Vectrawave
RF & Millimeter Wave MMIC Design

Application Note

Evaluation Board : P/N VM164DE

Die : VM164D

X-Band 50W GaN power amplifier Evaluation board

	Written	Controlled by	Approved by
Name	GDE		
Date	07/01/25		
Signature	OK		

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I. HISTORIC

Edition	Date	Description of Evolutions
1.0	15/09/22	Creation
2.0	07/01/25	Update

II. SUMMARY

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IV. INTRODUCTION

IV-1. Description

The VM164DE is an evaluation board of the VM164D die. It is working in the X-band frequency bandwidth.

The evaluation board is composed of 2 mains parts:

- VM164D X-Banbd HPA Die with the first order decoupling (1)
- Test structure support: PCB's with SMA/DC connectors and heatsink (2)

The test structure support uses a RF PCB on a CuW carrier with SMA connectors, 2 DC PCB's with second order decoupling components and connectors to bias the component, all this on an aluminum mechanical support screwed on a heat sink (with fan).

Supply cables are not provided.

This document describes the way to use the VM164DE Evaluation board

Typical RF results are included.

IV-2. Evaluation Board photo

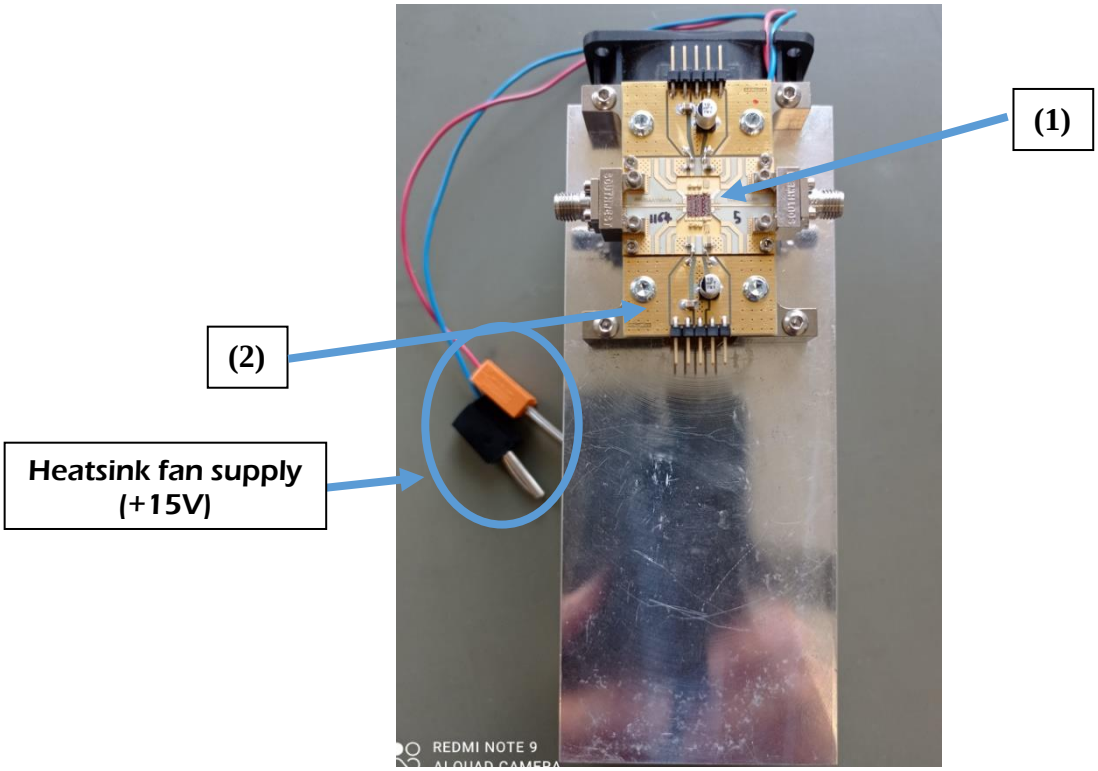

Figure 1. VM164DE evaluation board with its dissipator

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V. INTERFACE AND COMPONENTS

V-1. VM164DE interface

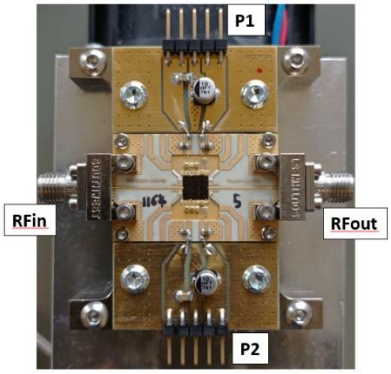

Figure 2. Evaluation board VM164DE interface

Connector	Type	Allocation
P1/P2	DC connectors	- V_D power supply - V_G power supply - GND
RF IN	SMA female	HPA RF input
RF OUT	SMA female	HPA RF output

Table 1. VM164DE EVB PINOUT

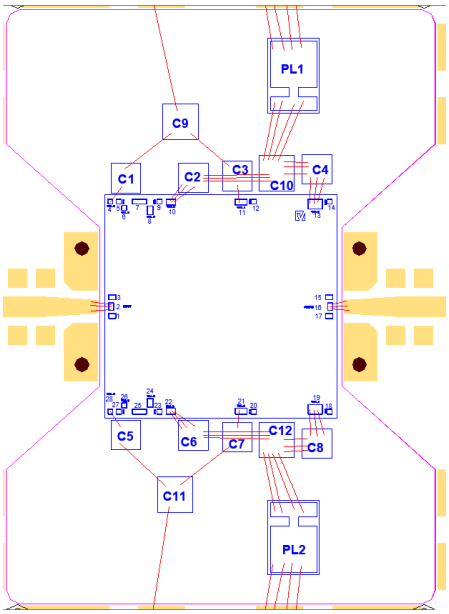

Figure 3. DC PCB's cabling (first order decoupling)

Components	Value	Type
C1 to C8	1 nF	D25 MIM capacitor
C9 to C12	10 nF	D30 MIM capacitor

Table 2. RF PCB's first order decoupling

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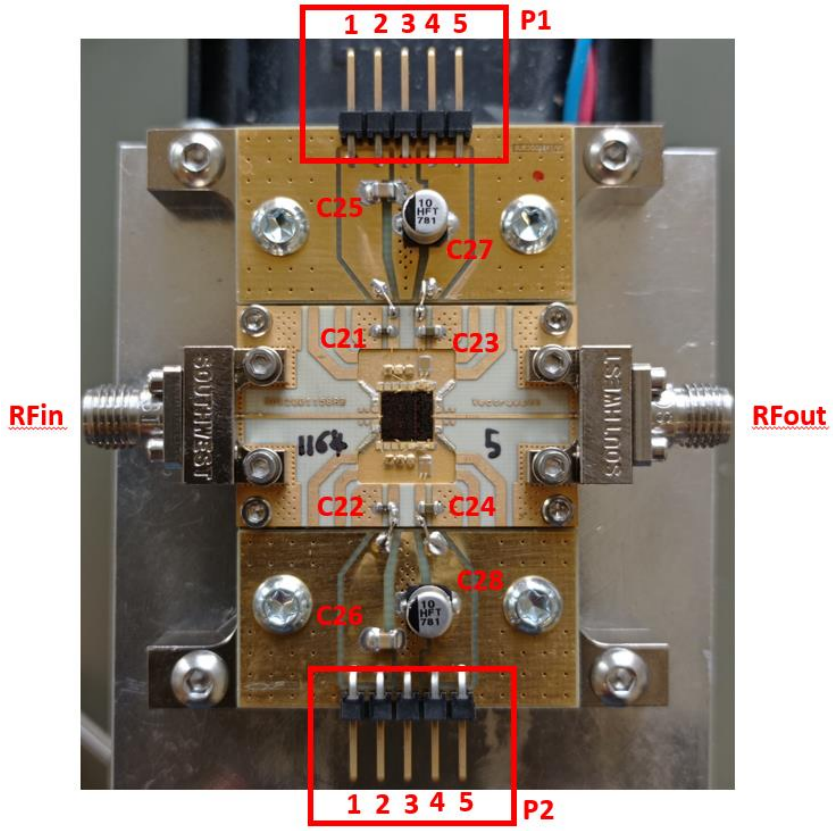

Figure 4. DC PCB's cabling (second order decoupling)

P1	
PIN	**P1 Identification**
1	V_G
2	V_G
3	GND
4	V_D
5	V_D

P2	
PIN	**P2 Identification**
1	V_G
2	V_G
3	GND
4	V_D
5	V_D

Table 3. P1/P2 PINOUT identification

Components	Value	Type
C21, C22	1µF/16V	0402
C23, C24	1µF/50V	0603
C25, C26	100µF/6.3V	0805
C27, C28	10µF/50V	electrolytic

Table 4. DC PCB's second order decoupling

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VI. BIASING PROCEDURE AND OPERATING CONDITIONS

VI-1. Electrical operating conditions

- V_D = +28V
- I_{DQ} = 450mA (Typically VG= -2.35 V)
- RF pulsed (pulse width : 30µs, duty cycle 10%)

VI-2. Biasing procedure

Switch on

1. Set V_G to 0V
2. Set V_D to 0V
3. Set +15V on dissipator fan
4. Set V_G to -3V
5. Set V_D to +28V
6. Increase V_G to obtain I_{DQ}= 450mA (Typically VG= -2.35 V)
7. Turn RF (pulsed mode) ON

- Always apply V_G before applying V_D
- Do not respect this may cause permanent damage on component.

Switch off

1. Turn RF OFF
2. Decrease V_G to -3V
3. Decrease V_D to 0V
4. Decrease V_G to 0V
5. Turn OFF dissipator fan

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VII. ABSOLUTE MAXIMUM RATING

Symbols	Parameter	Max	Units
V_D	Drain voltage	32	V
I_{DQ}	Drain quiescent current	0.7	A
Pin	maximum input power overdrive	30	dBm

Table 5. Absolute Maximum Rating

Operation of this device above any of these parameters may cause permanent damages.

VIII. TYPICAL EVB MEASUREMENTS RESULTS

VIII-1. Measurements conditions

Reference plane measurements :

SMA connectors

Losses estimation :

For information, the losses of a 50Ohms line in the same structure and dimensions that the VM164DE Evaluation board RF PCB :

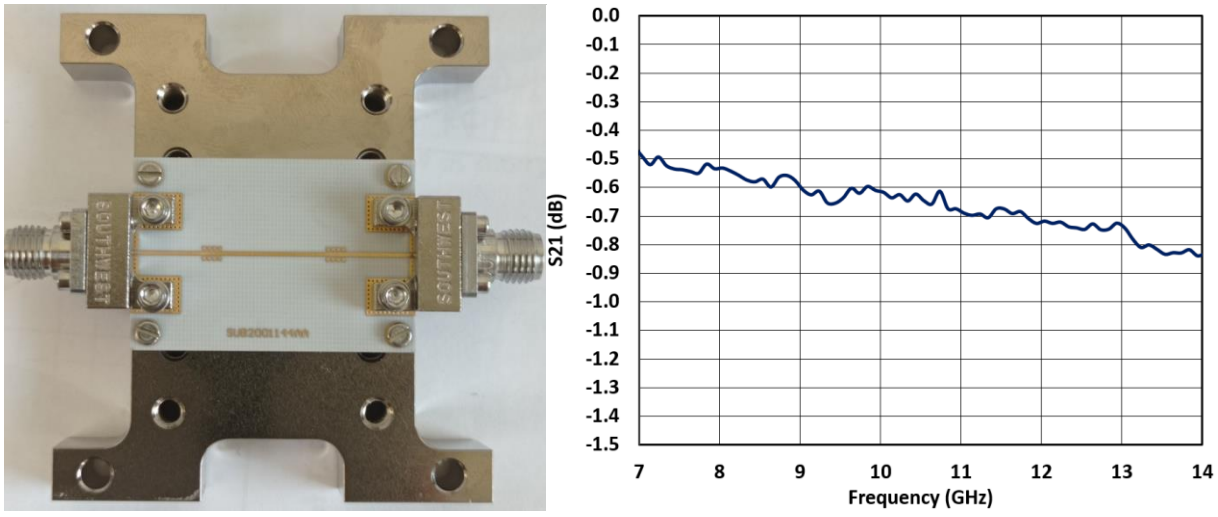

Figure 5. Losses estimation

50Ohms line S2P files can be provided on demand

Measurement conditions :

- V_D = +28V

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- I_{DQ} = 450mA (Typically VG= -2.35 V)
- RF pulsed (pulse width : 30µs, duty cycle 10%)

Room temperature : +23°C.
Structure temperature (V_D =28V, I_{DQ} = 550mA, RF OFF) : +28°C
Heatsink with fan Rth : 0.175°C/W

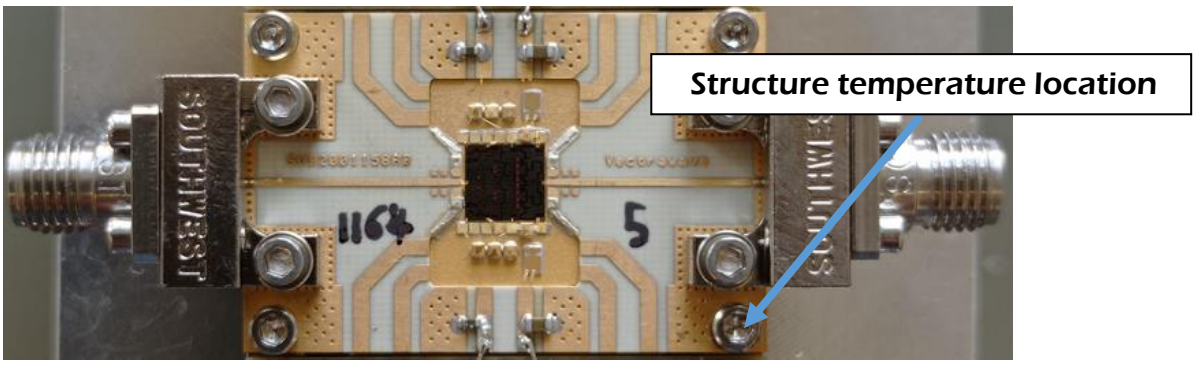

Figure 6. Structure temperature location

VIII-2. S-Parameters

RF CW (Pin =-25 dBm).

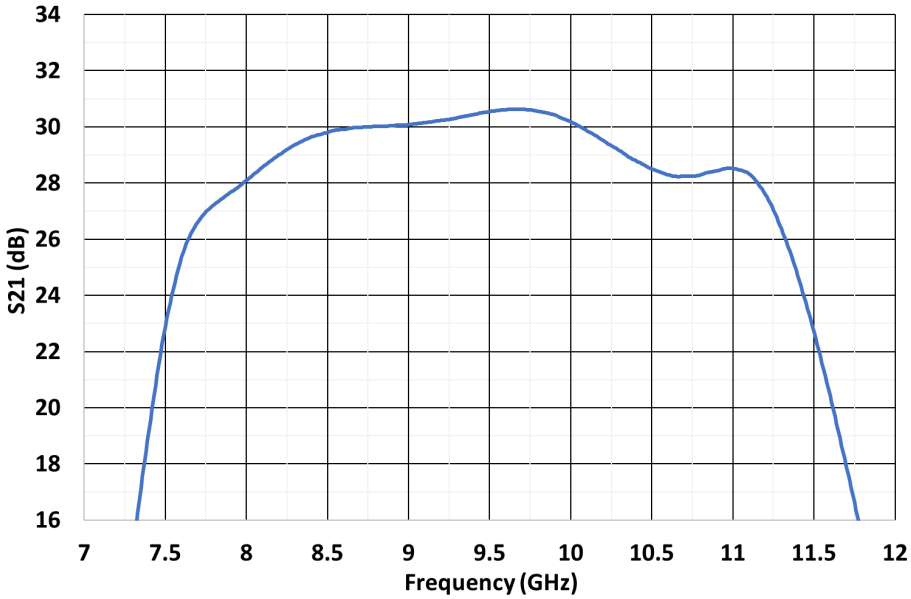

Figure 7. Gain (S21)

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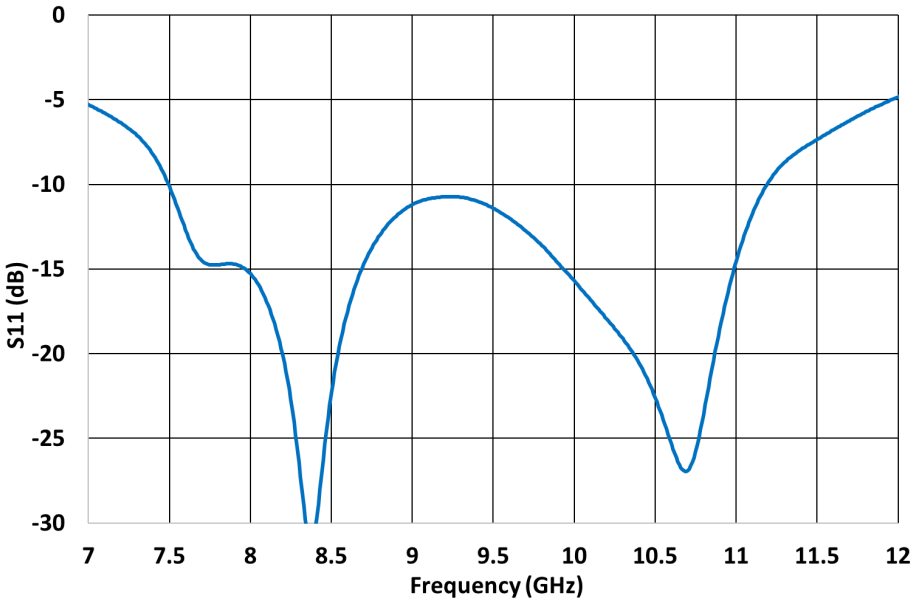

Figure 8. Input return loss (S11)

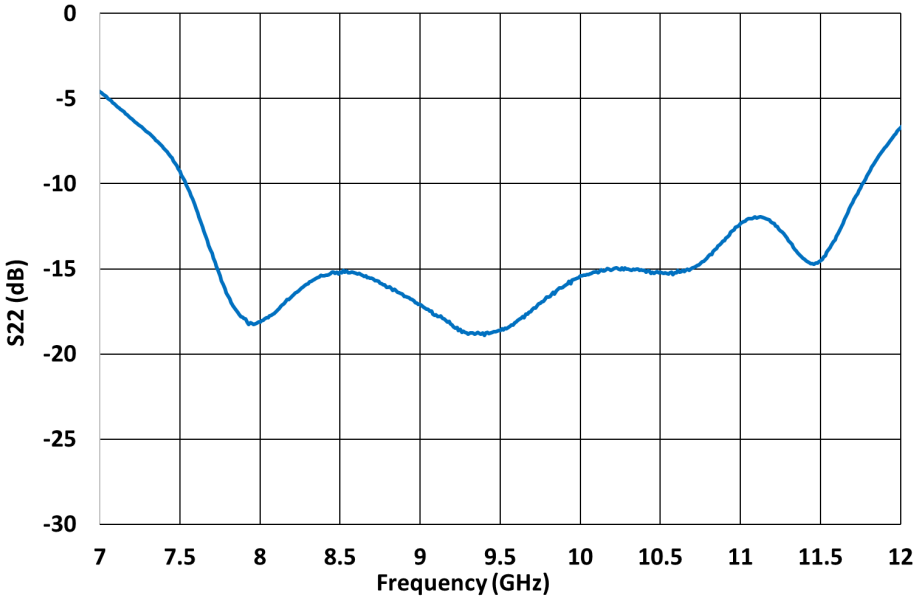

Figure 9. Output return loss (S22)

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VIII-3. Large Signal

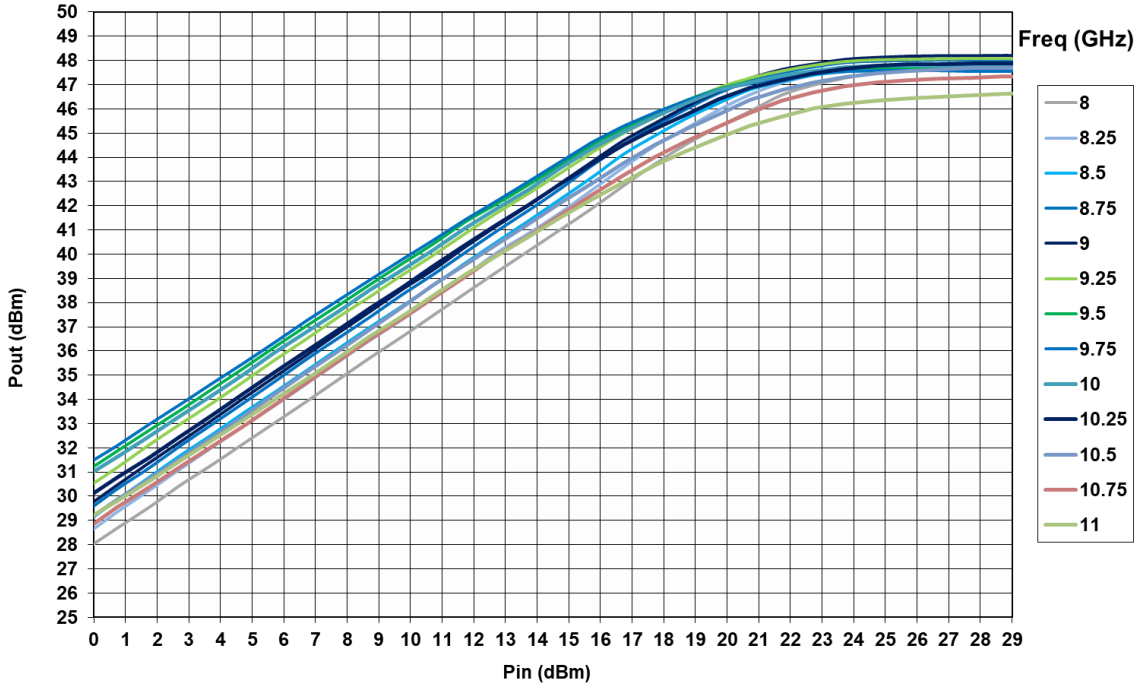

Figure 10. Output Power vs Input Power vs Frequency

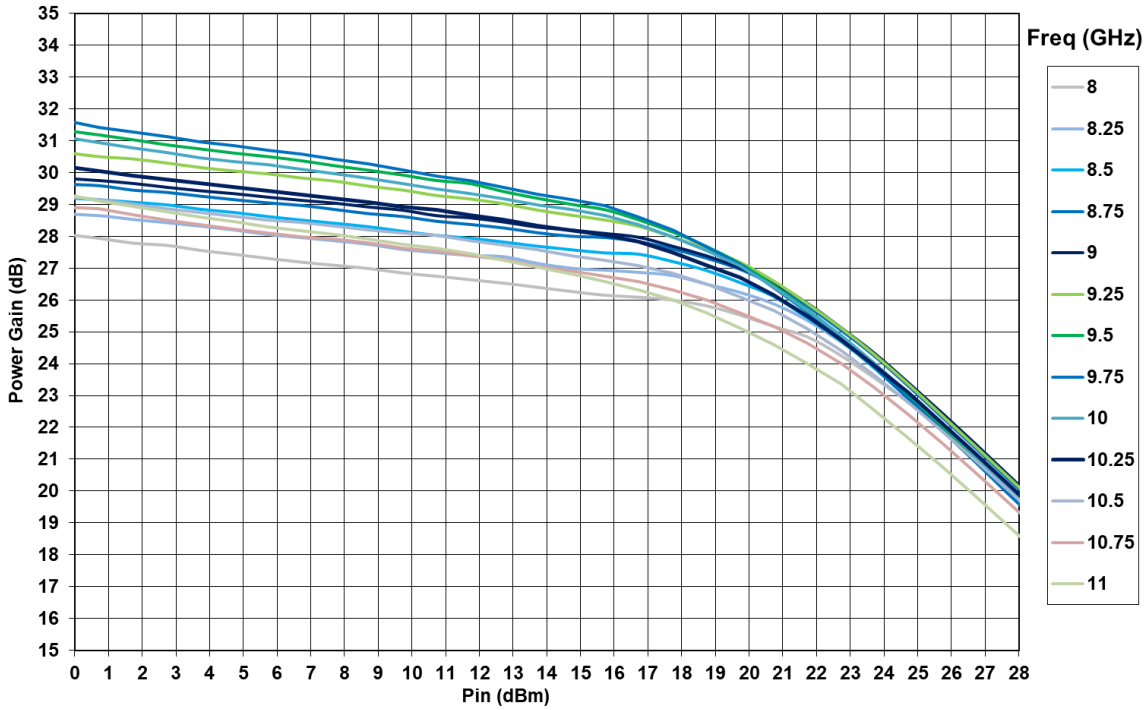

Figure 11. Gain vs Input Power vs Frequency

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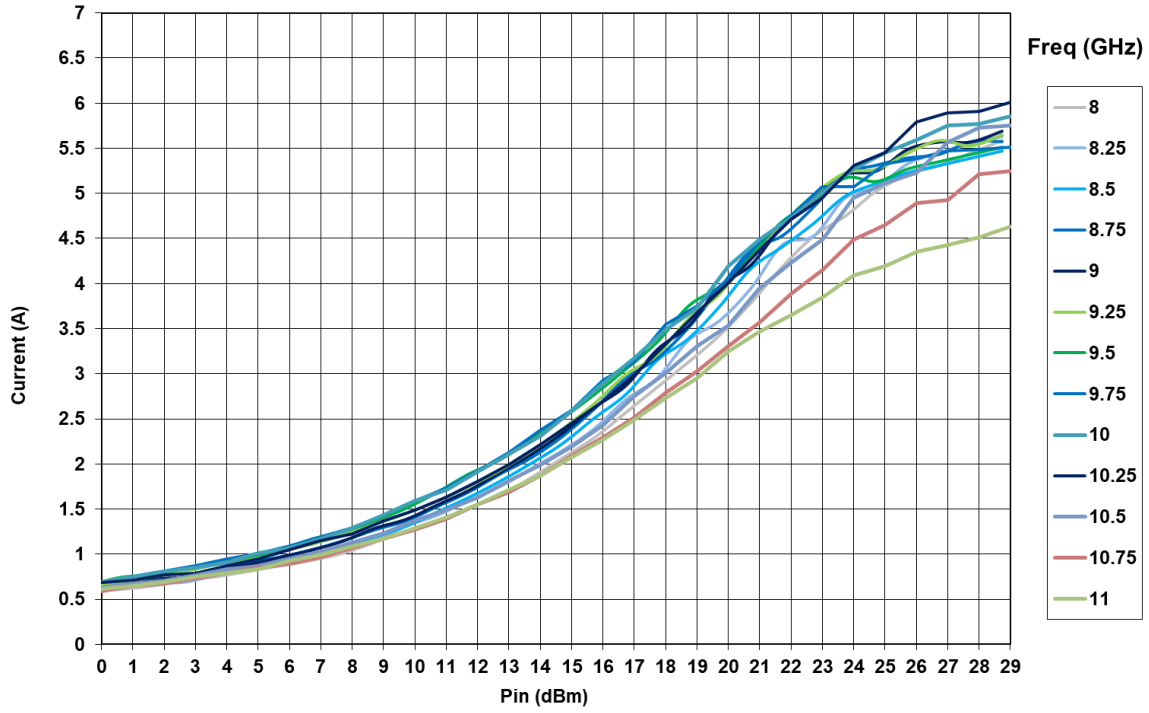

Figure 12. Drain current vs Input Power vs Frequency

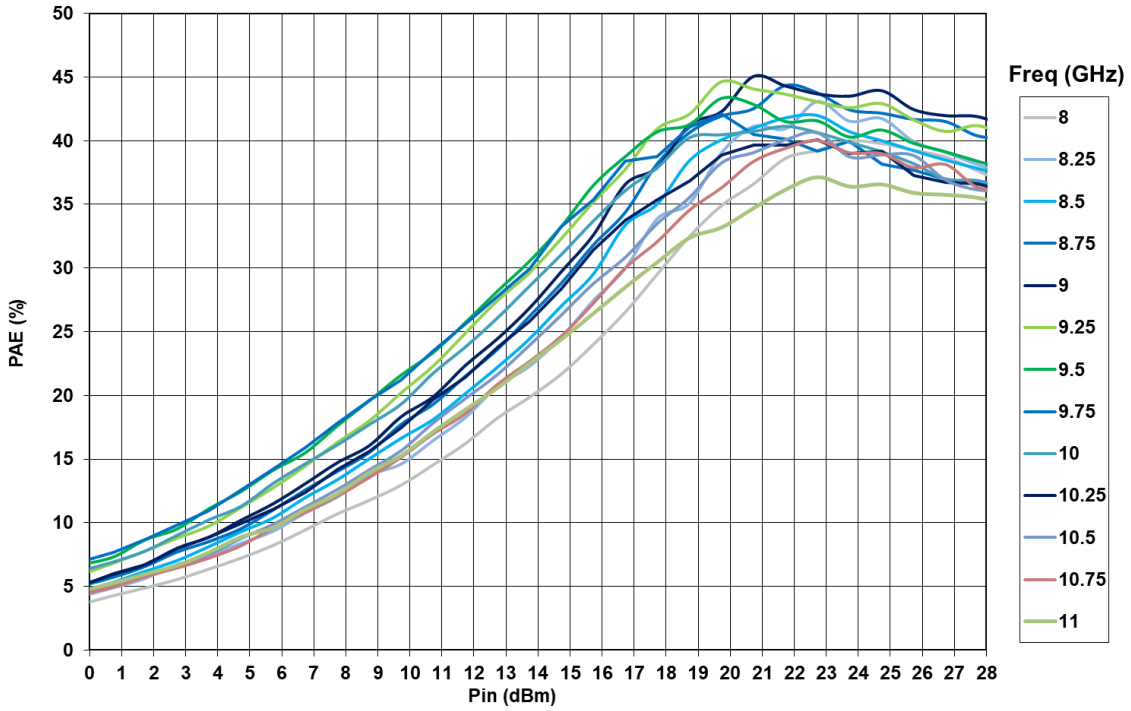

Figure 13. Efficiency vs Input Power vs Frequency

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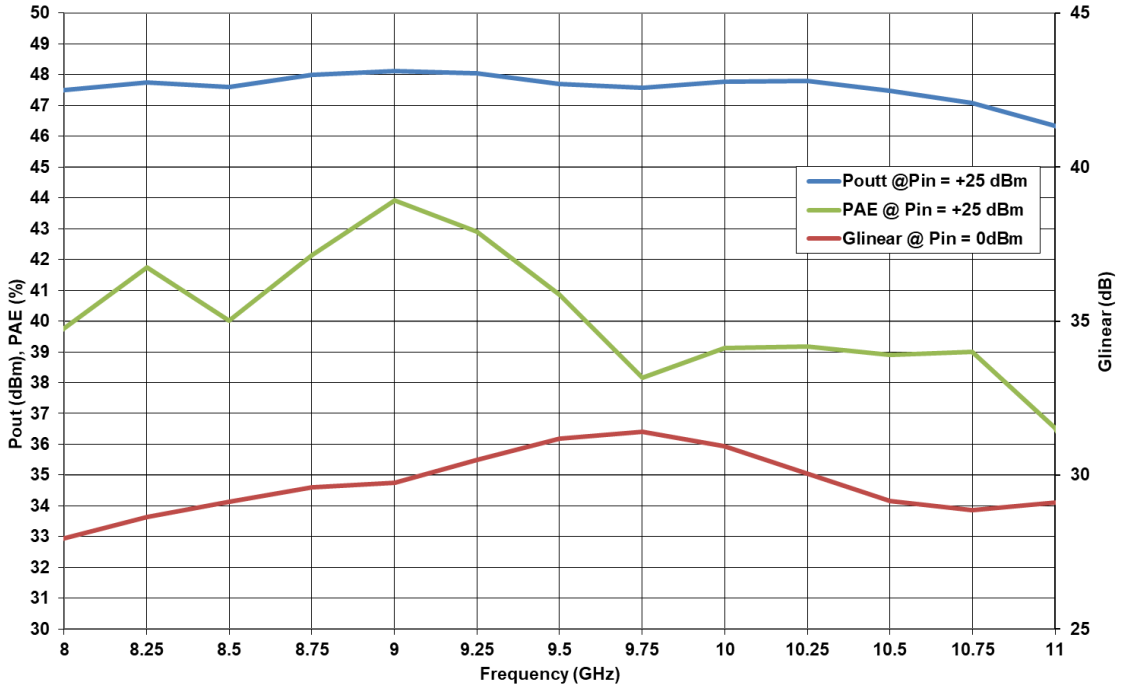

Figure 14. Saturated Output Power, Gain and Efficiency vs Frequency

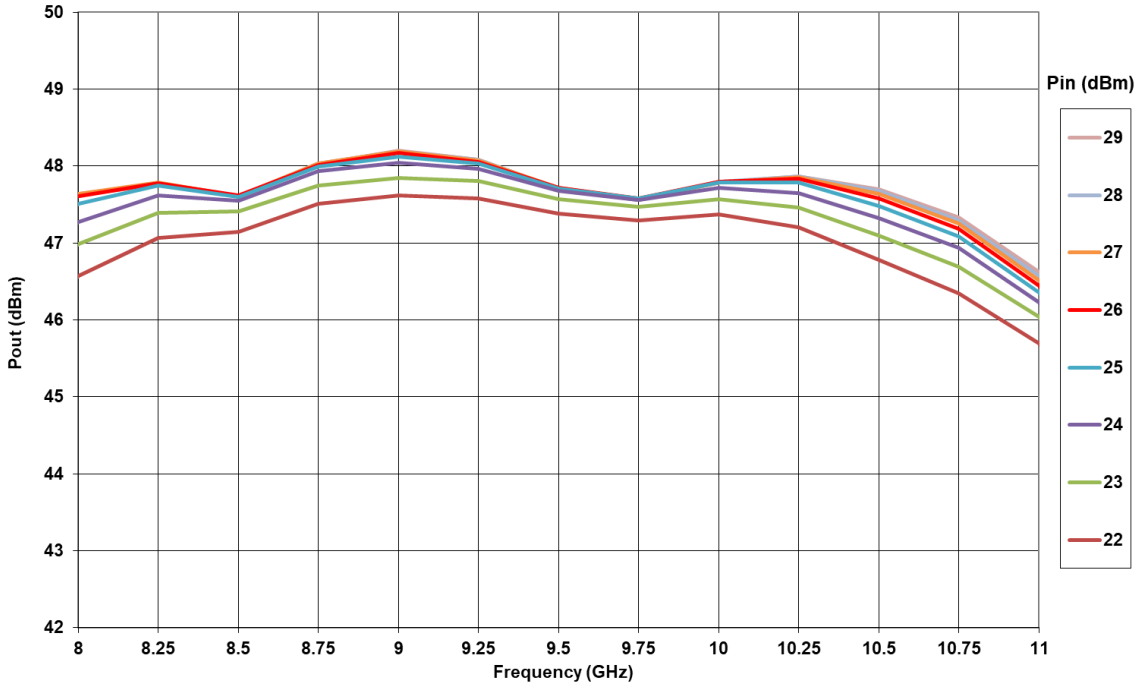

Figure 15. Output Power vs Frequency vs Input Power

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