



### 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.

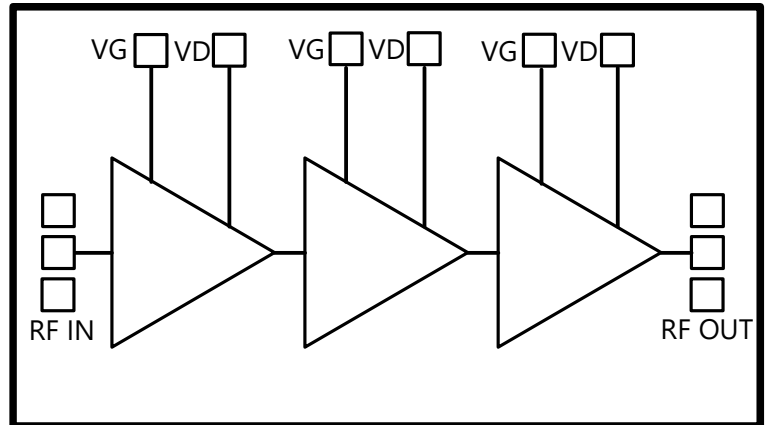
### Features

- 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 |



### 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 |

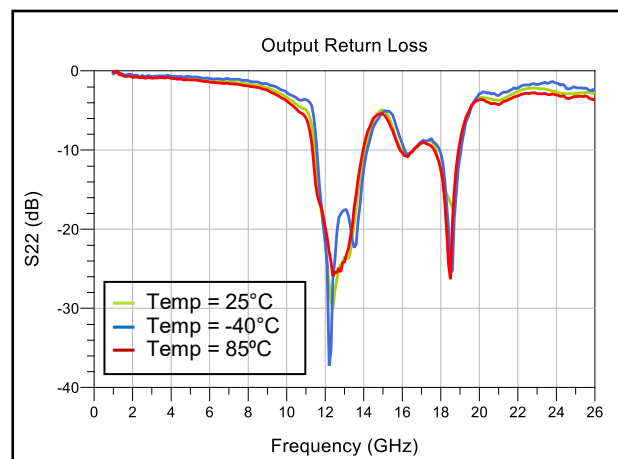
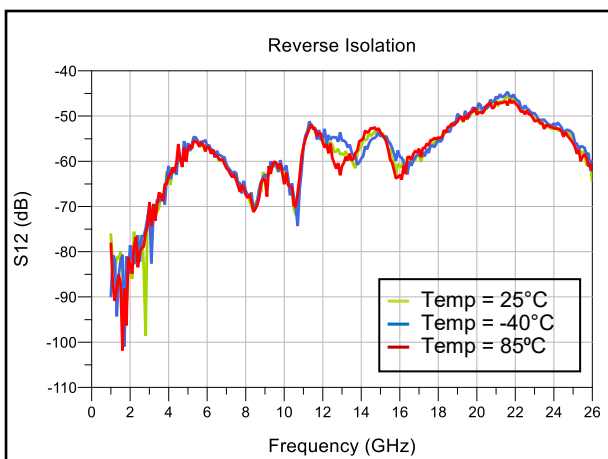
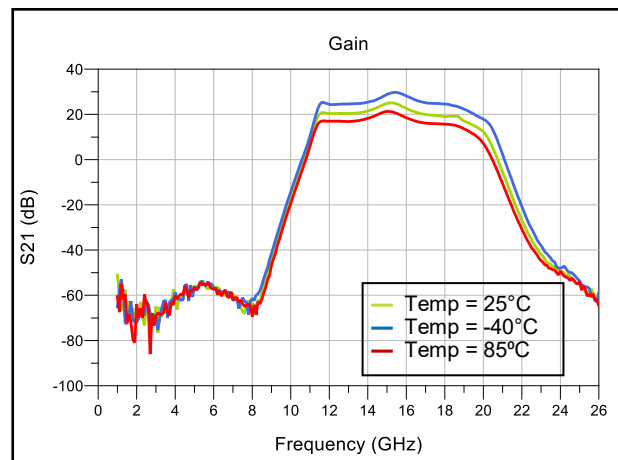
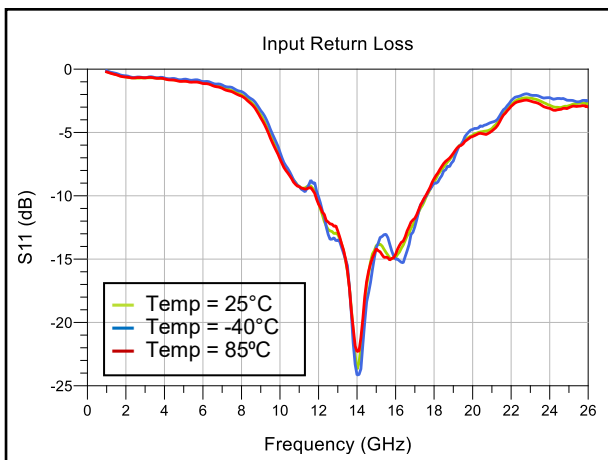
#### Notes

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

### Ordering Information

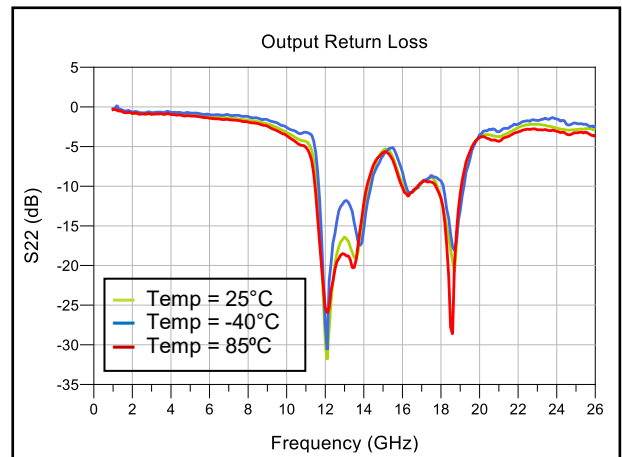
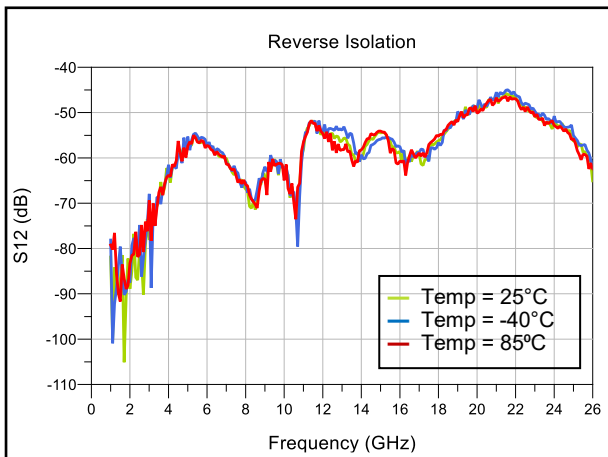
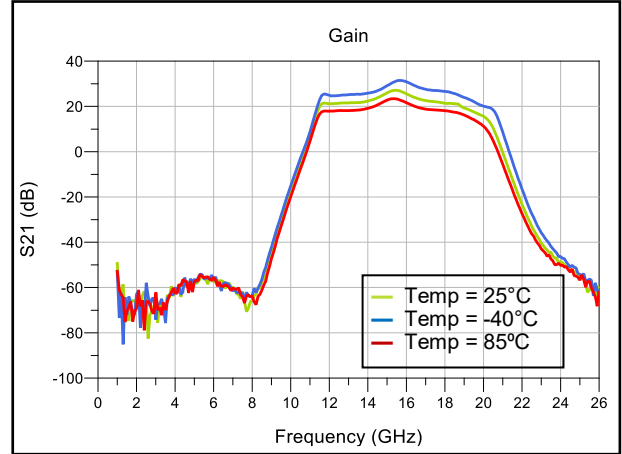
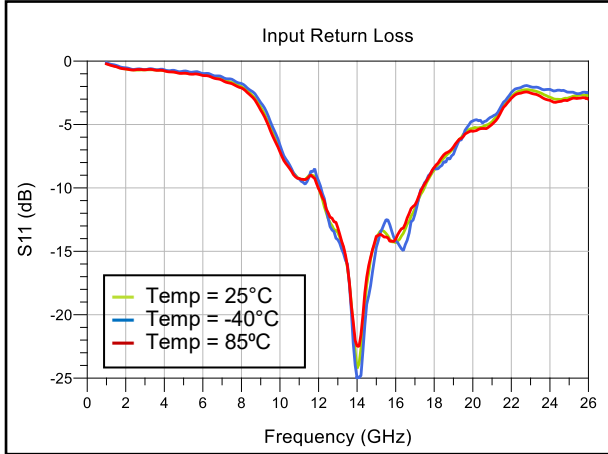
| Part No.       | Description                       |
|----------------|-----------------------------------|
| ICP1543-1-110I | Bare die in Gel-Pack trays        |
| EV83T37A       | ICP1543-1-501U EVB SMA connectors |

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



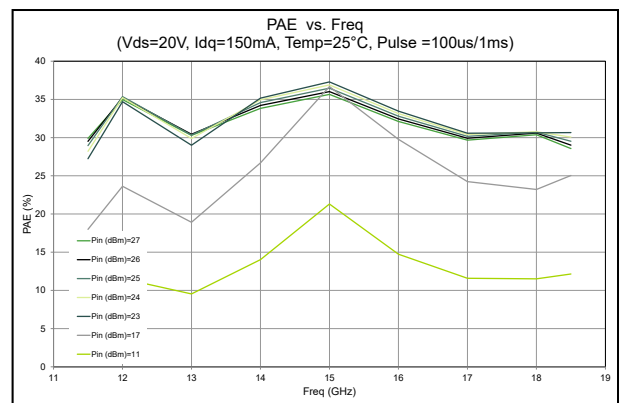
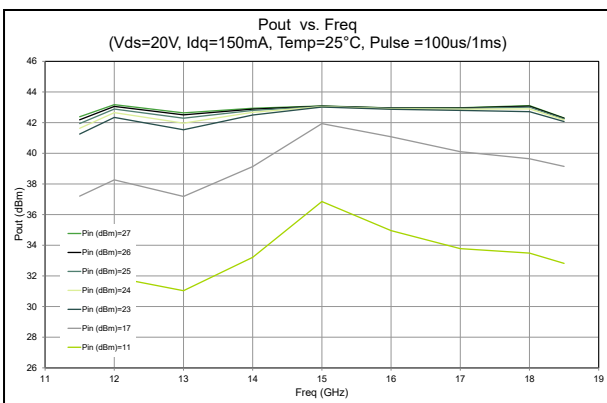
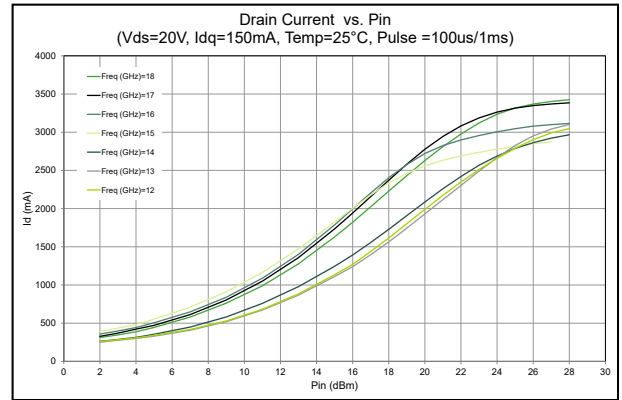
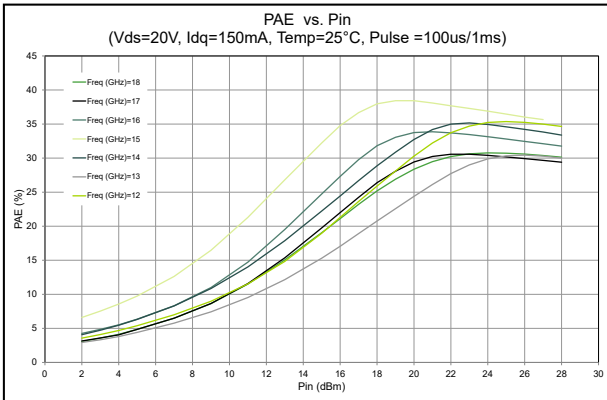
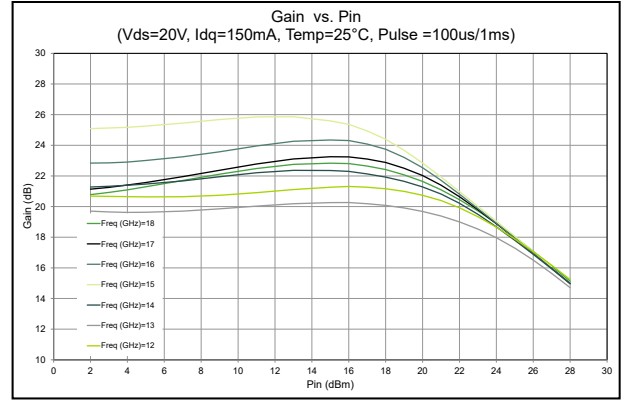
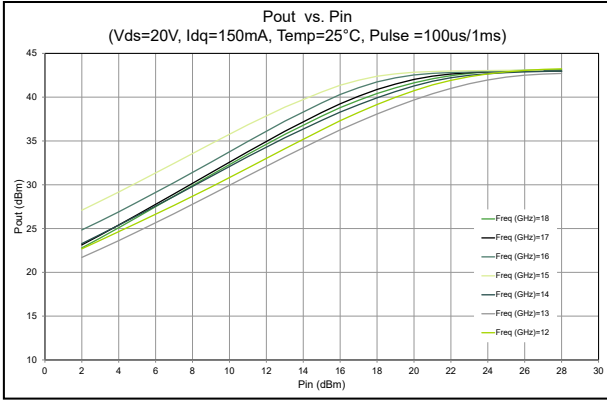


### Typical Small Signal Data | Test conditions unless otherwise stated $V_D=24V$ , $I_{DQ}=150mA$





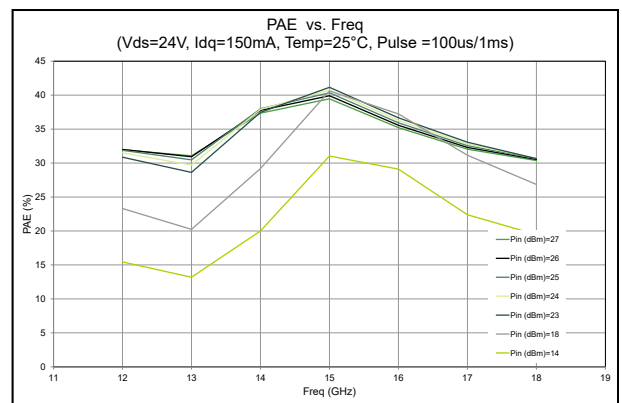
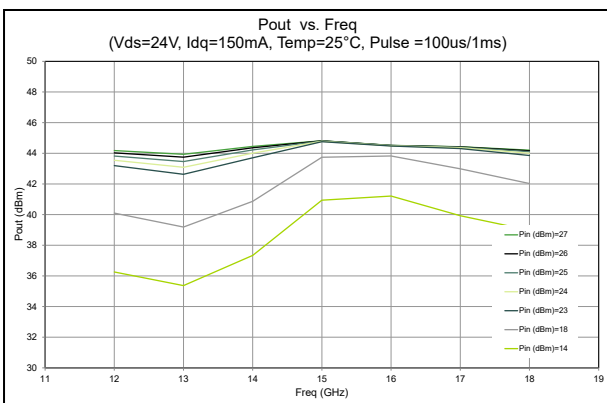
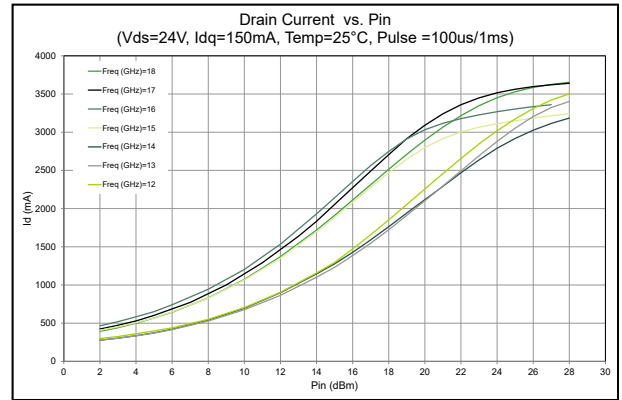
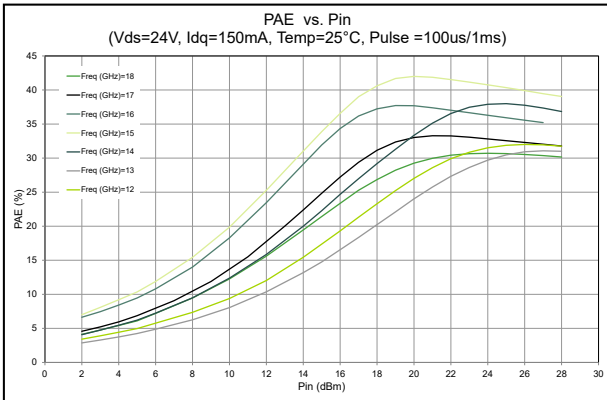
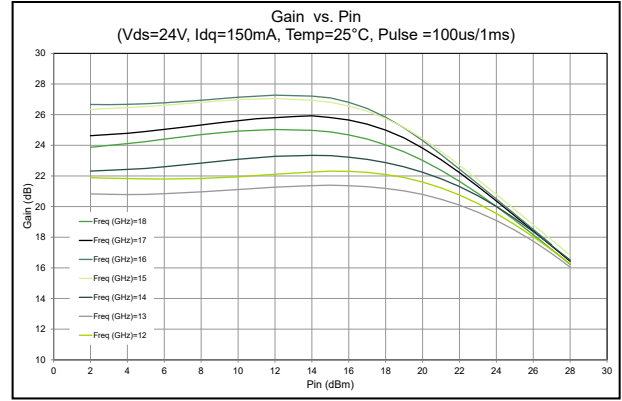
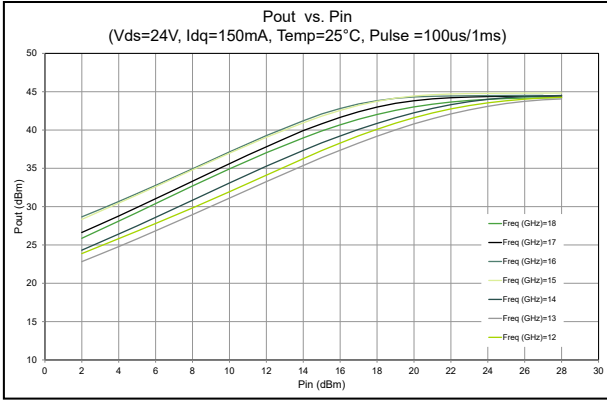
## Typical Large Signal Data | Test conditions unless otherwise stated $V_D=20V$ , $I_{DQ}=150mA$ , $T_A=25^\circ C$ , Pulse width=100us, Pulse period=1ms





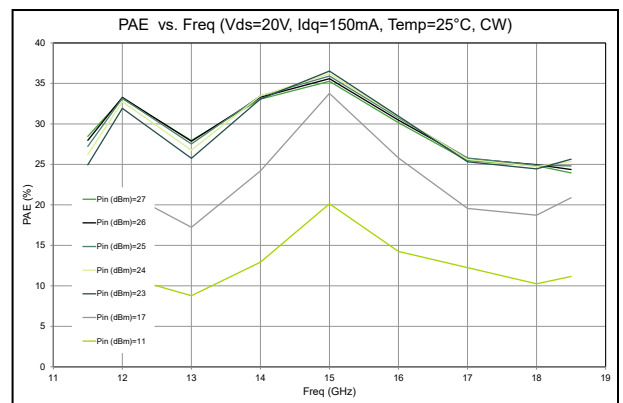
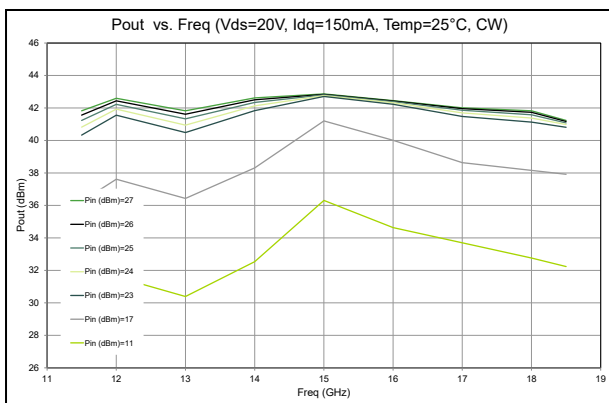
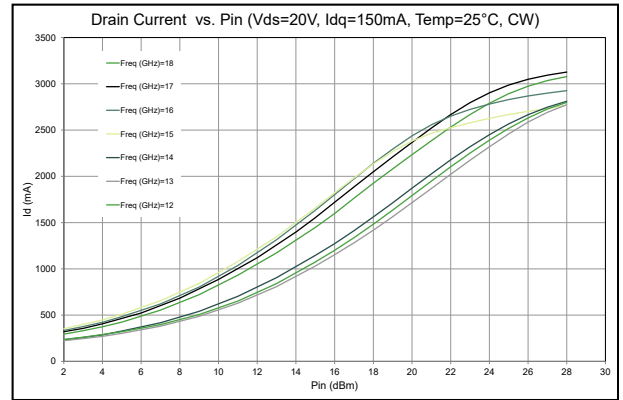
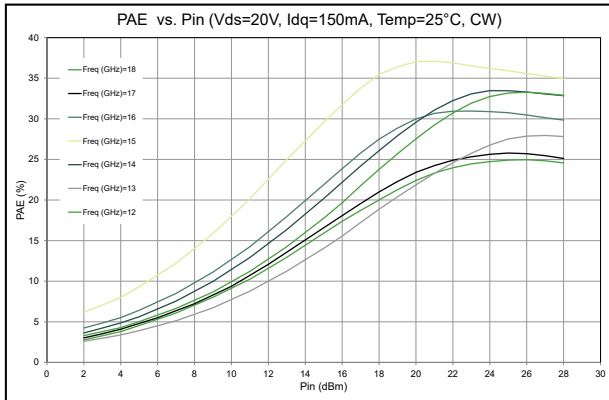
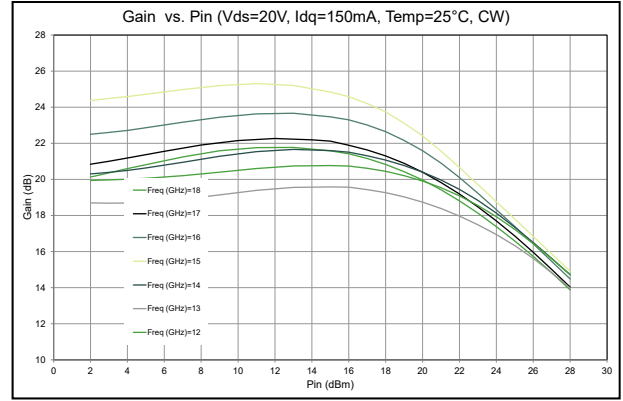
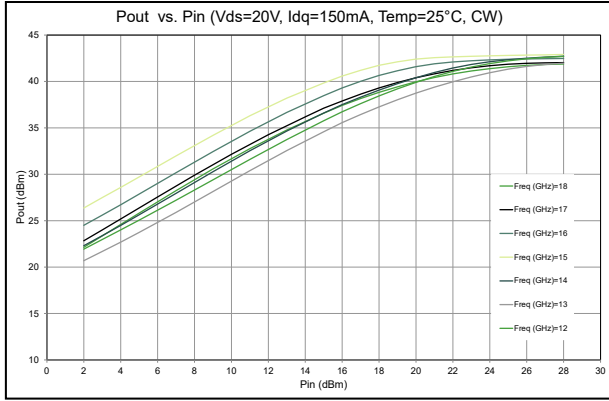
### Typical Large Signal Data | Test conditions unless otherwise stated

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



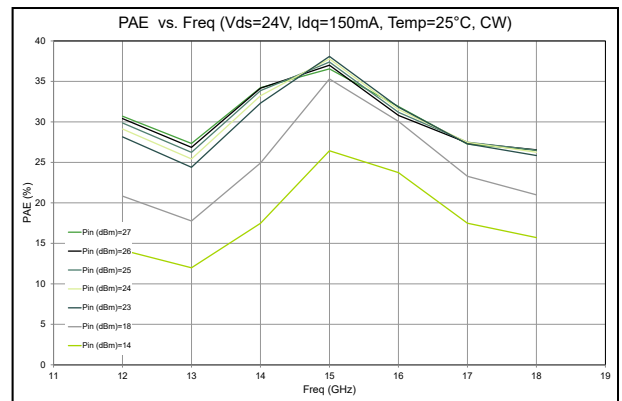
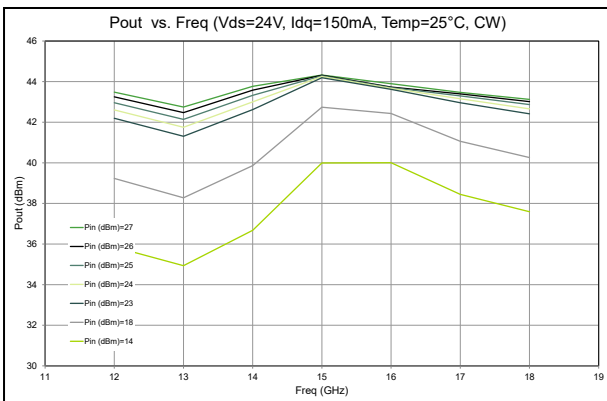
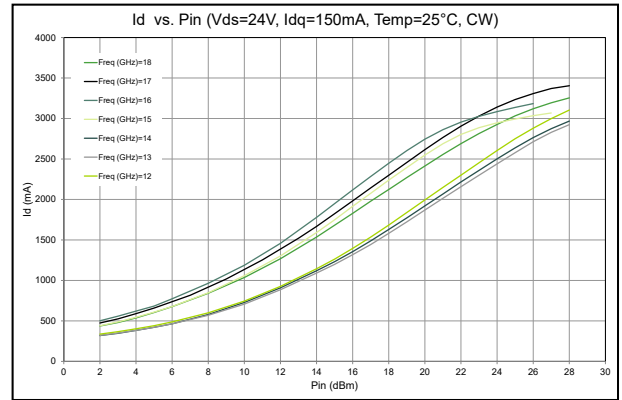
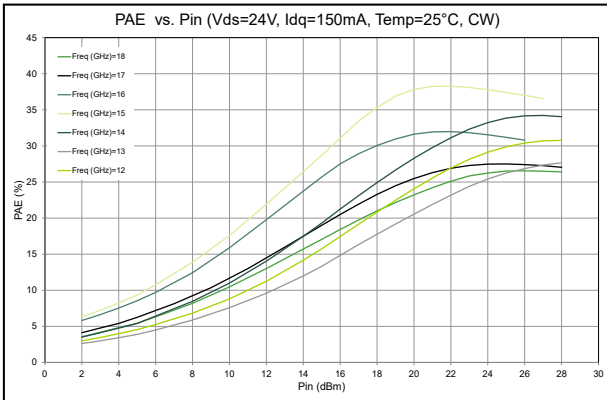
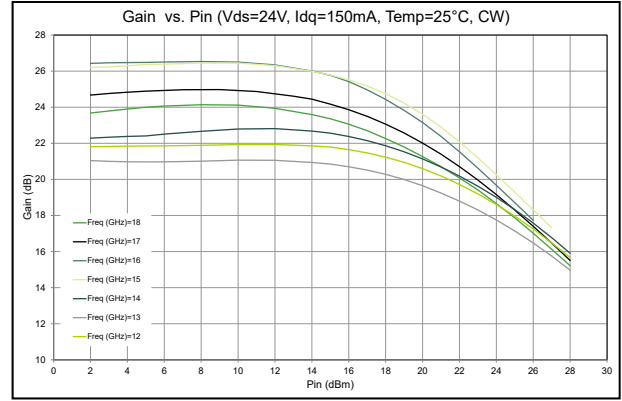
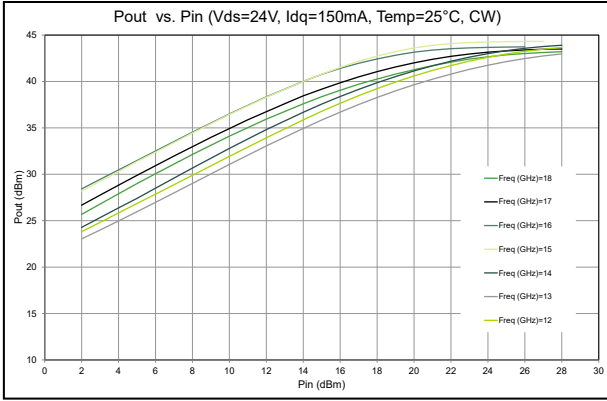


## Typical Large Signal Data | Test conditions unless otherwise stated $V_D=20V$ , $I_{DQ}=150mA$ , $T_A=25^\circ C$ , CW



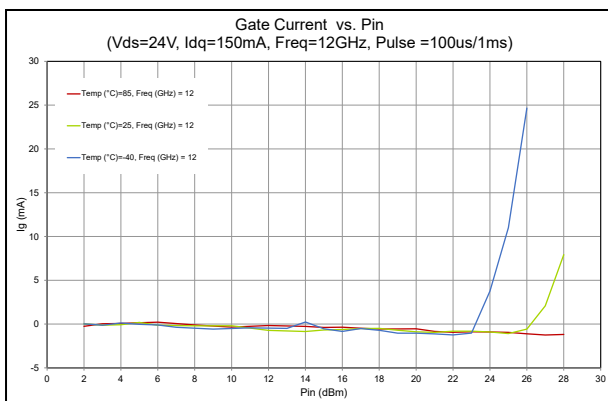
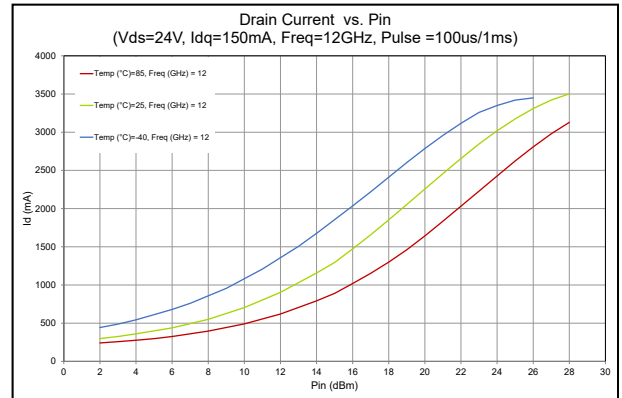
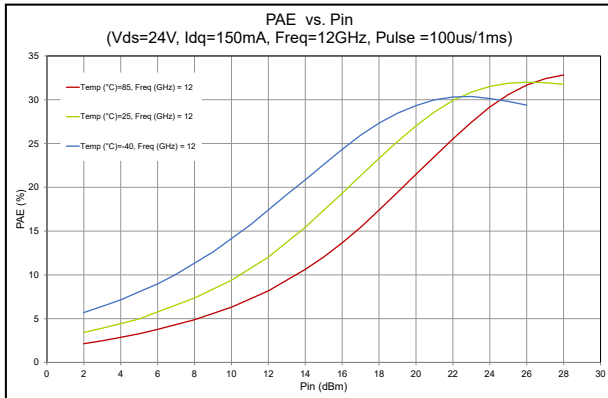
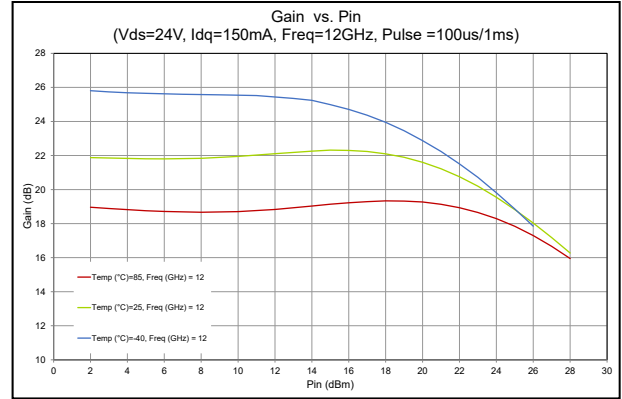
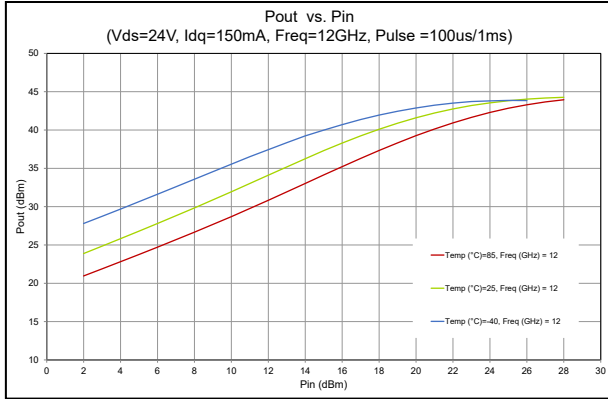


### Typical Large Signal Data | Test conditions unless otherwise stated $V_D=24V$ , $I_{DQ}=150mA$ , $T_A=25^\circ C$ , CW





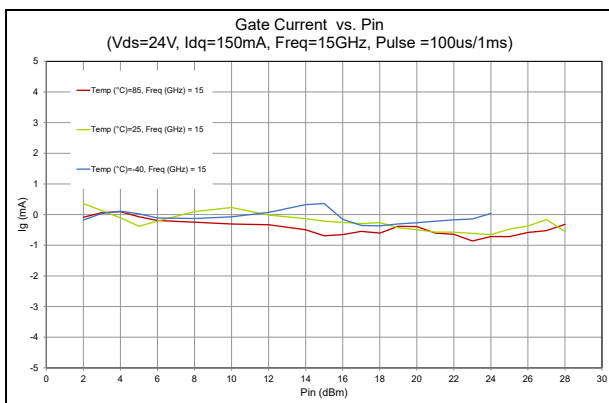
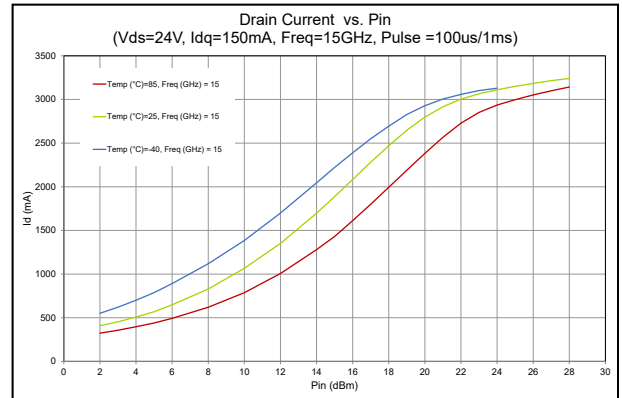
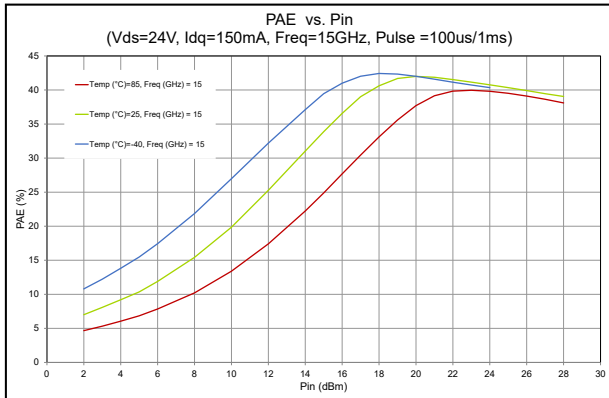
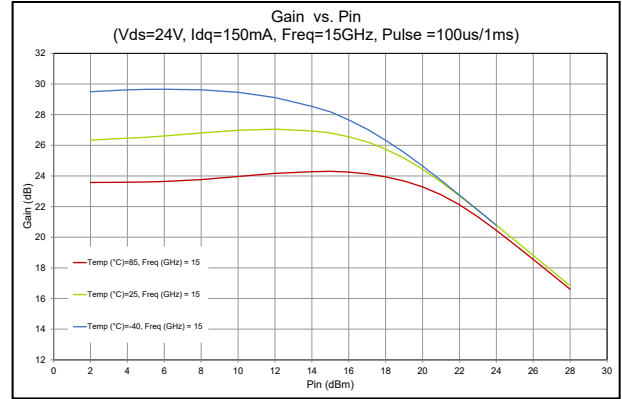
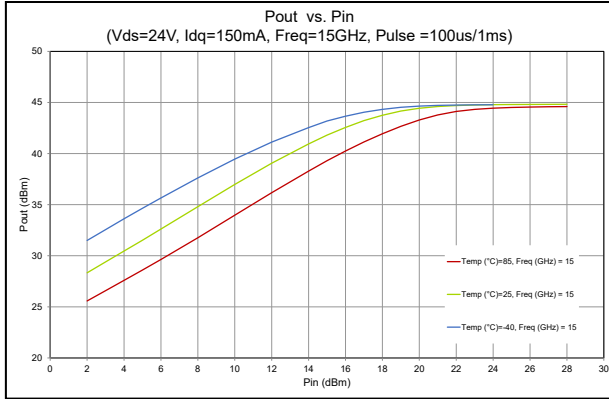
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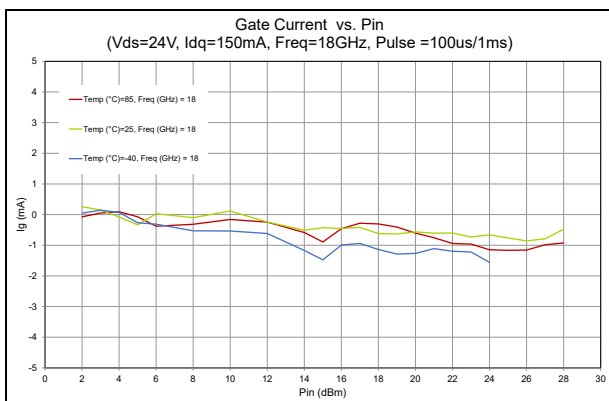
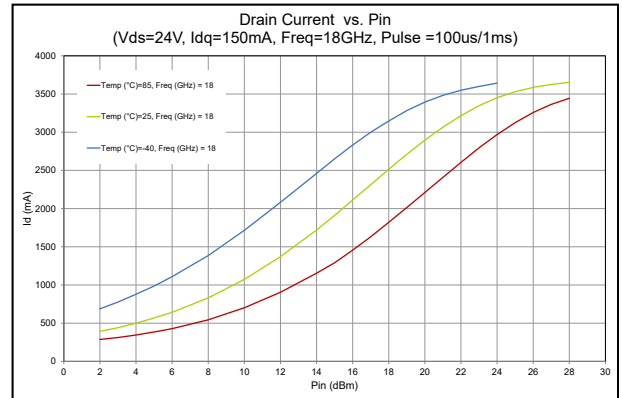
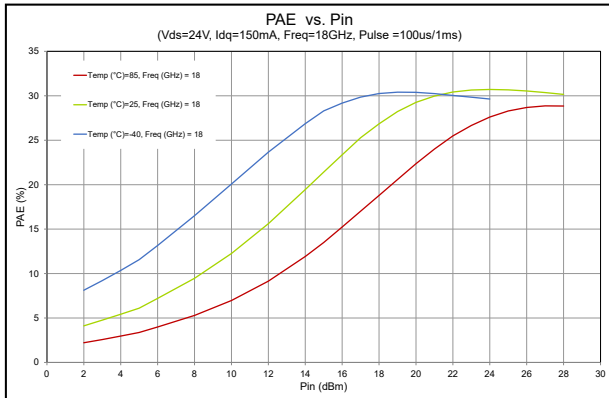
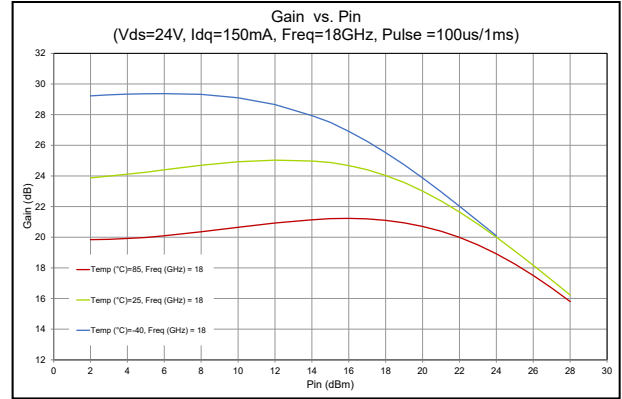
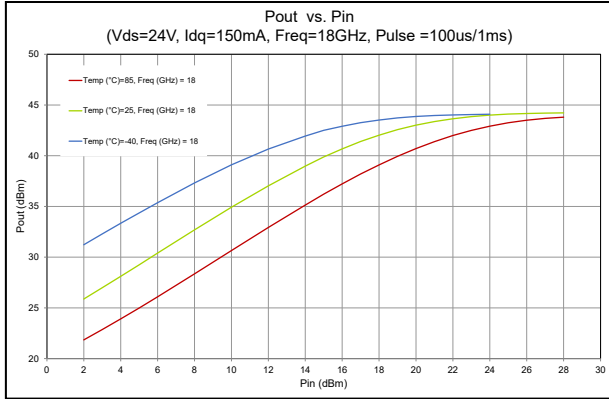


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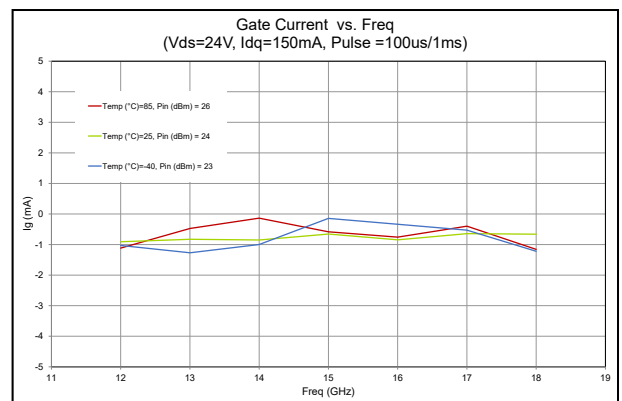
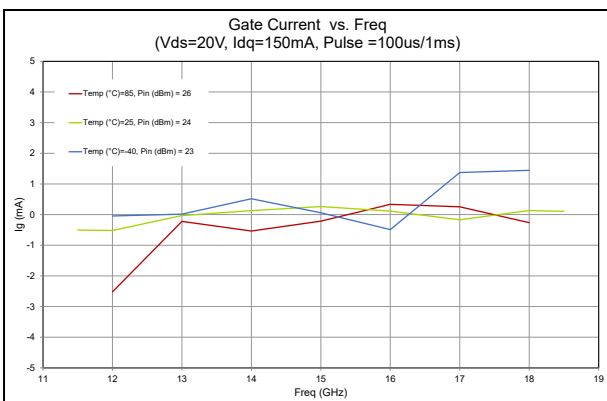
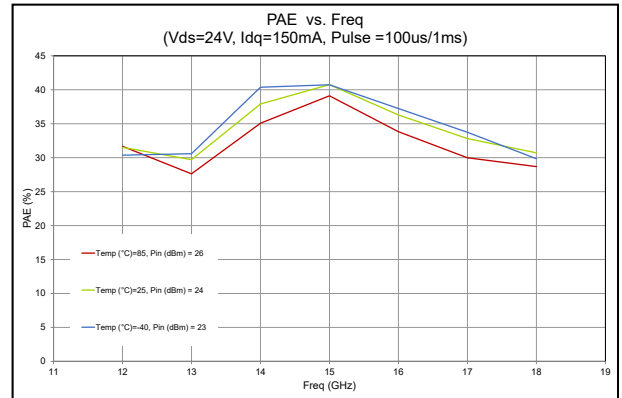
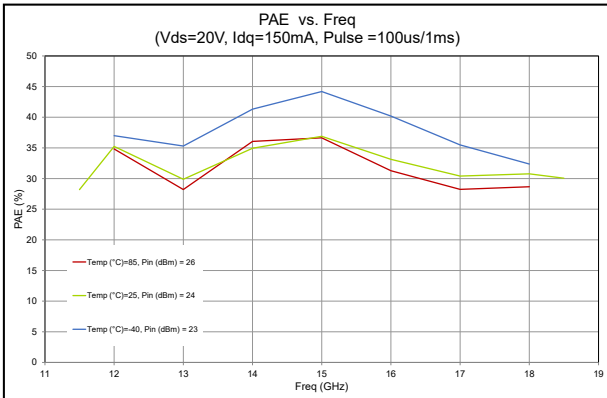
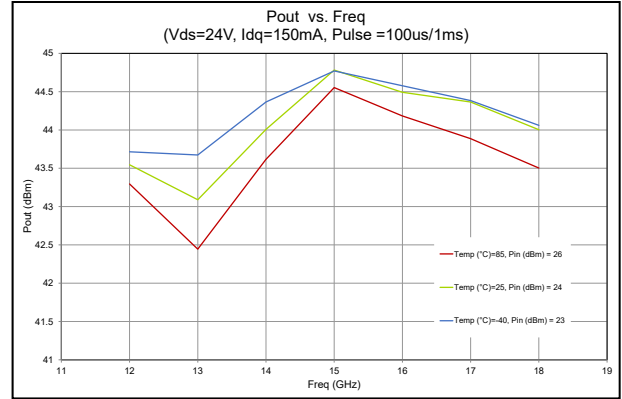
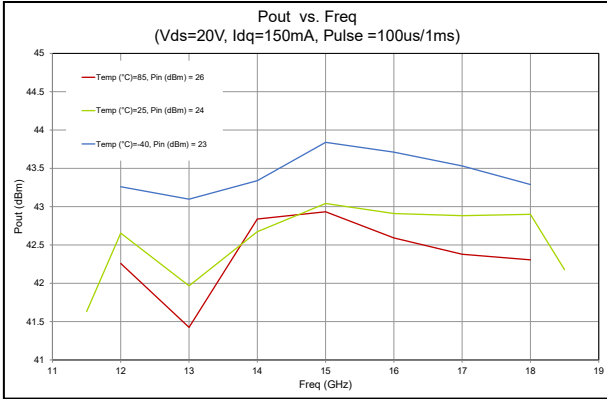


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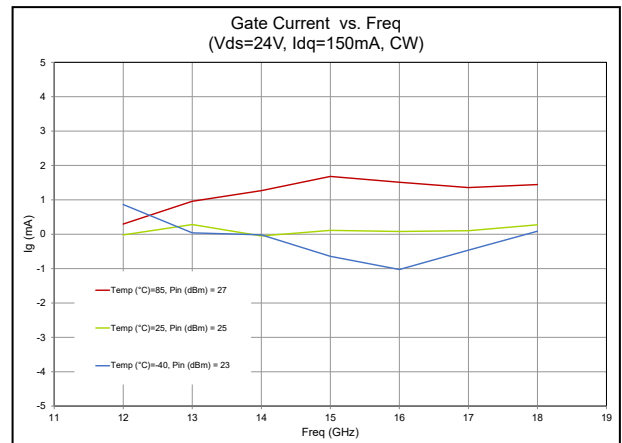
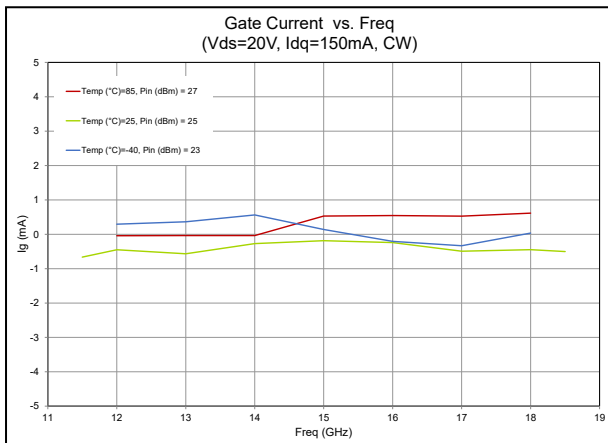
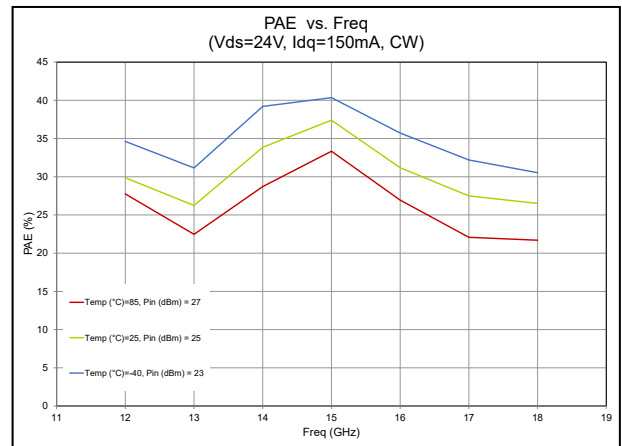
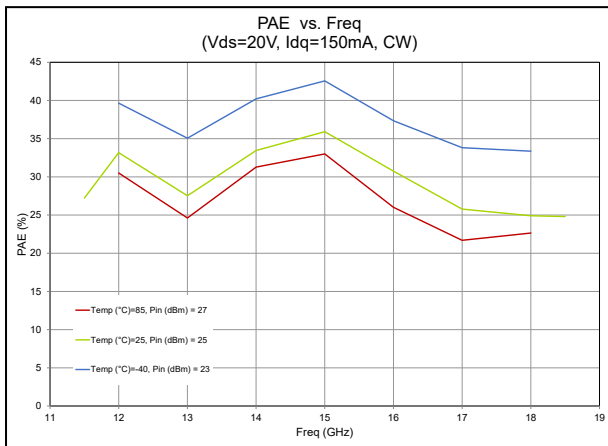
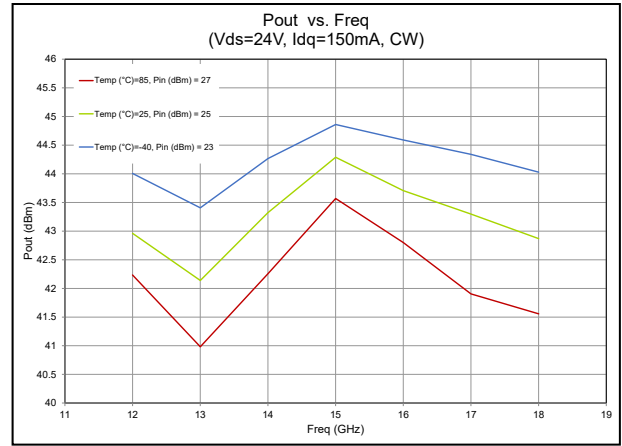
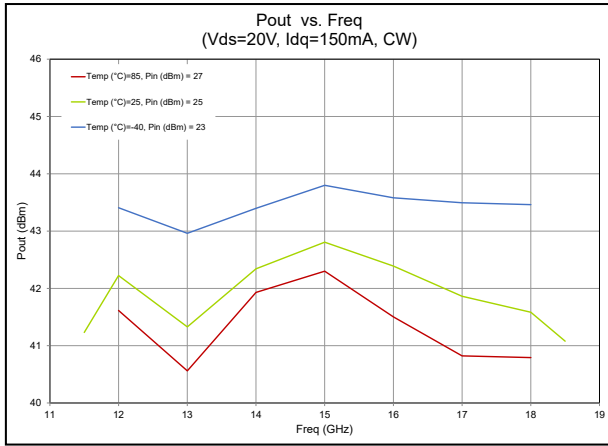


### Typical Large Signal Data | Test conditions unless otherwise stated $I_{DQ}=150\text{mA}$ , Pulse width=100us, Pulse period =1ms



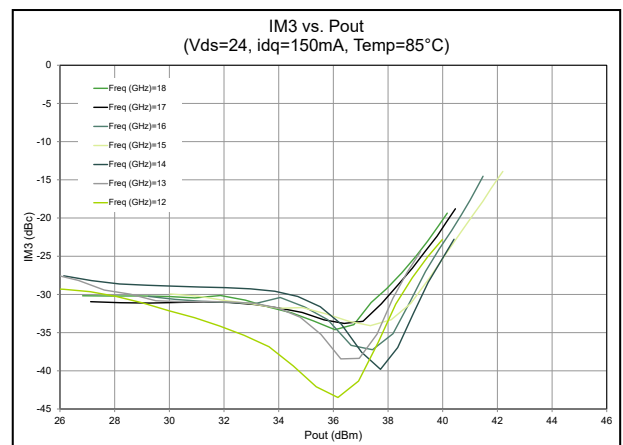
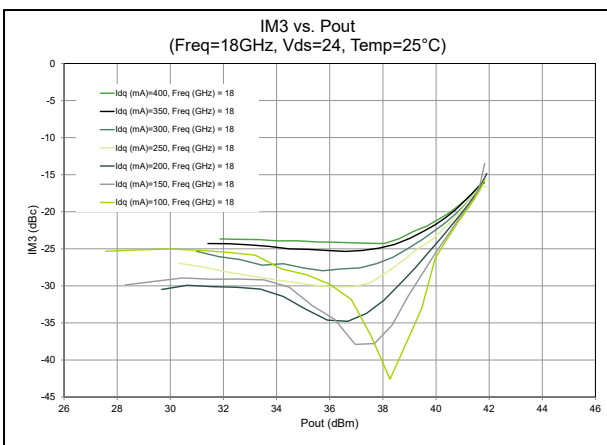
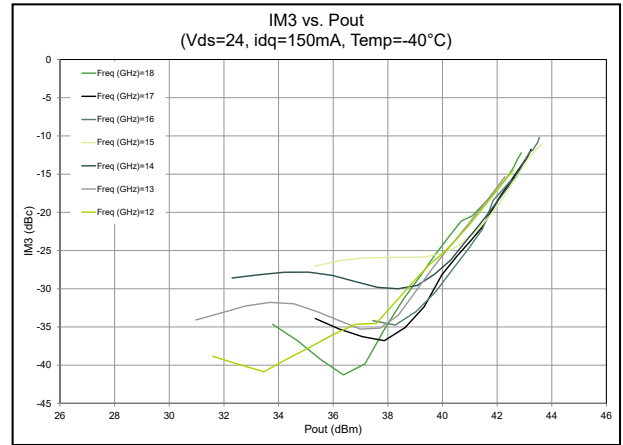
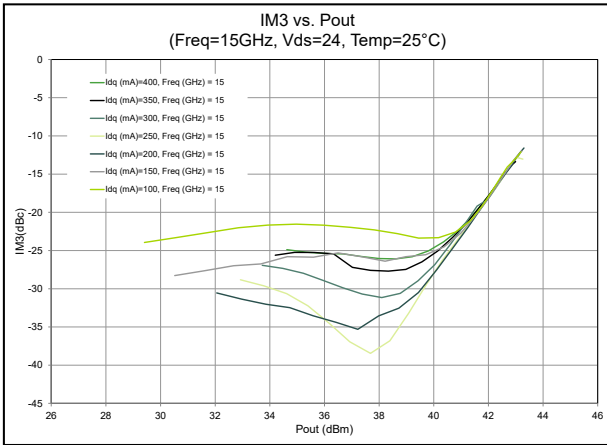
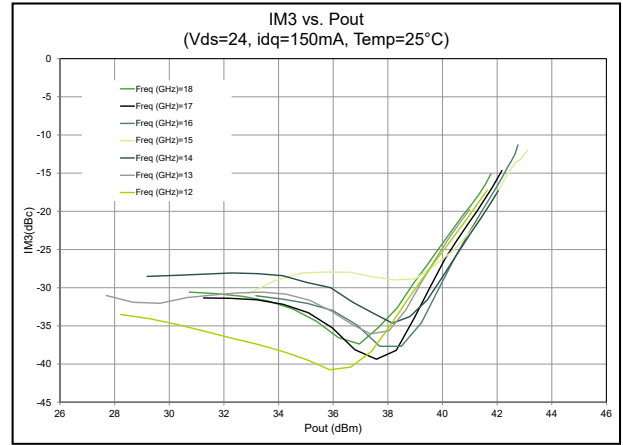
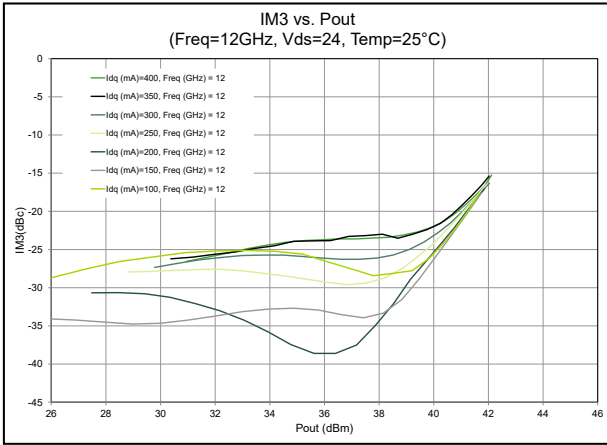


### Typical Large Signal Data | Test conditions unless otherwise stated $I_{DQ}=150\text{mA}$ , CW



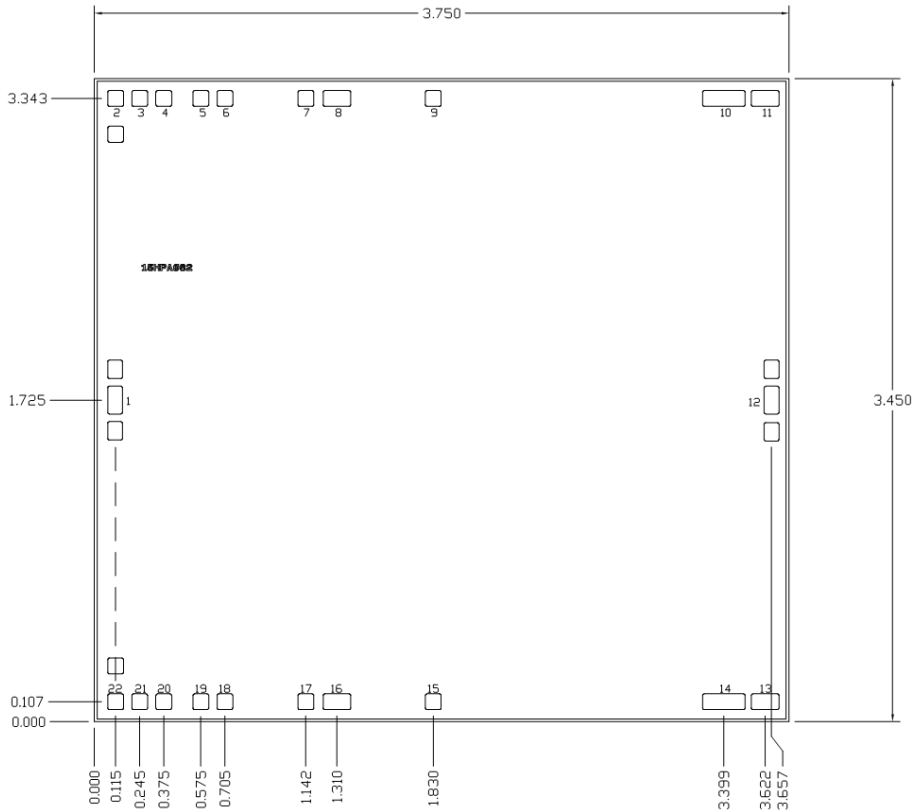


### Typical Two Tone Data | Test conditions unless otherwise stated $V_D=24V$ , $I_{DQ}=150mA$ , Tone Spacing = 1MHz





Mechanical Drawing

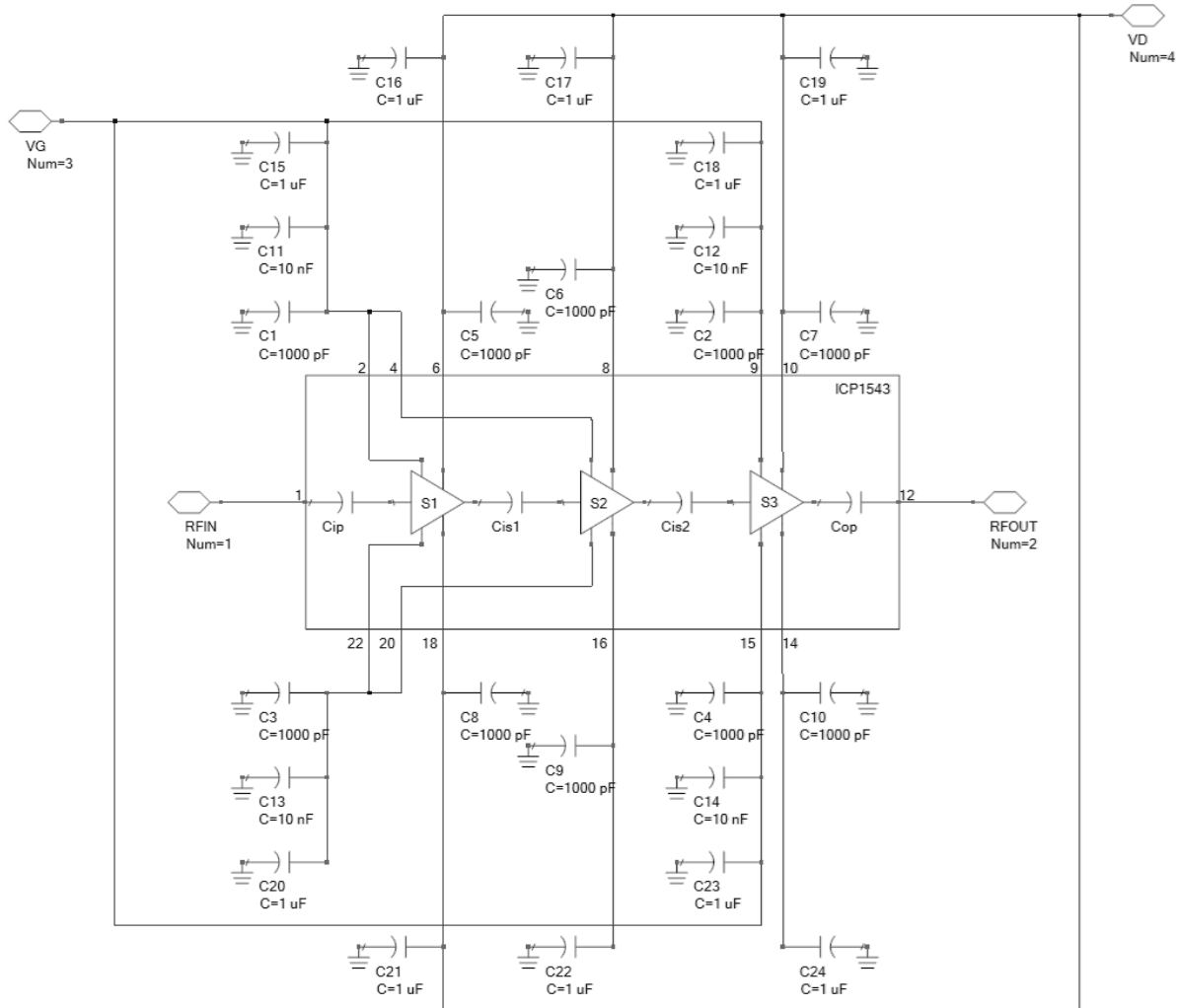


Units: mm  
 Thickness: 0.1mm  
 Backside is RF and DC ground

| 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  |
| 3,5,7,17,19,21 | 85x85         | GND      | Topside ground  |
| 11,13          | 150x85        | GND      | Topside ground  |



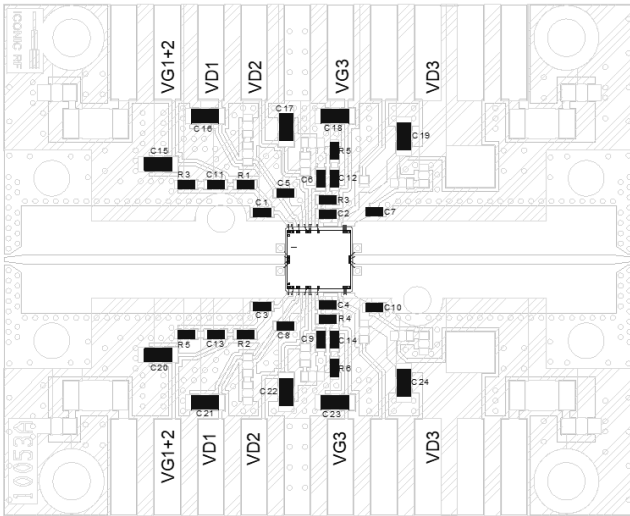
### Application Circuit



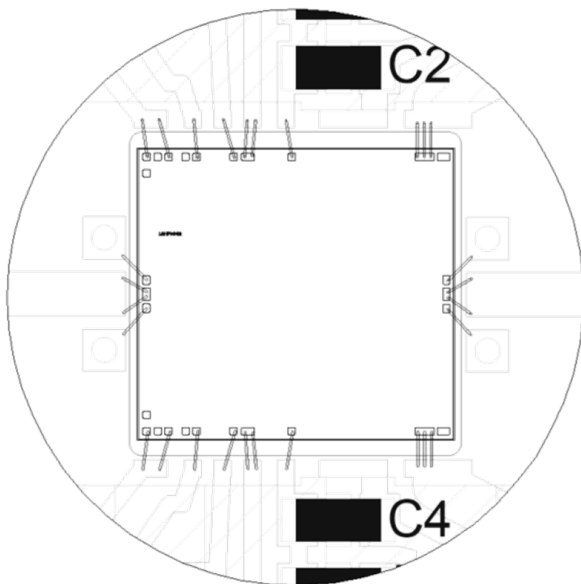
| Component ID | Value  | Quantity | Description                     | Manufacturer Part No. |
|--------------|--------|----------|---------------------------------|-----------------------|
| C1-C10       | 1000pF | 10       | 1000pF Capacitor 0402, COG, 50V | Various               |
| C11-C14      | 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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