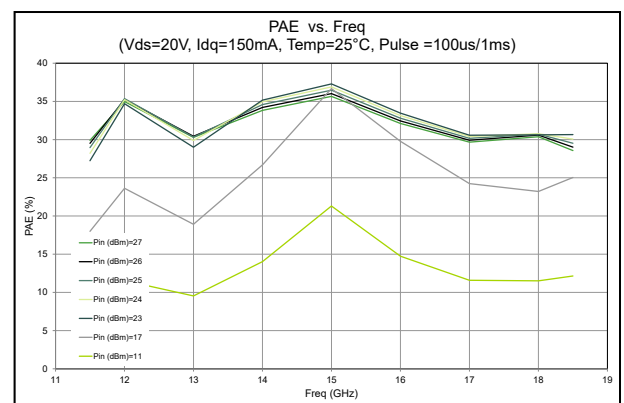
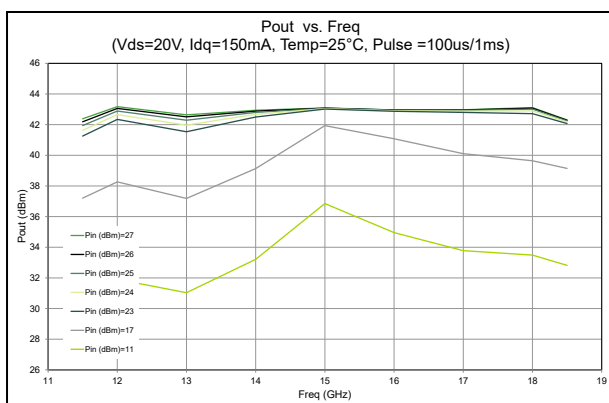
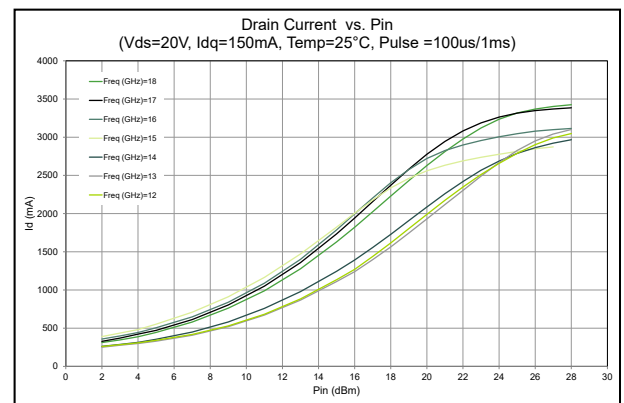
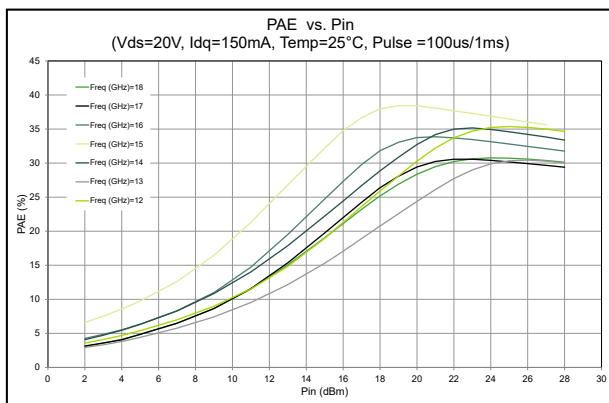
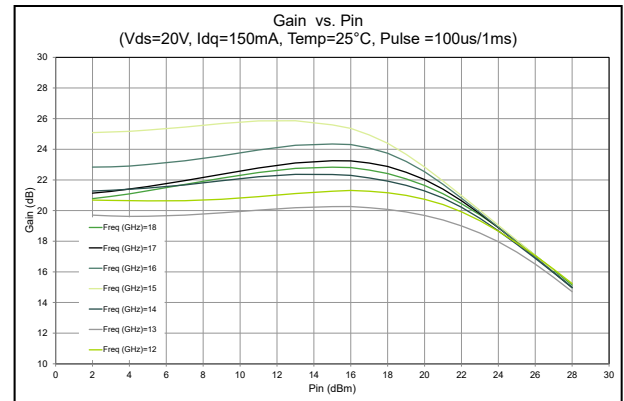
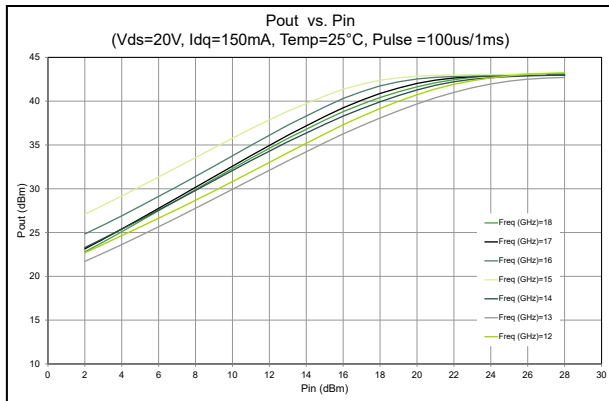
## 12-18GHz 20W GaN PA MMIC

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### Typical Large Signal Data | Test conditions unless otherwise stated

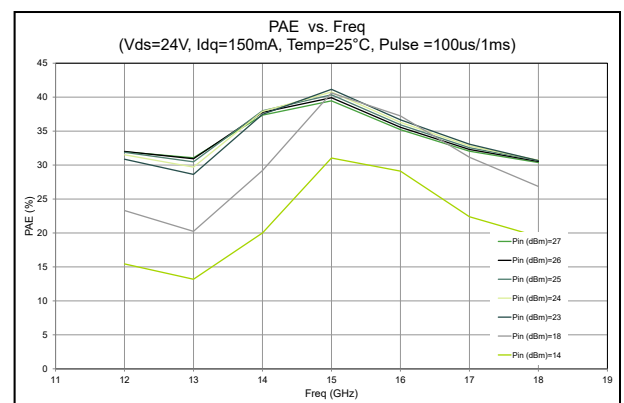
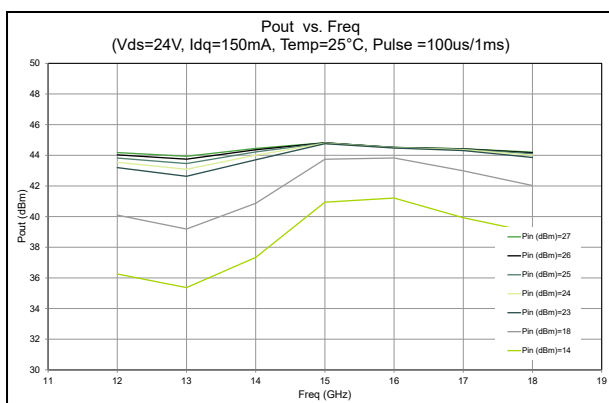
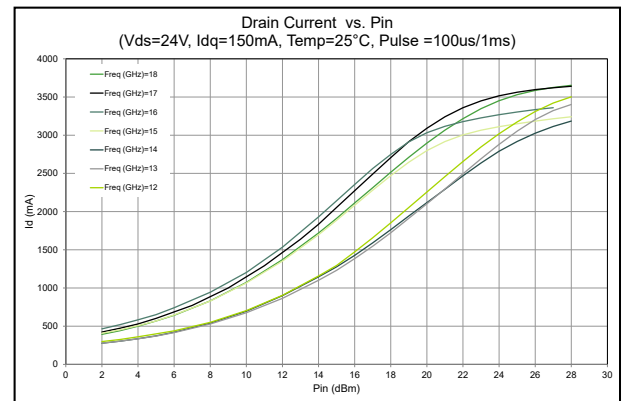
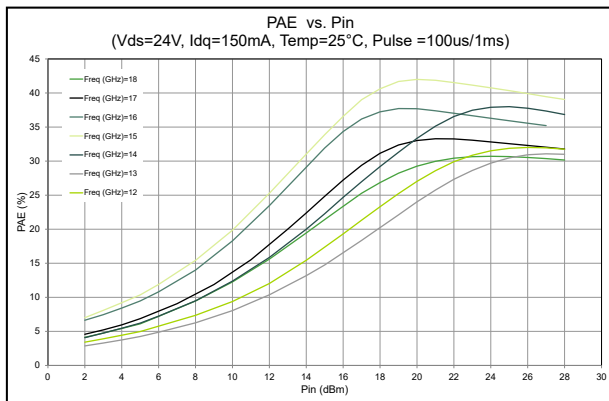
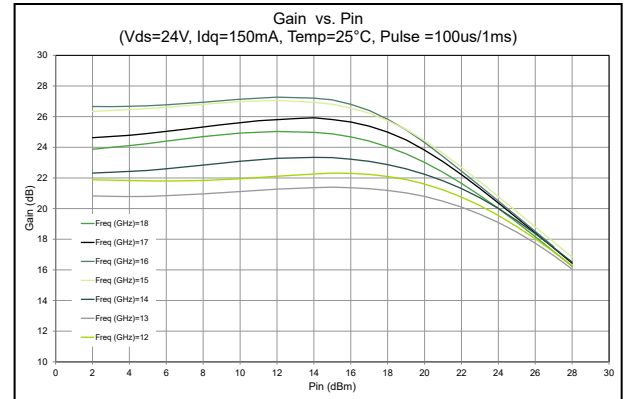
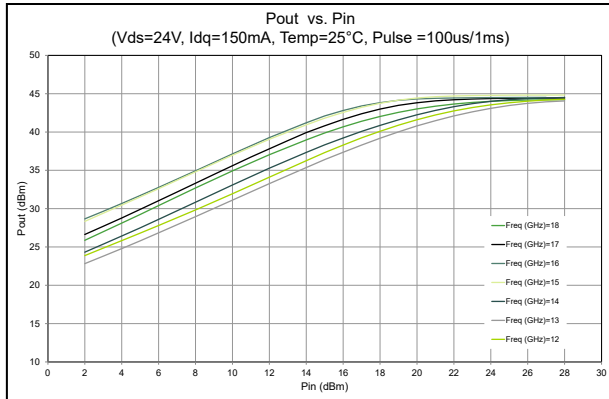
$V_D=20V$ ,  $I_{DQ}=150mA$ ,  $T_A=25^\circ C$ , Pulse width=100us, Pulse period=1ms





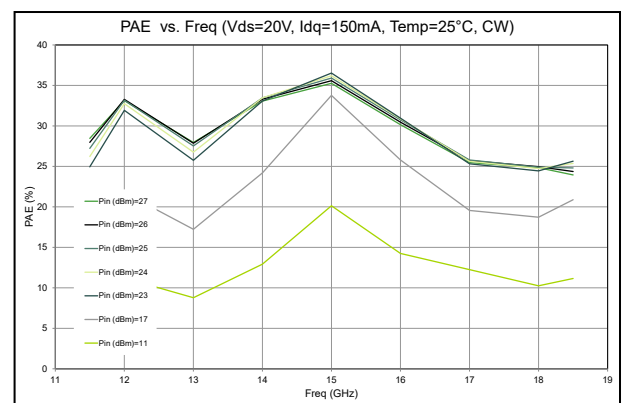
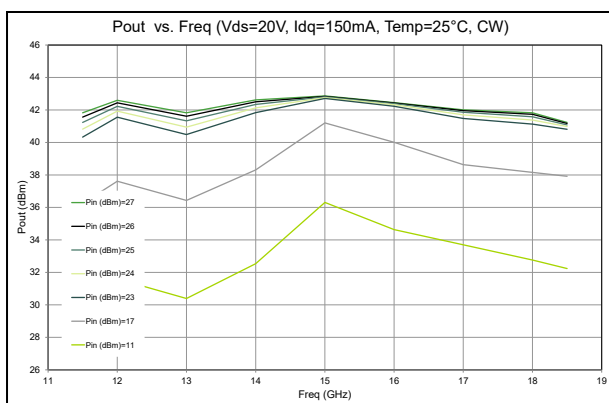
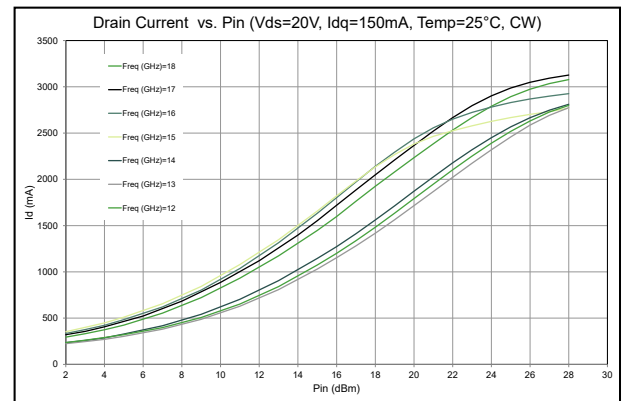
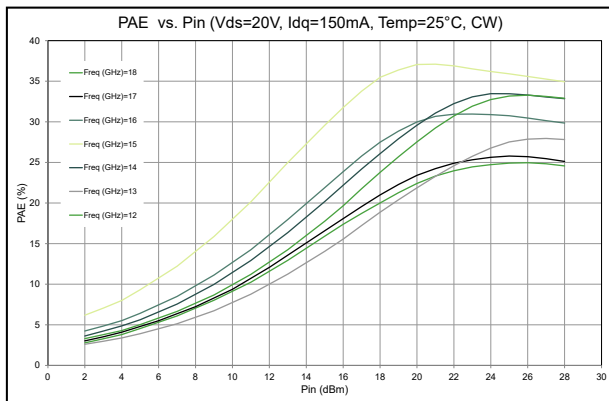
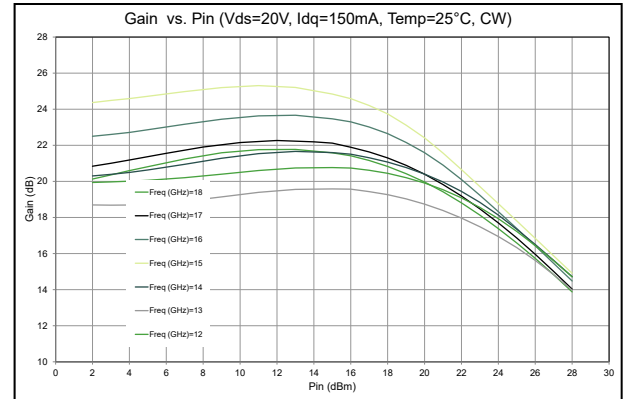
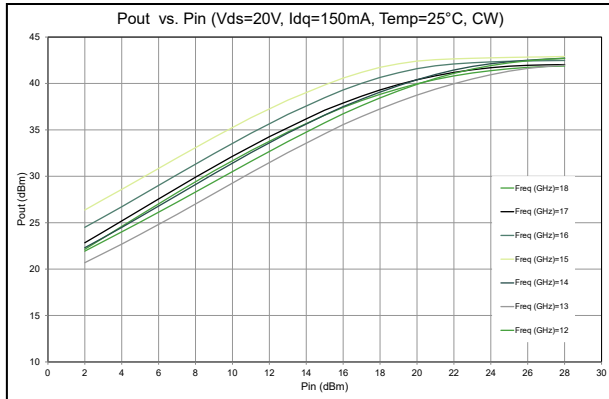
### Typical Large Signal Data | Test conditions unless otherwise stated

$V_D=24V$ ,  $I_{DQ}=150mA$ ,  $T_A=25^\circ C$ , Pulse width=100us, Pulse period=1ms



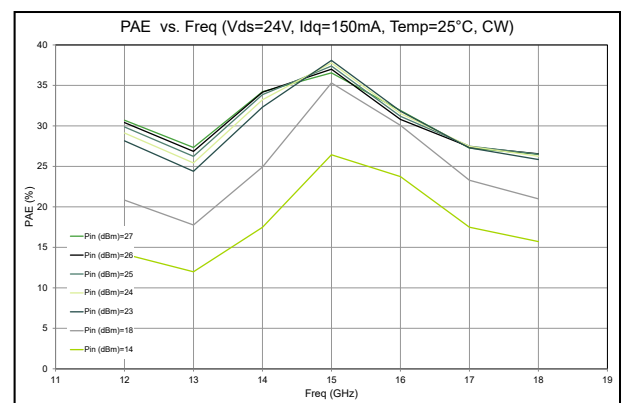
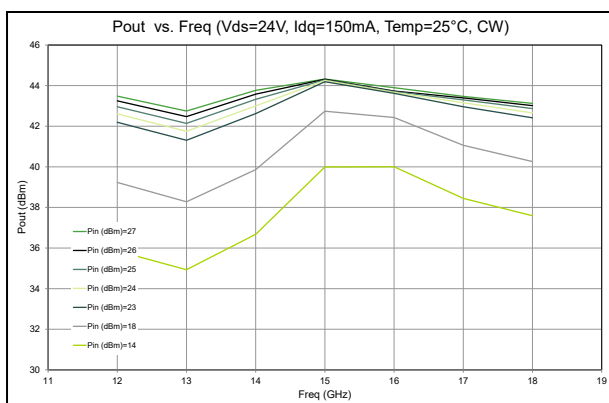
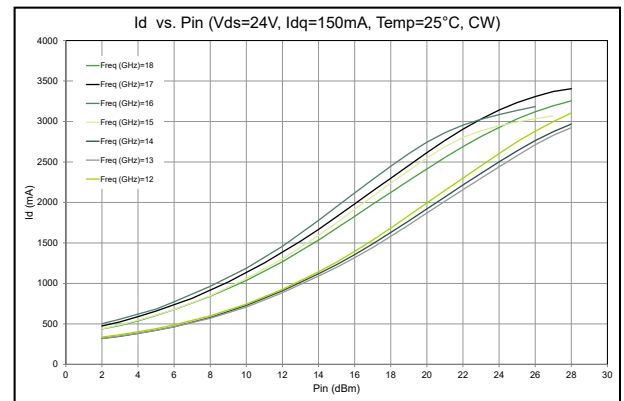
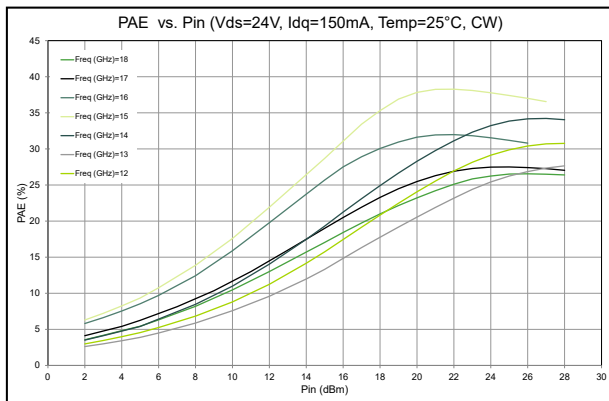
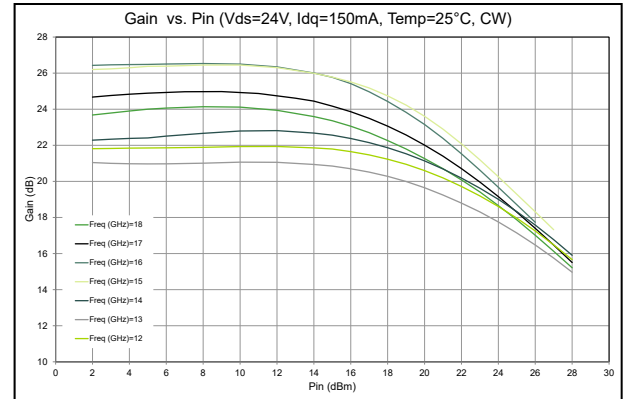
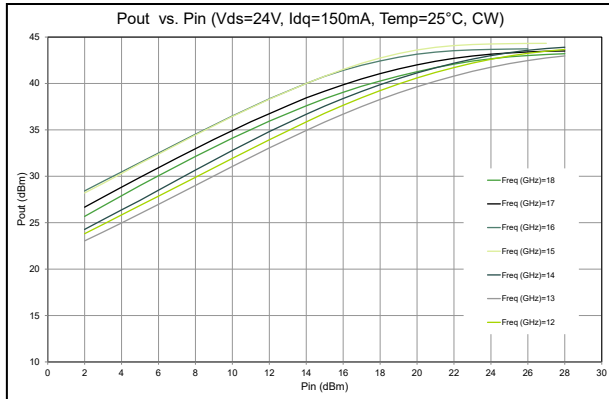


### Typical Large Signal Data | Test conditions unless otherwise stated $V_D=20V$ , $I_{DQ}=150mA$ , $T_A=25^\circ C$ , CW





### Typical Large Signal Data | Test conditions unless otherwise stated $V_D=24V$ , $I_{DQ}=150mA$ , $T_A=25^\circ C$ , CW

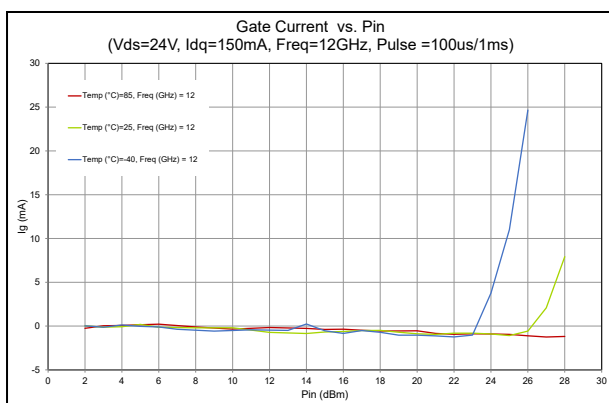
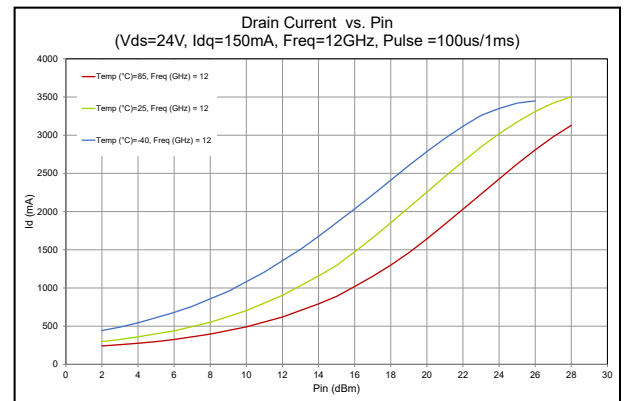
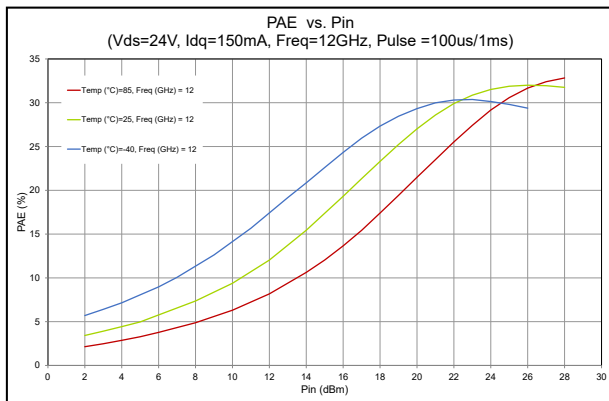
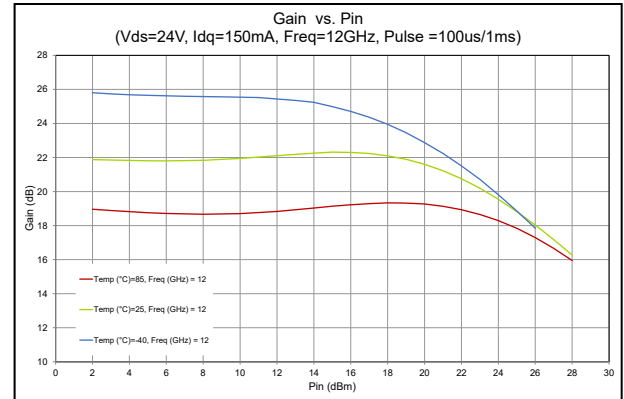
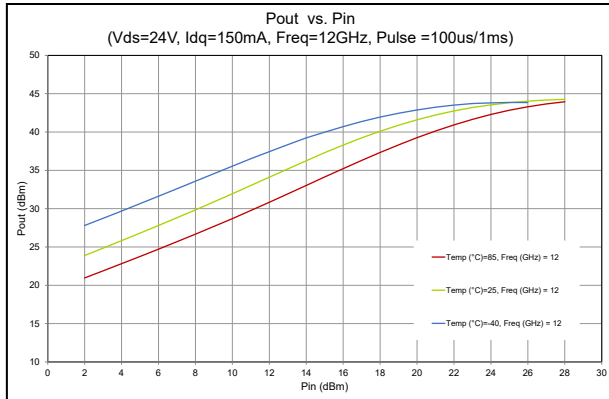




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Test conditions unless otherwise stated

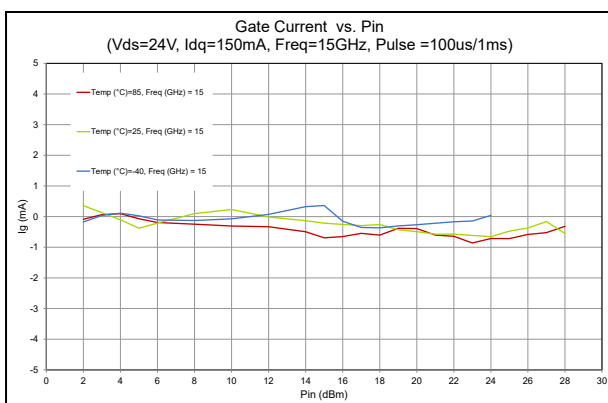
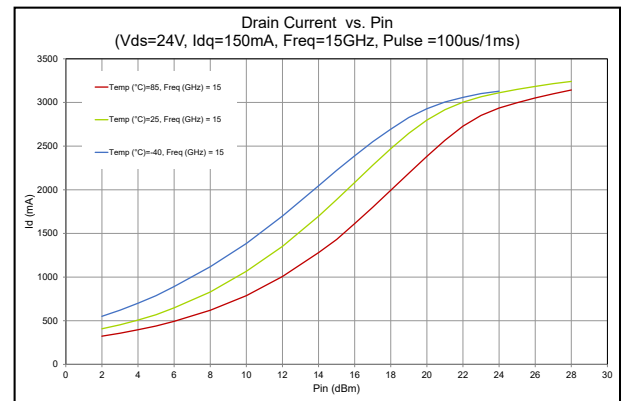
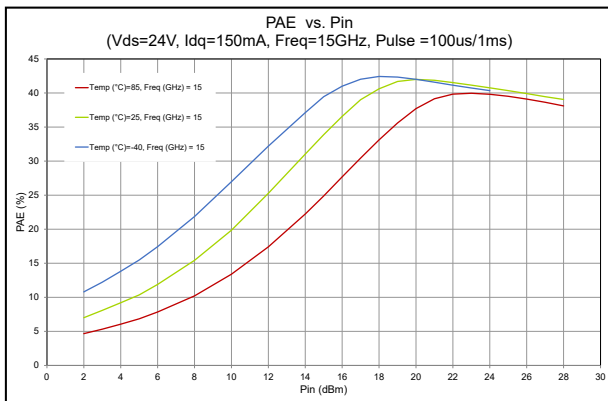
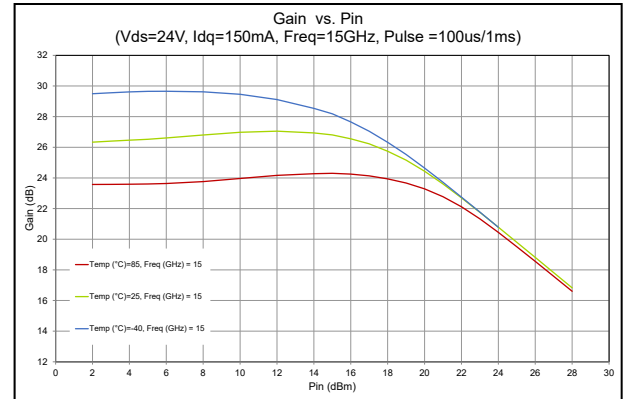
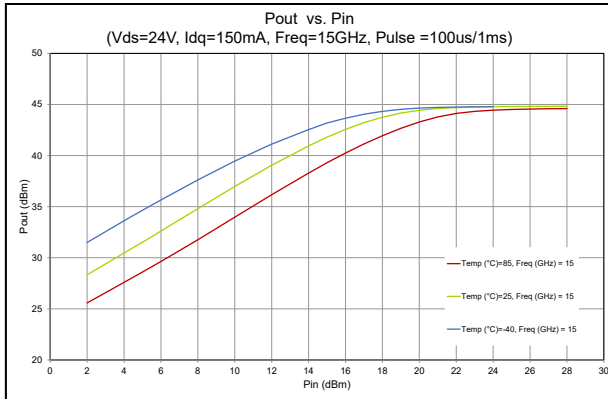
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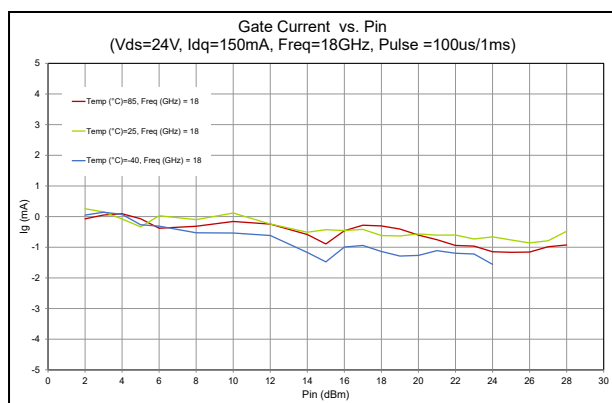
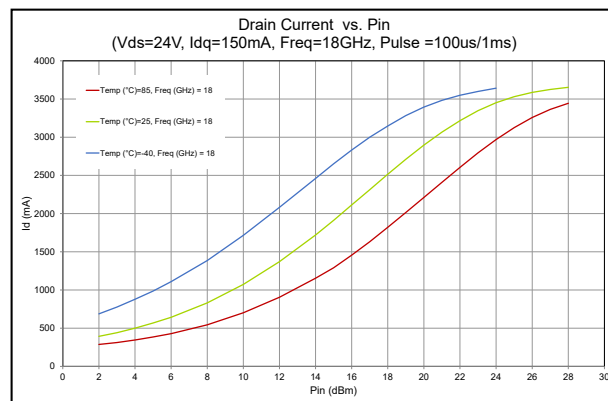
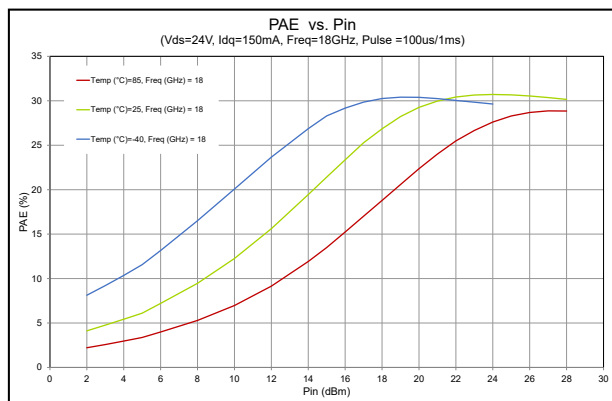
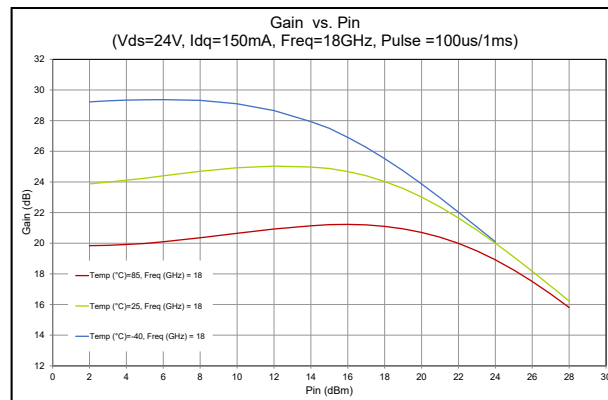
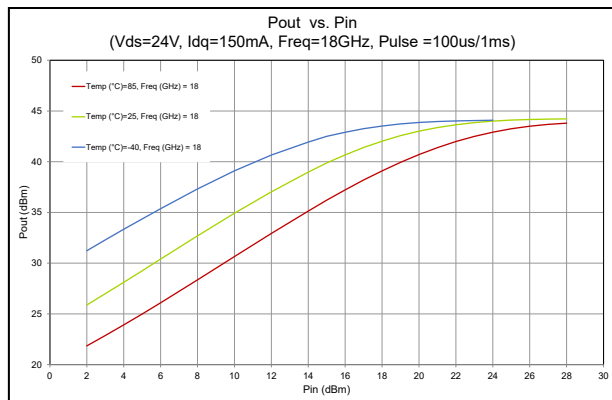




### Typical Large Signal Data | Test conditions unless otherwise stated

$V_D=24V$ ,  $I_{DQ}=150mA$ , Frequency=15GHz, Pulse width=100us, Pulse period =1ms



**Typical Large Signal Data** | Test conditions unless otherwise stated $V_D=24V$ ,  $I_{DQ}=150mA$ , Frequency=18GHz, Pulse width=100us, Pulse period =1ms



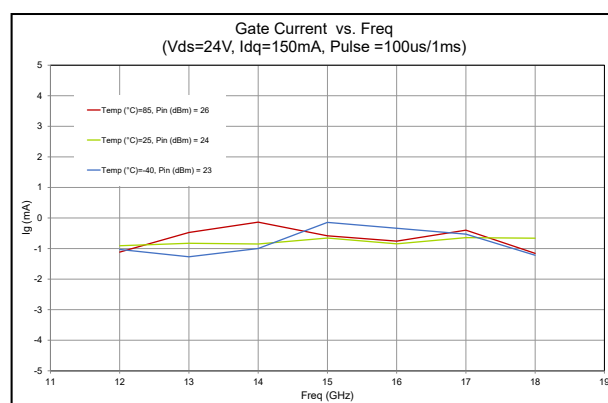
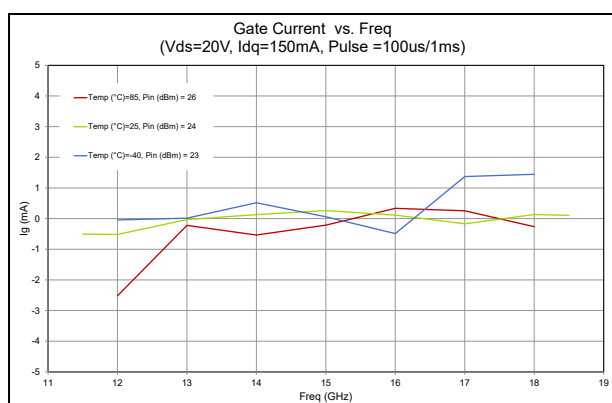
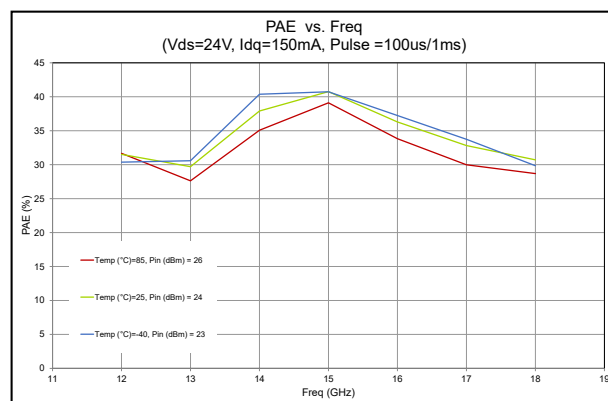
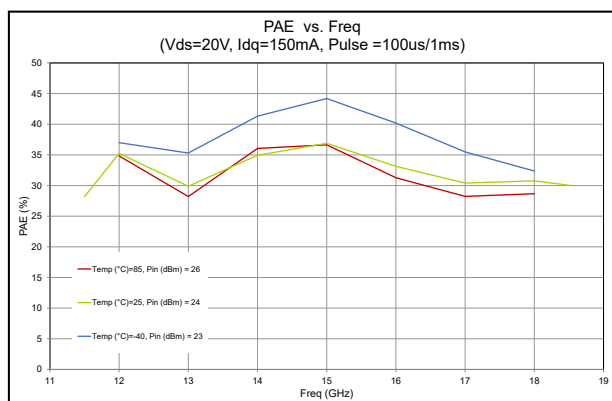
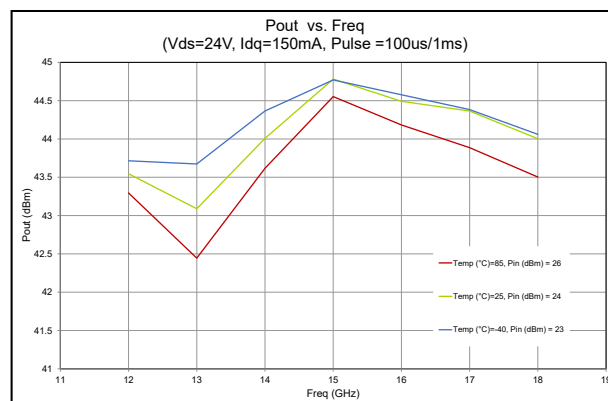
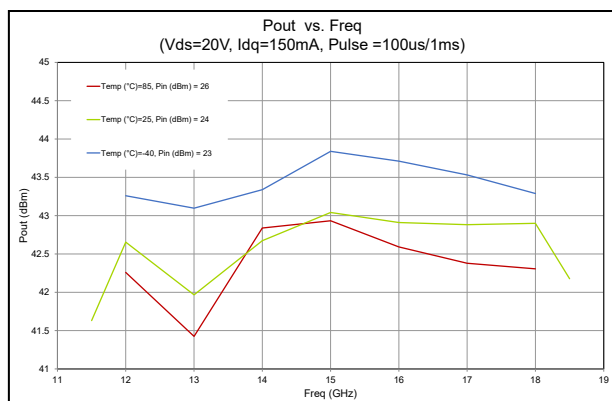
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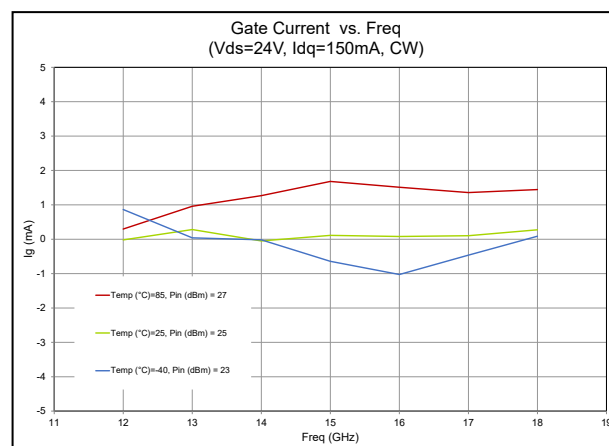
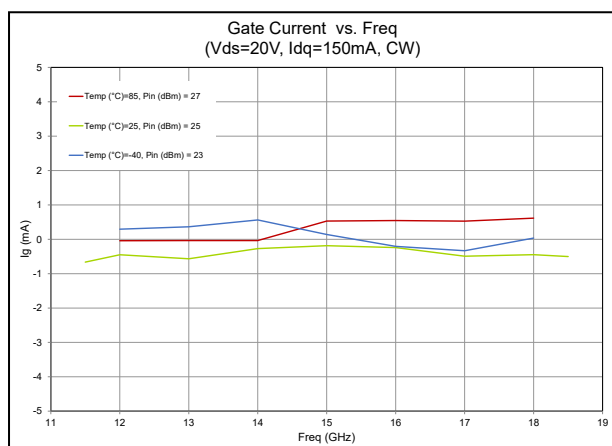
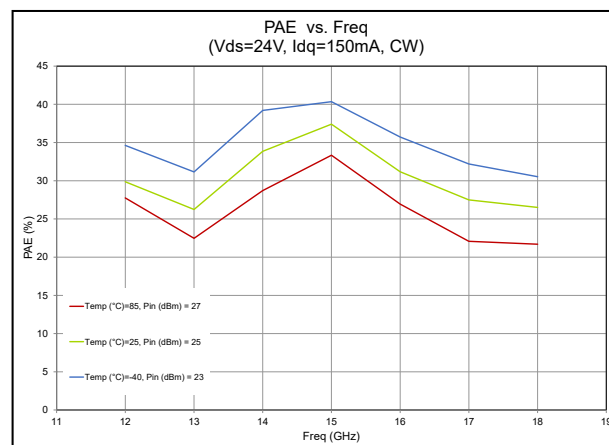
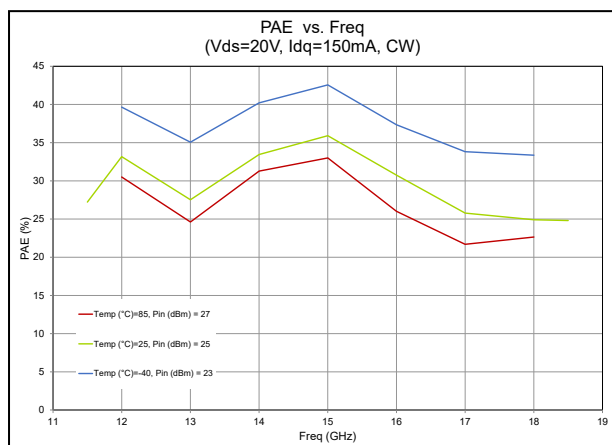
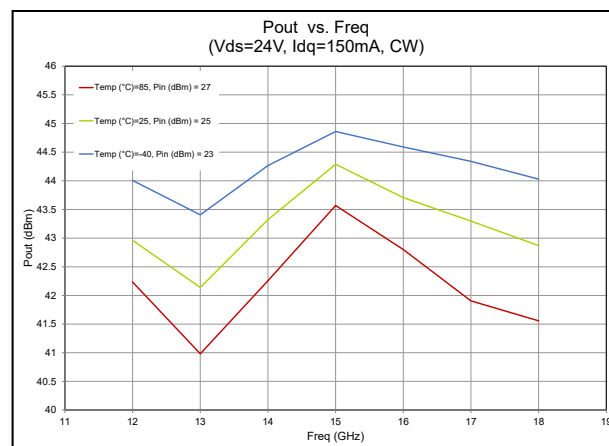
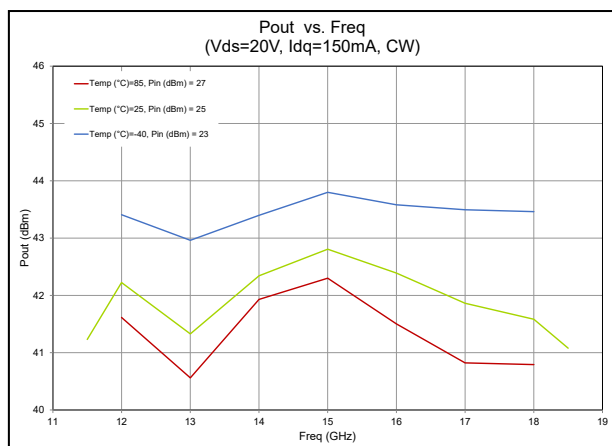
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**Typical Large Signal Data** | Test conditions unless otherwise stated  $I_{DQ}=150\text{mA}$ , Pulse width=100us, Pulse period =1ms



Typical Large Signal Data | Test conditions unless otherwise stated  $I_{DQ}=150\text{mA}$ , CW



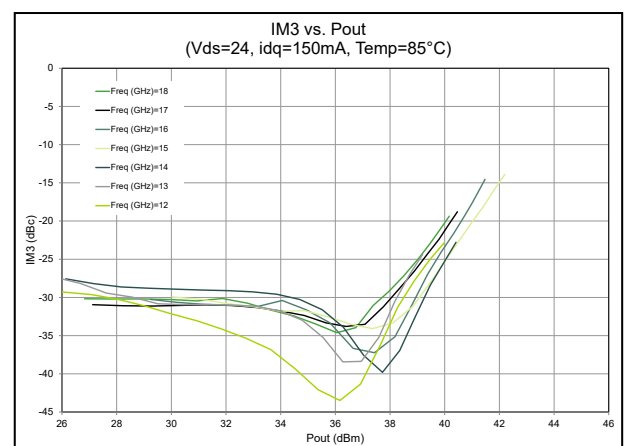
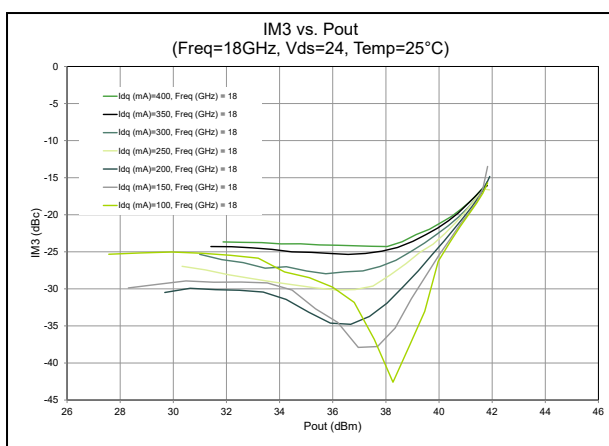
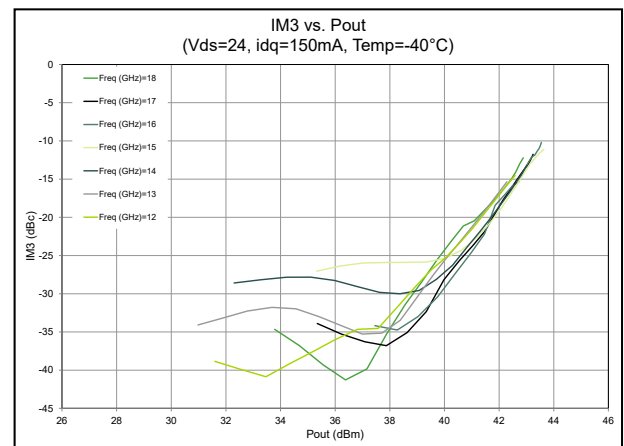
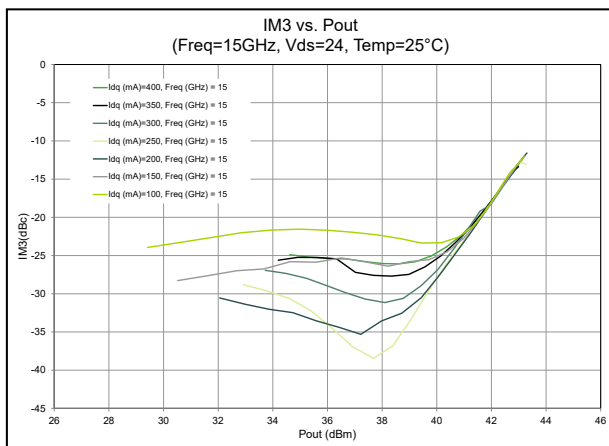
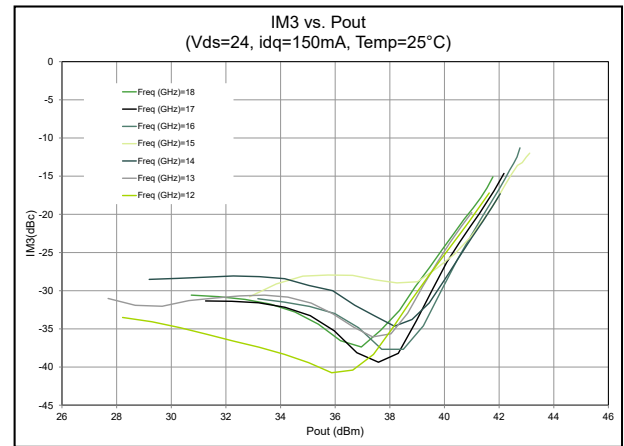
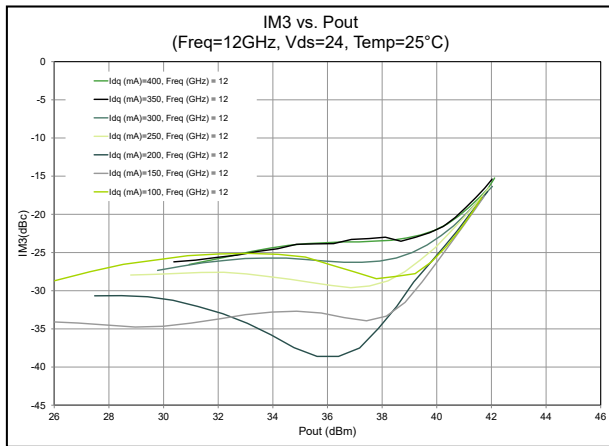
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## 12-18GHz 20W GaN PA MMIC

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**Typical Two Tone Data** | Test conditions unless otherwise stated  $V_D=24V$ ,  $I_{DQ}=150mA$ , Tone Spacing = 1MHz





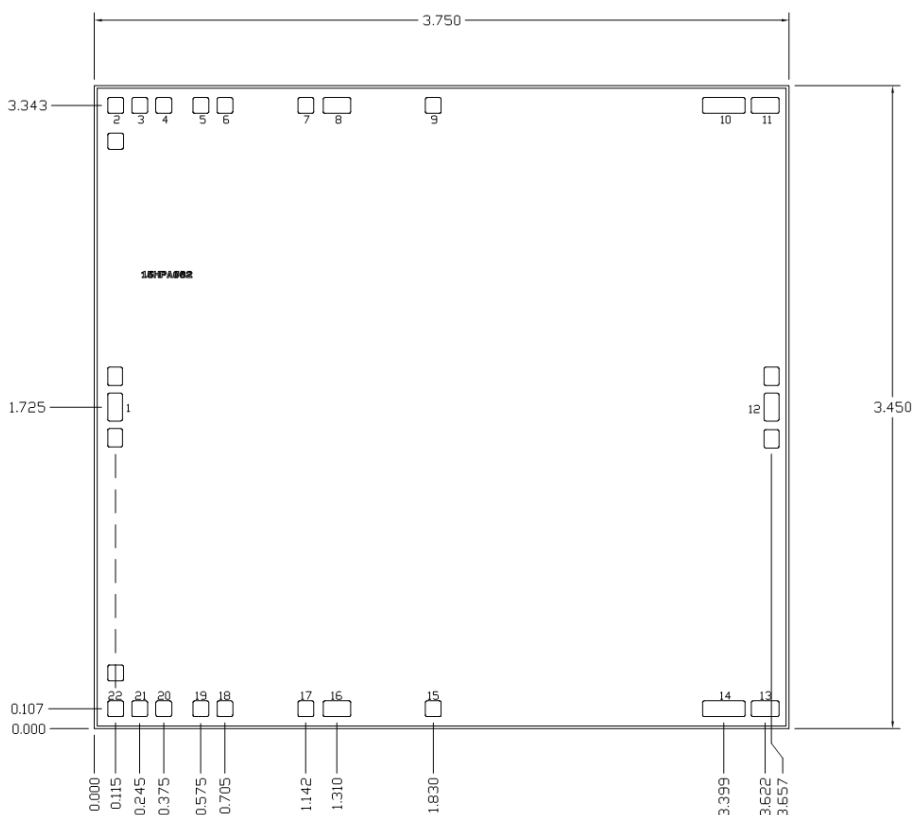
# ICONIC RF

## 12-18GHz 20W GaN PA MMIC

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### Mechanical Drawing



Units: mm

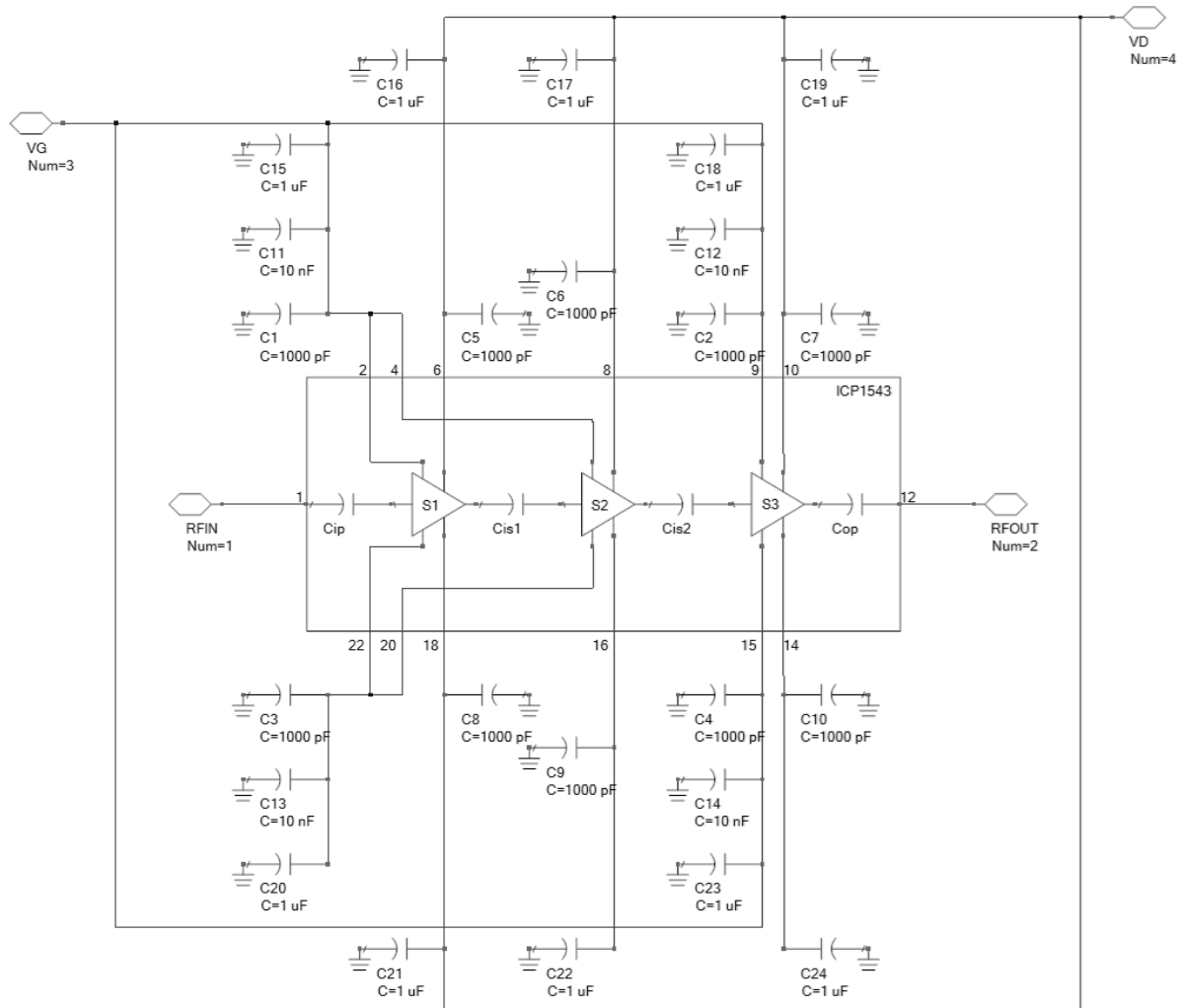
Thickness: 0.1mm

Backside is RF and DC ground

| Pad No             | Pad Size (um) | Function | Description                                                                                     |
|--------------------|---------------|----------|-------------------------------------------------------------------------------------------------|
| 1                  | 80x150        | RFIN     | 50 ohm RF input, DC blocked                                                                     |
| 2,22               | 85x85         | VG1      | First stage gate bias, decoupling and bypass caps required, must be biased from both sides      |
| 4,20               | 85x85         | VG2      | Second stage gate bias, decoupling and bypass caps required, must be biased from both sides     |
| 6,18               | 85x85         | VD1      | First stage drain voltage, decoupling and bypass caps required, must be biased from both sides  |
| 8,16               | 150x85        | VD2      | Second stage drain voltage, decoupling and bypass caps required, must be biased from both sides |
| 9,15               | 85x85         | VG3      | Third stage gate bias, decoupling and bypass caps required, must be biased from both sides      |
| 10,14              | 230x85        | VD3      | Third stage drain voltage, decoupling and bypass caps required, must be biased from both sides  |
| 12                 | 80x150        | RFOUT    | 50 ohm RF output, DC blocked, pad is DC grounded                                                |
| 3,5,7,17,<br>19,21 | 85x85         | GND      | Topside ground                                                                                  |
| 11,13              | 150x85        | GND      | Topside ground                                                                                  |



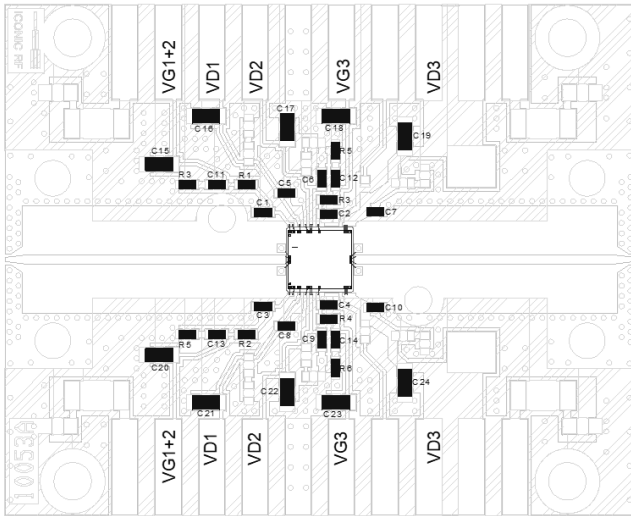
## Application Circuit



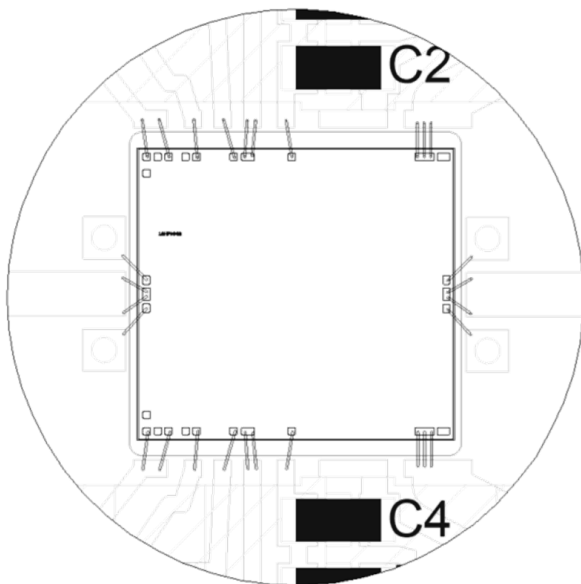
| Component ID | Value  | Quantity | Description                     | Manufacturer Part No. |
|--------------|--------|----------|---------------------------------|-----------------------|
| C1-C10       | 1000pF | 10       | 1000pF Capacitor 0402, COG, 50V | Various               |
| C11-C14      | 10nF   | 4        | 10nF Capacitor 0402, COG, 50V   | Various               |
| C15-C24      | 1uF    | 10       | 1uF Capacitor 0603, 35V         | Various               |



## Evaluation Circuit Assembly Drawing



Die Bonding



## Assembly Guidance

Amplifier must be biased from both sides.  
Optimum RF power performance achieved by minimizing output RF bond wire length.

### Interconnect assembly Notes

- Ball bonding or wedge bonding is preferred technique
- Force, time and ultrasonic parameters are critical
- Aluminum wire bonding is not recommended
- Bond Wire diameter of 1mil is recommended

### Die attach of component using adhesive

- Vacuum collets are preferred method of pickup.
- Pickup method must consider the avoidance of die air bridges.
- Silver sintered epoxy is recommended -Namics H9890-11, Kyocera CT2700R7S

### Die attach of component using Eutectic

- Flux-less gold-tin (AuSn) (80% Au, 20% Sn with a melting point of 280°C) preform is preferred between the die and attached surface.
- Recommended preform should be approximately 0.0012" thick.
- Die bonder using heated collet with a temperature of 310°C and die scrubbing should be used to ensure wetting and prevent formation of voids.
- Exposure to extreme temperature should be kept to a minimum.
- The optimum die attach environment is nitrogen atmosphere.

### Reflow Process

- Maximum temperature 320°C for 30 seconds.
- Material matching for Coefficient of thermal expansion is crucial for long-term reliability

## Bill of Materials

| Component ID | Value  | Quantity | Description                     | Manufacturer Part No. |
|--------------|--------|----------|---------------------------------|-----------------------|
| C1-C10       | 1000pF | 10       | 1000pF Capacitor 0402, COG, 50V | Various               |
| C11-C14      | 10nF   | 4        | 10nF Capacitor 0402, COG, 50V   | Various               |
| C15-C24      | 1uF    | 10       | 1uF Capacitor 0603, 35V         | Various               |
| R1-R6        | 0ohm   | 6        | 0 ohm resistor 0402 (link)      | Various               |



### Bias-Up Procedure

1. Set  $V_G = -5V$
2. Set  $V_D$  to 24V
3. Adjust  $V_G$  positive until  $I_D$  quiescent is 150mA  
(Typical  $V_G = -1.9V$ )
4. Limit  $I_D$  to 5A
5. Apply RF Signal

### Bias-down Procedure

1. Turn off  $R_F$
2. Turn off  $V_D$ , allow drain capacitor to discharge
3. Turn off  $V_G$ .

### Handling Procedures

Please observe the following precautions to avoid damage:

### Static Sensitivity

Integrated Circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these devices.



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ISBN: 978-1-5224-9497-3



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