

GaN High Power Amplifier, 60 W

13.75 - 15.5 GHz



CMPA1E1F060T

Rev. V1

Features

- Die-on-Tab
- Saturated Power: 60 W
- Power Added Efficiency: 35%
- Large Signal Gain: 26 dB
- Small Signal Gain: 34 dB
- Input Return Loss: <-10 dB
- IM3: <-25 dBc at 44 dBm Pout
- CW operation
- Small footprint

Applications

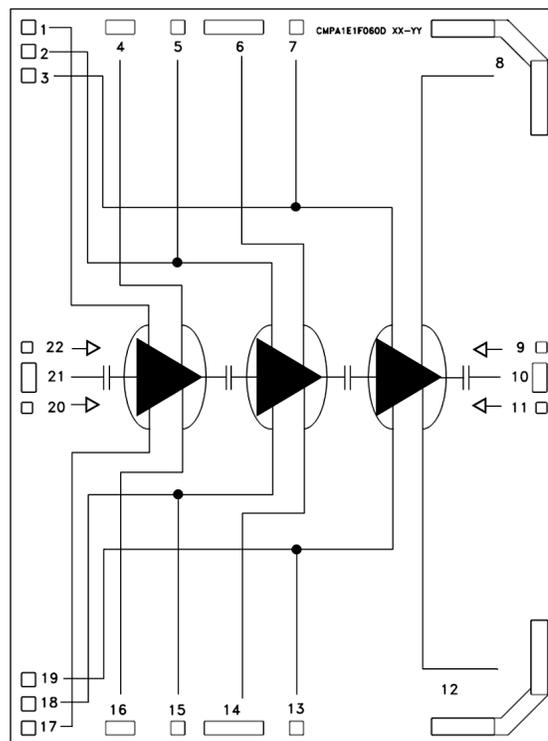
- Ku-Band Satcom Uplink
- Ku-Band Common Data Link

Description

The CMPA1E1F060T is a 60 W, MMIC HPA utilizing MACOM's high performance, 0.15 μm GaN-on-SiC production process. This amplifier operates from 13.75 - 15.5 GHz and targets both satellite communications and common datalink applications. Under saturation, this device achieves 60 W of typical output power with 26 dB of large signal gain and >35% power-added efficiency. Targeting an IM3 level of -25 dBc or better, this HPA delivers 25 W of output power with 31 dB of gain and 30% power-added efficiency.

The tabbed die solution provides peak performance while supporting the first-level assembly in thermal management.

Functional Schematic



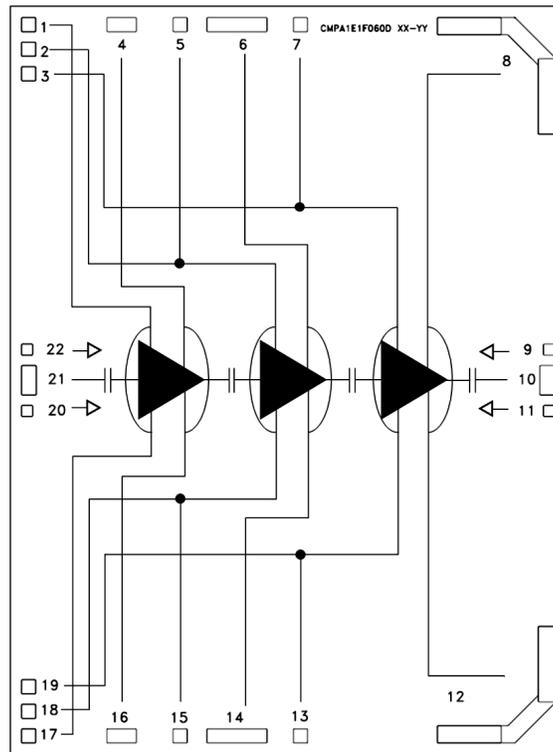
Pin Configuration¹

Pin #	Name
9, 11, 20, 22	GND
1, 17	VG1
2, 18	VG2
5, 15	VG2A
3, 19	VG3
7, 13	VG3A
4, 16	VD1
6, 14	VD2
8, 12	VD3
10	RF _{OUT}
21	RF _{IN}

1. The backside of the MMIC must be connected to RF, DC and thermal ground.

Ordering Information

Part Number	Package (MOQ/ Mult)
CMPA1E1F060T	Tray (10/10)
CMPA1E1F060T-AMP	Sample Board (1/1)



Pin Description

Pin #	Name	Description	Pad Size (µm)
9, 11, 20, 22,	GND	RF and DC ground.	90 x 90
1, 17	VG1	Gate bias for stage 1. Both pins must be connected.	115 x 115
2, 18	VG2	Gate bias for stage 2. Both pins must be connected..	115 x 115
5, 15	VG2A	Alternate VG2 pads. Electrically connected to VG2.	115 x 115
3, 19	VG3	Gate bias for stage 3. Both pins must be connected..	115 x 115
7, 13	VG3A	Alternate VG3 pads. Electrically connected to VG3.	115 x 115
4, 16	VD1	Drain bias for stage 1. Both pins must be connected.	115 x 240
6, 14	VD2	Drain bias for stage 2. Both pins must be connected.	115 x 490
8, 12	VD3	Drain bias for stage 3. Both pins must be connected.	140 x 520, 140 x 615
10	RF _{OUT}	RF Output. 50-ohm matched. Internally DC blocked.	120 x 240
21	RF _{IN}	RF Input. 50-ohm matched. Internally DC blocked.	120 x 240
MMIC backside	GND	RF and DC ground.	NA

RF Electrical Specifications: $V_D = 28V$, $I_{DQ} = 650\text{ mA}$, CW, $T_C = 25^\circ\text{C}$, $Z_0 = 50\ \Omega$

Parameter	Test Conditions	Frequency (GHz)	Units	Min.	Typ.	Max.
Output Power	$P_{IN} = 22\text{ dBm}$	13.75 14.5 15.5	dBm	47.25 46.75 46.50	48 47.5 47.5	—
Power Added Efficiency		13.75 14.5 15.5	%	36 33 33	42 38 40	—
Large Signal Gain		13.75 14.5 15.5	dB	25.25 24.75 24.50	26 25.5 25.5	—
Small Signal Gain	$P_{IN} = -20\text{ dBm}$	13.75 14.5 15.5	dB	—	36.2 33.3 32.6	—
Input Return Loss		13.75-15.5	dB	—	-15	—
Output Return Loss		13.75-15.5	dB	—	-10	—
IM3	$P_{OUT}/\text{Tone} = 41\text{ dBm}$ Tone/Spacing = 300 MHz	13.75 14.5 15.5	dBc	—	-28 -25 -25	—

DC Electrical Specifications:

Parameter	Units	Min.	Typ.	Max.
Drain Voltage	V	—	28	—
Gate Voltage	V	—	-2	—
Quiescent Drain Current	mA	—	650	—
Saturated Drain Current	A	—	5.5	—

Recommended Operating Conditions

Parameter	Symbol	Unit	Min.	Typ.	Max.
Input Power	P_{IN}	dBm	—	22	—
Drain Voltage	V_D	V	—	28	—
Gate Voltage	V_G	V	—	-2.0	—
Quiescent Drain Current	I_{DQ}	mA	—	650	—
Operating Temperature	T_C	°C	-40	—	+85

Absolute Maximum Ratings^{2,3}

Parameter	Symbol	Unit	Min.	Max.
Input Power	P_{IN}	dBm	—	24
Drain to Source Voltage	V_{DS}	V	—	84
Drain Voltage	V_D	V	—	28
Gate Voltage	V_G	V	-8	+2
Drain Current	I_D	A	—	7.8
Gate Current	I_G	mA	—	15
Dissipated Power @ +85°	P_{DISS}	W	—	122
VSWR	—	Ratio	—	5:1
Junction Temperature (MTTF > 1E6 Hrs)	T_J	°C	—	+225°C
Storage Temperature	T_{STG}	°C	-65	+150
Mounting Temperature (30 seconds)	T_M	°C	—	+320

2. Exceeding any one or combination of these limits may cause permanent damage to this device.
3. MACOM does not recommend sustained operation near these survivability limits.

Handling Procedures

Please observe the following precautions to avoid damage:

Static Sensitivity

These electronic devices are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these HBM Class 1B devices.

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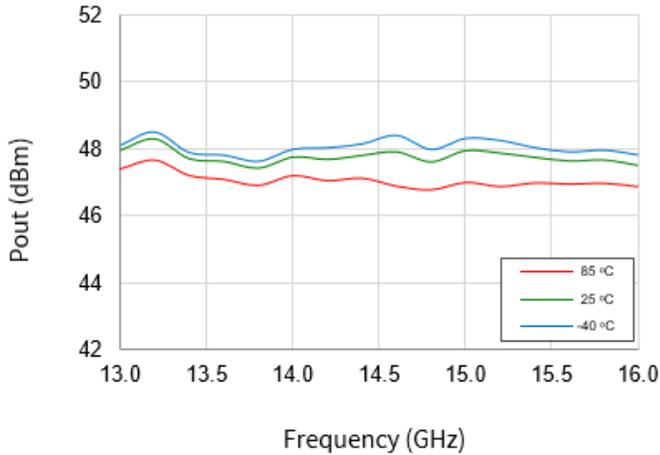
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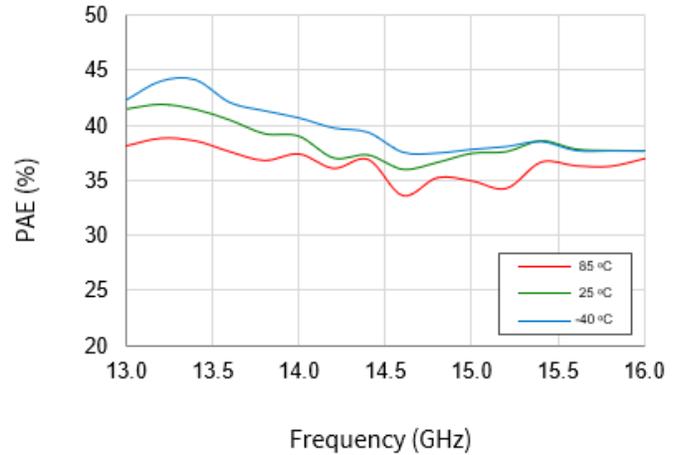
Typical Performance Curves - Large Signal over Temperature:

$V_D = 28\text{ V}$, $I_{DQ} = 650\text{ mA}$, CW, $P_{IN} = 22\text{ dBm}$

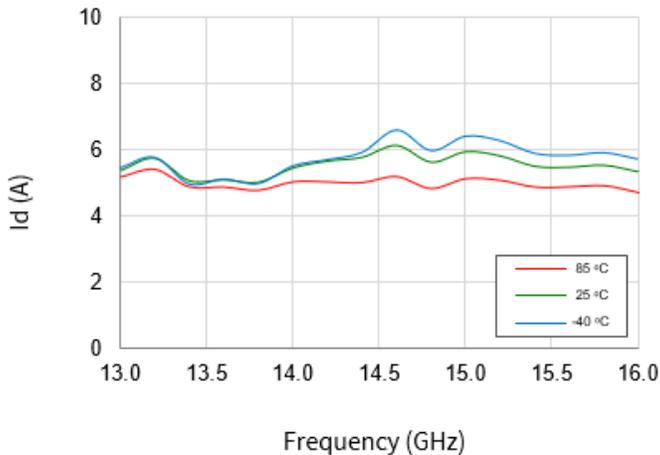
Output Power vs. Frequency



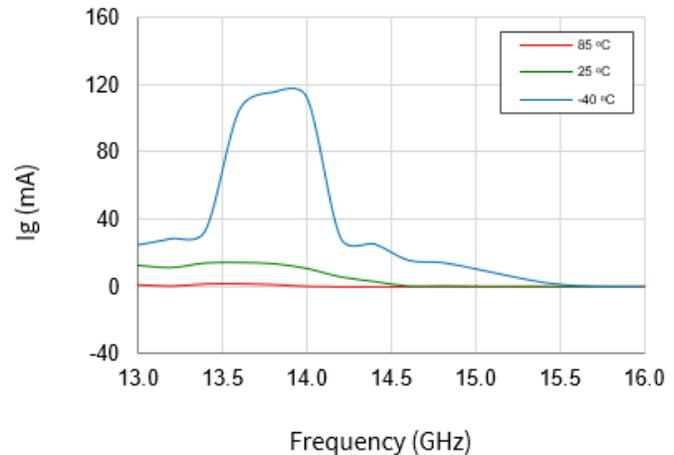
Power Added Efficiency vs. Frequency



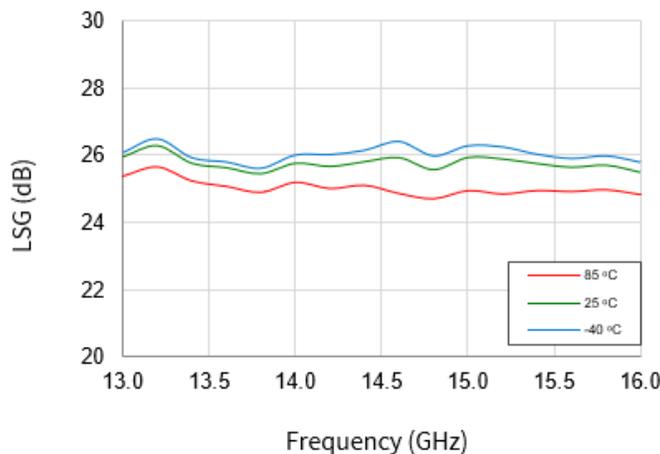
Drain Current vs. Frequency



Gate Current vs. Frequency



Large Signal Gain vs. Frequency



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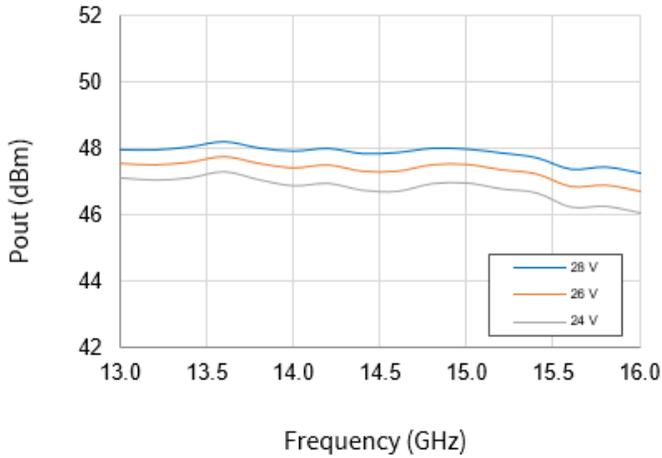


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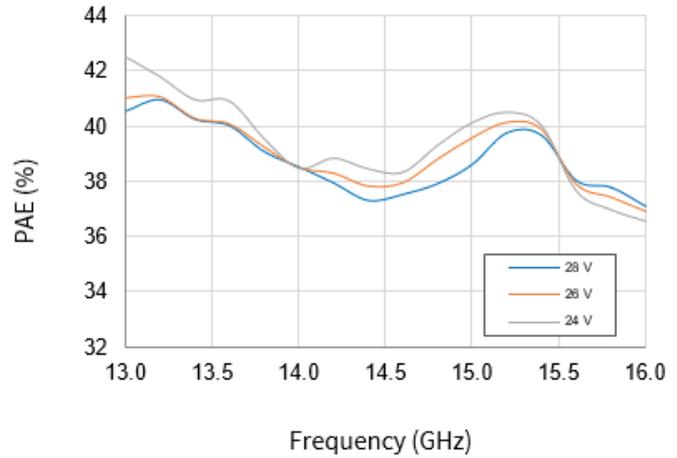
Typical Performance Curves - Large Signal over V_D :

$I_{DQ} = 650$ mA, CW, $P_{IN} = 22$ dBm, $T_C = 25^\circ\text{C}$

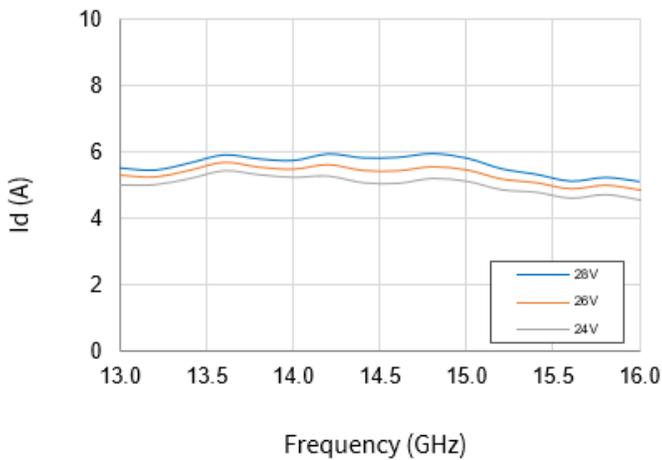
Output Power vs. Frequency



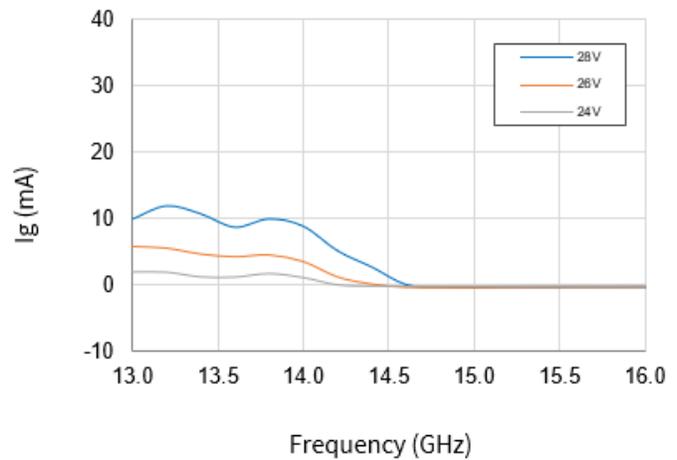
Power Added Efficiency vs. Frequency



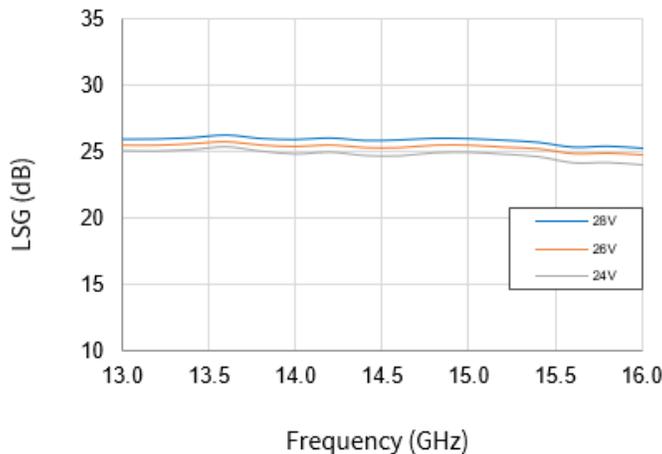
Drain Current vs. Frequency



Gate Current vs. Frequency



Large Signal Gain vs. Frequency



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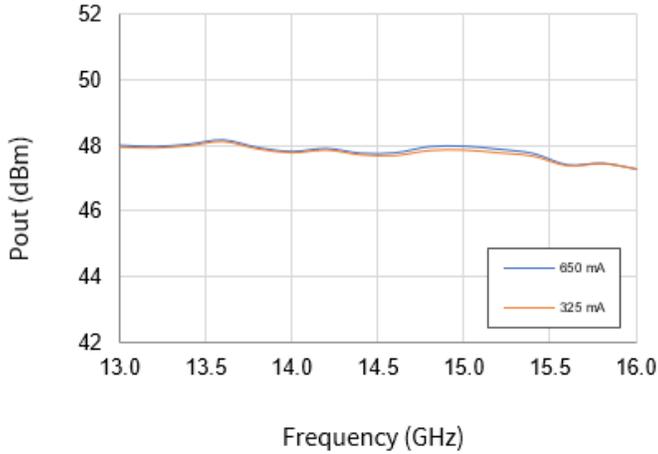


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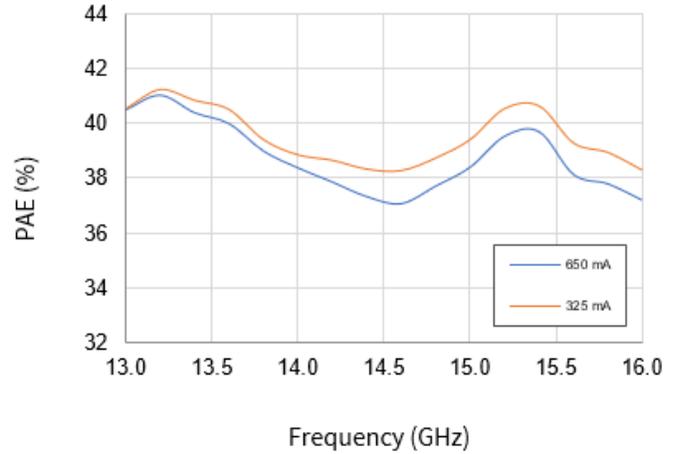
Typical Performance Curves - Large Signal over I_{DQ} :

$V_D = 28$ V, CW, $P_{IN} = 22$ dBm, $T_C = 25^\circ\text{C}$

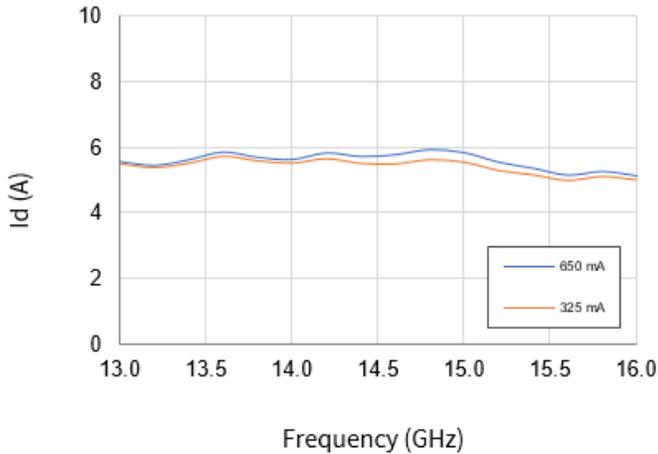
Output Power vs. Frequency



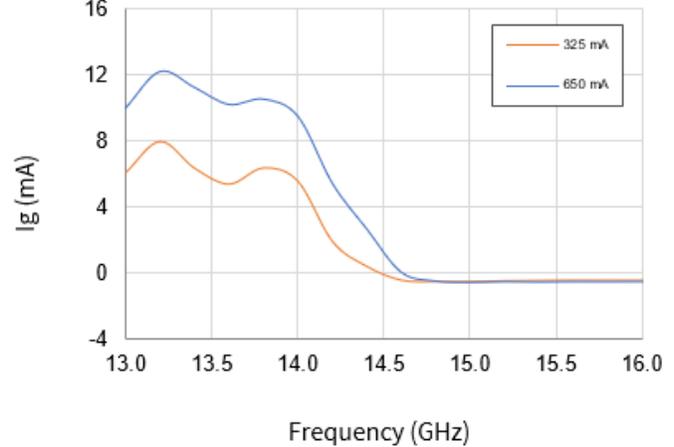
Power Added Efficiency vs. Frequency



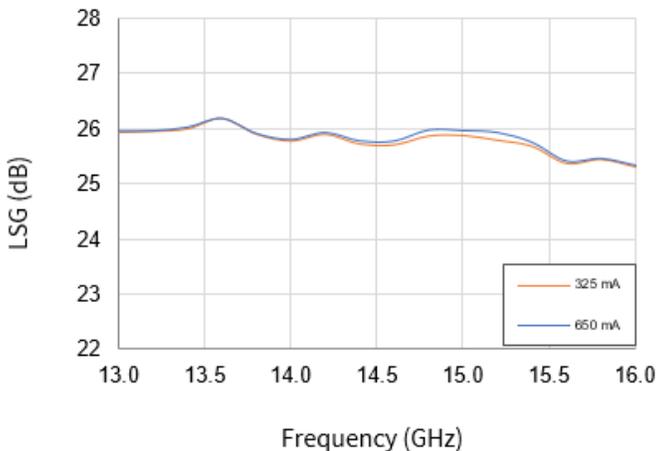
Drain Current vs. Frequency



Gate Current vs. Frequency



Large Signal Gain vs. Frequency



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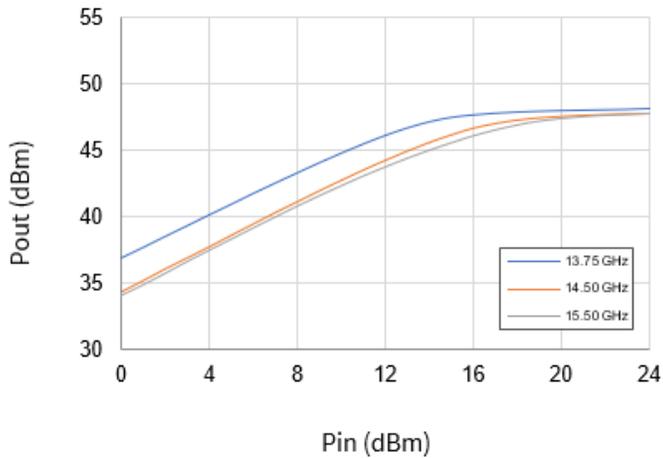
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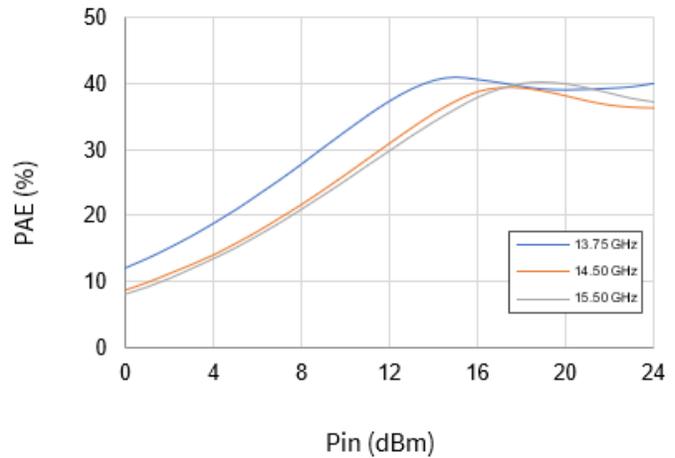
Typical Performance Curves - Drive-Up over Frequency:

$V_D = 28\text{ V}$, $I_{DQ} = 650\text{ mA}$, CW, $T_C = 25^\circ\text{C}$

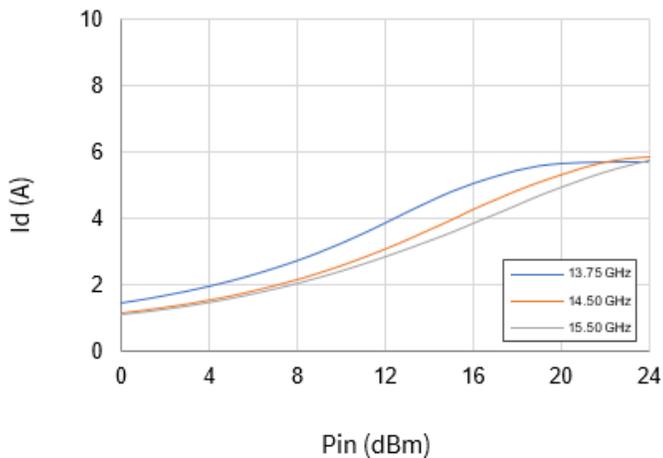
Output Power vs. Input Power



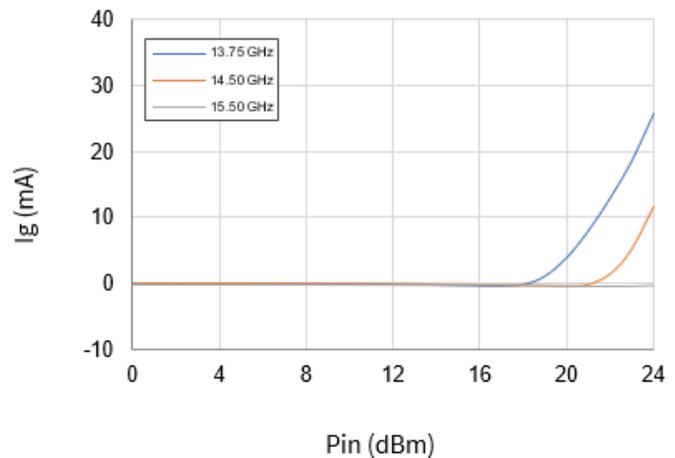
Power Added Efficiency vs. Input Power



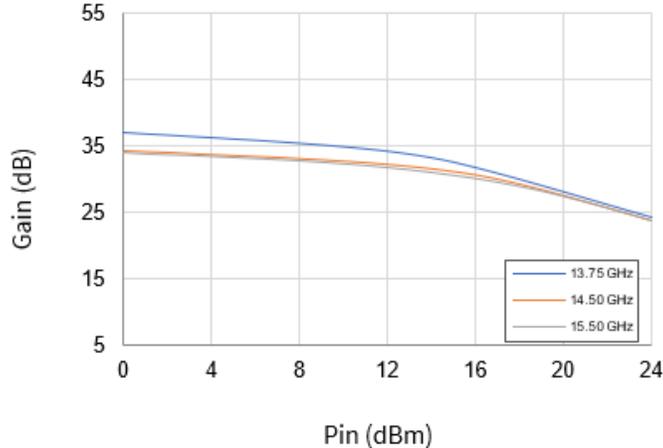
Drain Current vs. Input Power



Gate Current vs. Input Power



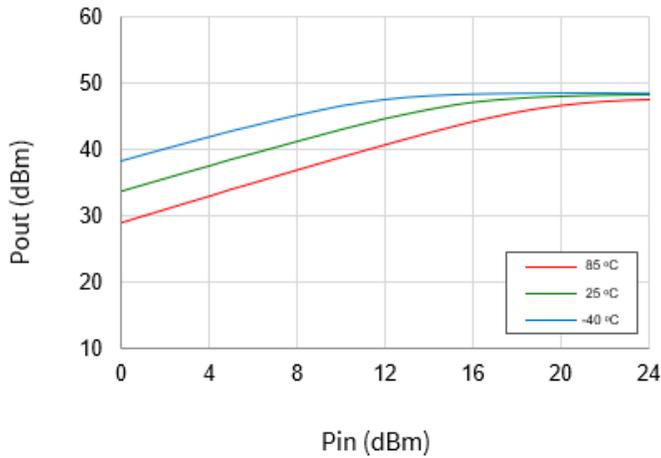
Gain vs. Input Power



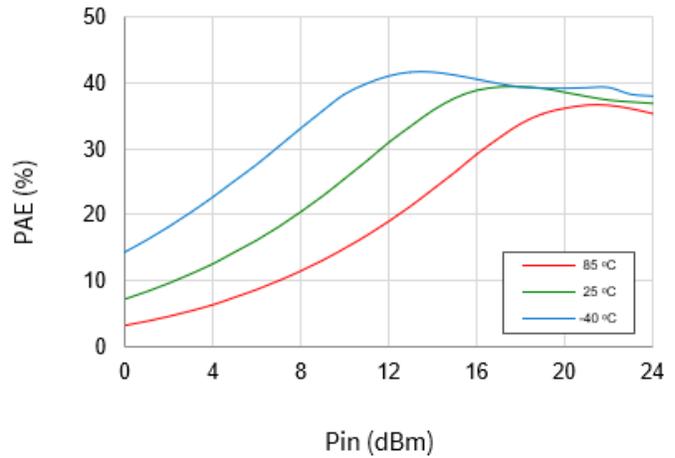
Typical Performance Curves - Drive-Up over Temperature:

$V_D = 28\text{ V}$, $I_{DQ} = 650\text{ mA}$, CW, Frequency = 14.5 GHz

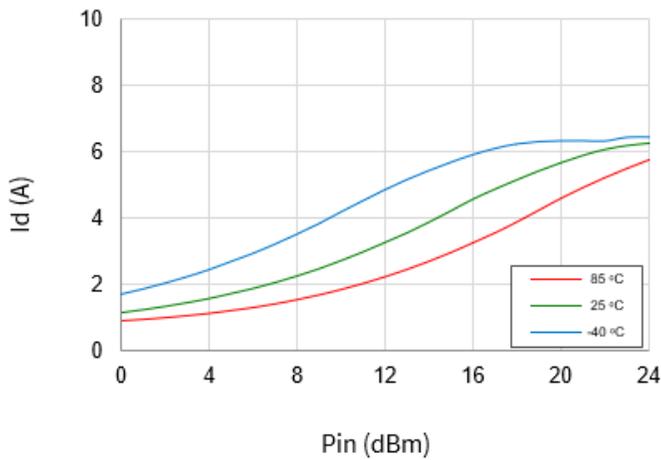
Output Power vs. Input Power



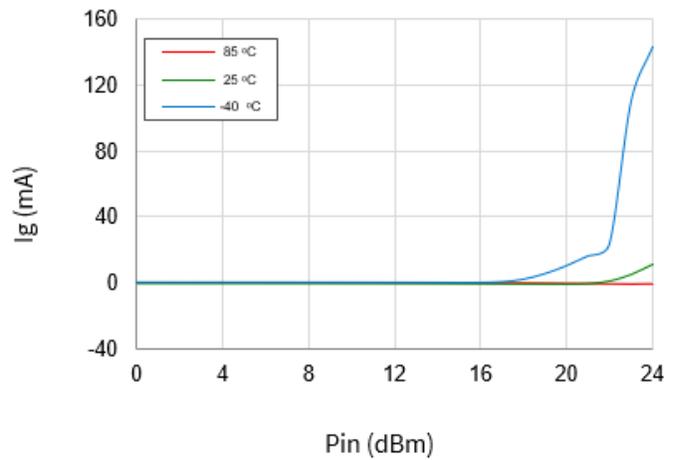
Power Added Efficiency vs. Input Power



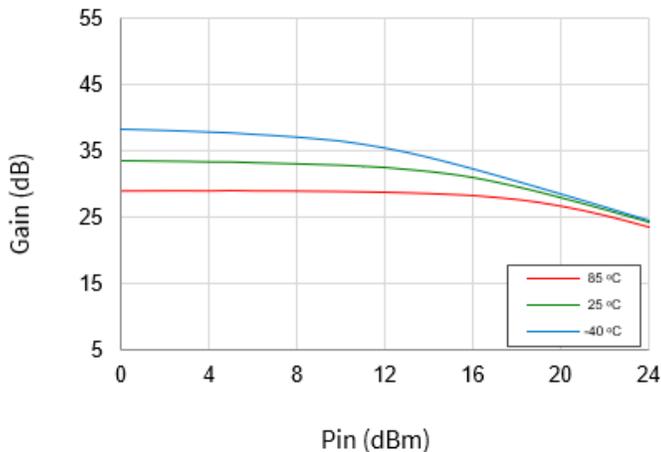
Drain Current vs. Input Power



Gate Current vs. Input Power



Gain vs. Input Power



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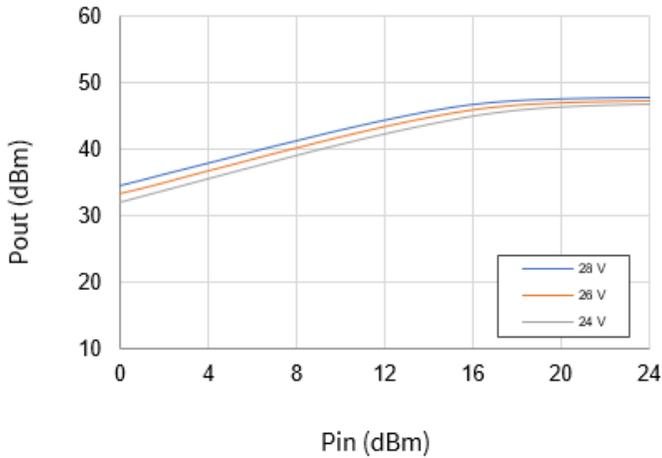


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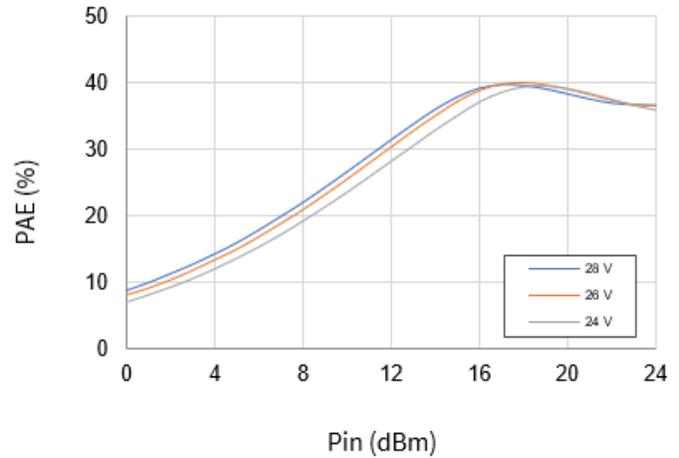
Typical Performance Curves - Drive-Up over V_D :

$I_{DQ} = 650$ mA, CW, Frequency = 14.5 GHz, $T_C = 25^\circ\text{C}$

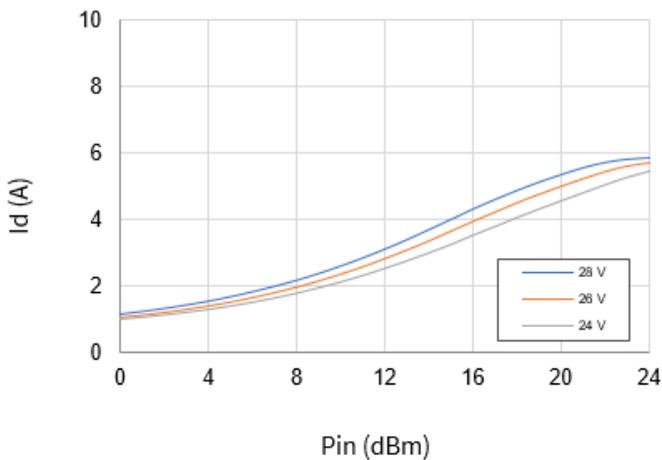
Output Power vs. Input Power



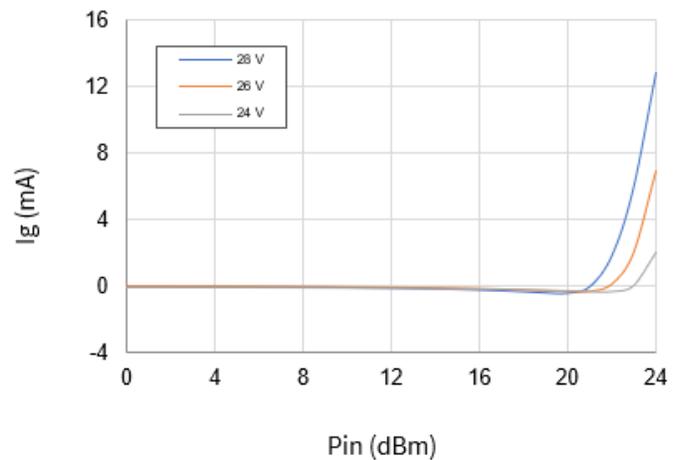
Power Added Efficiency vs. Input Power



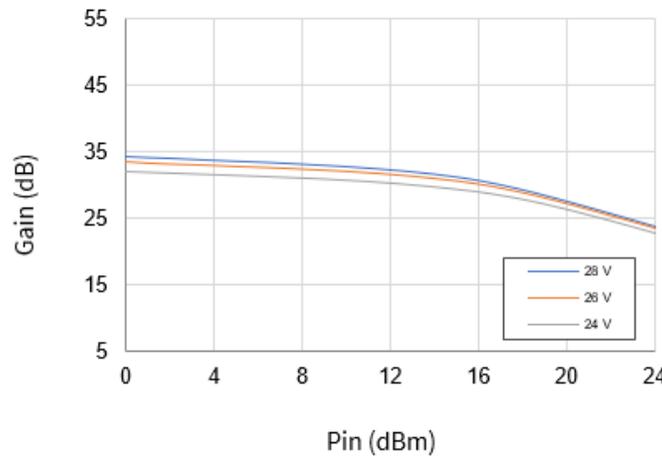
Drain Current vs. Input Power



Gate Current vs. Input Power



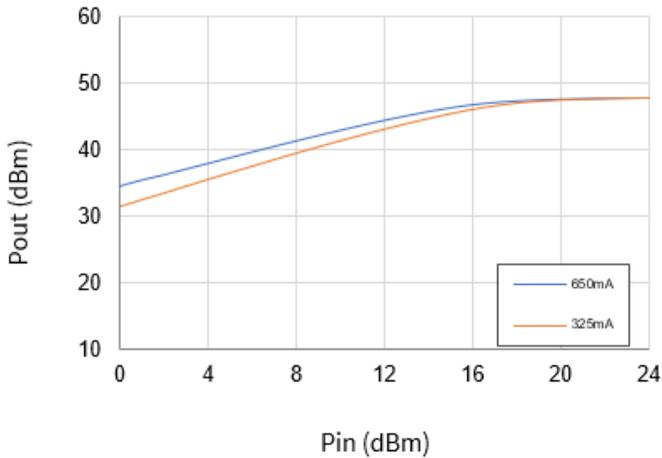
Gain vs. Input Power



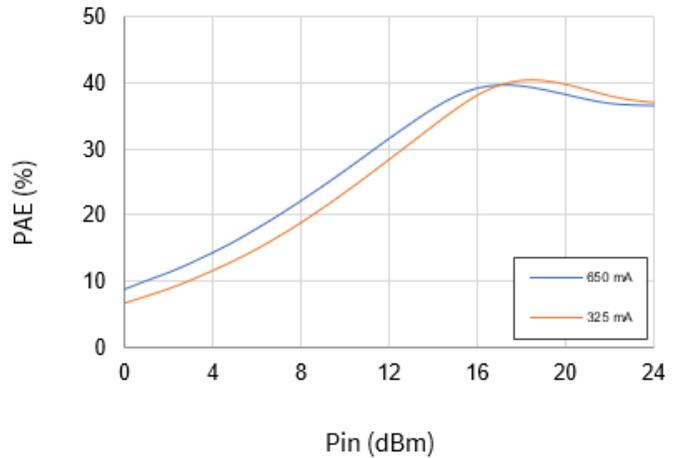
Typical Performance Curves - Drive-Up over I_{DQ} :

$V_D = 28$ V, CW, Frequency = 14.5 GHz, $T_C = 25^\circ\text{C}$

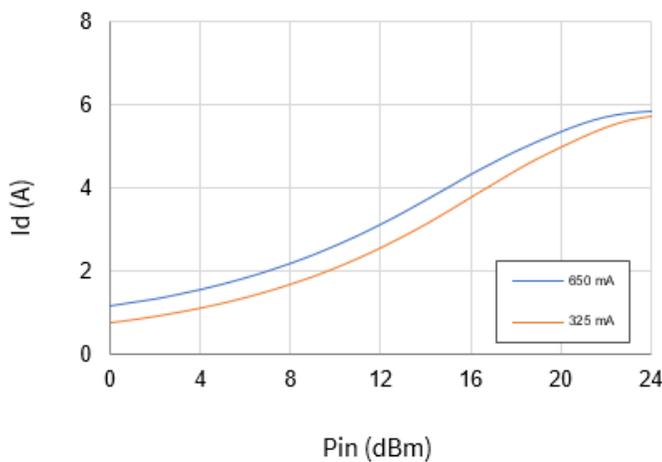
Output Power vs. Input Power



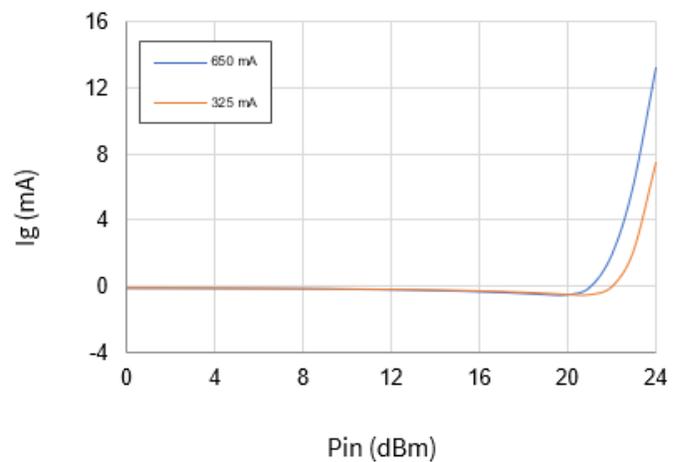
Power Added Efficiency vs. Input Power



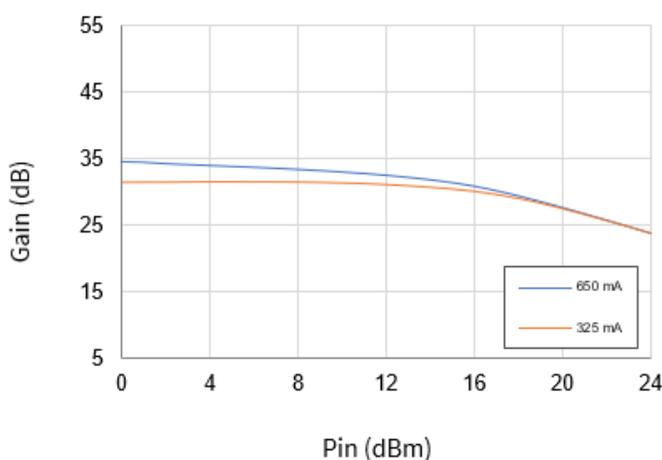
Drain Current vs. Input Power



Gate Current vs. Input Power



Large Signal Gain vs. Input Power



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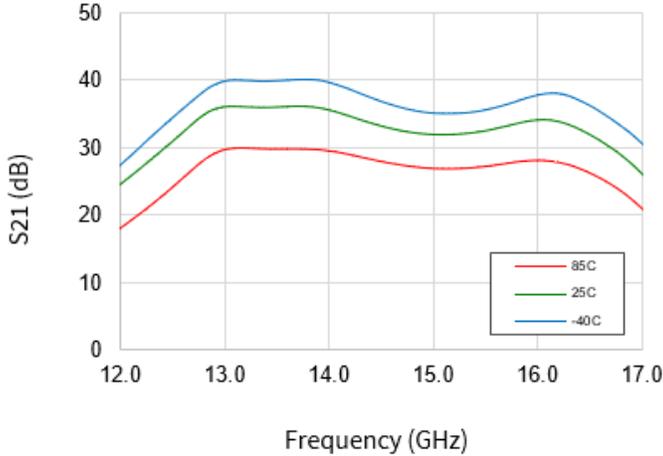


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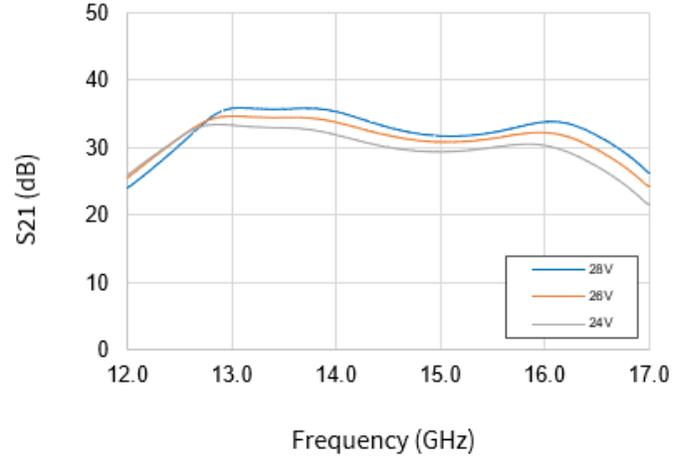
Typical Performance Curves - Small Signal over Temperature and V_D :

$I_{DQ} = 650$ mA, CW, $P_{IN} = -20$ dBm

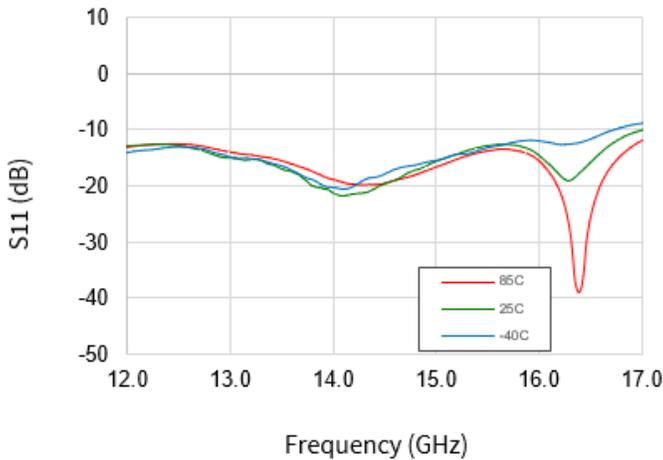
S_{21} vs. Frequency over Temperature @ $V_D = 28$ V



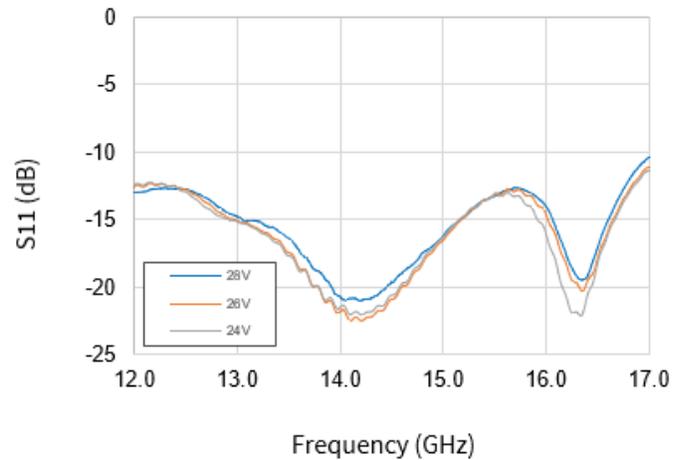
S_{21} vs. Frequency over V_D @ 25°C



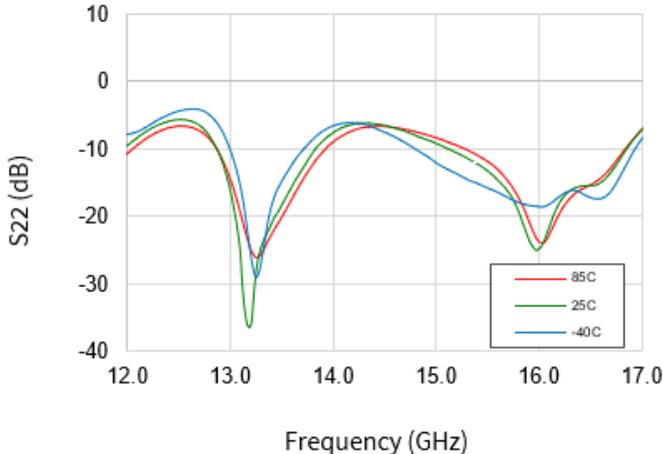
S_{11} vs. Frequency over Temperature @ $V_D = 28$ V



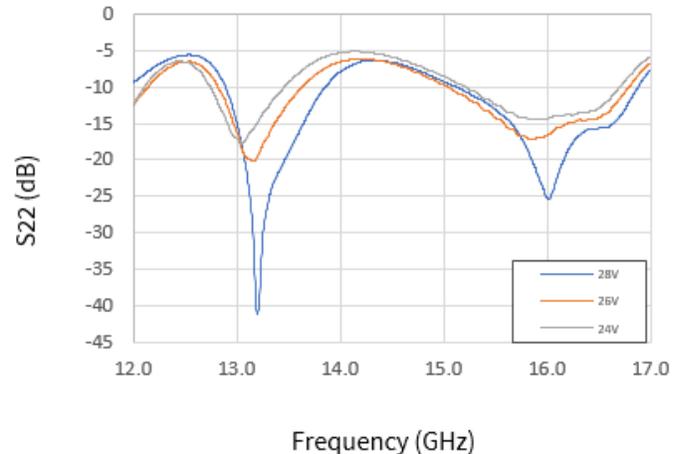
S_{11} vs. Frequency over V_D @ 25°C



S_{22} vs. Frequency over Temperature @ $V_D = 28$ V



S_{22} vs. Frequency over V_D @ 25°C



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Small-Signal vs I_{DQ}

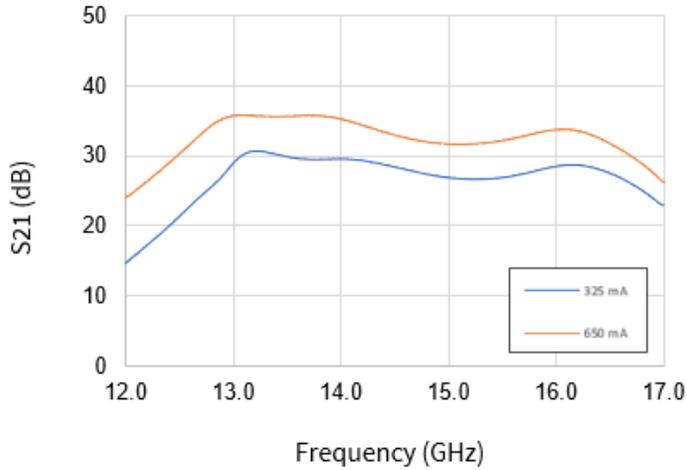
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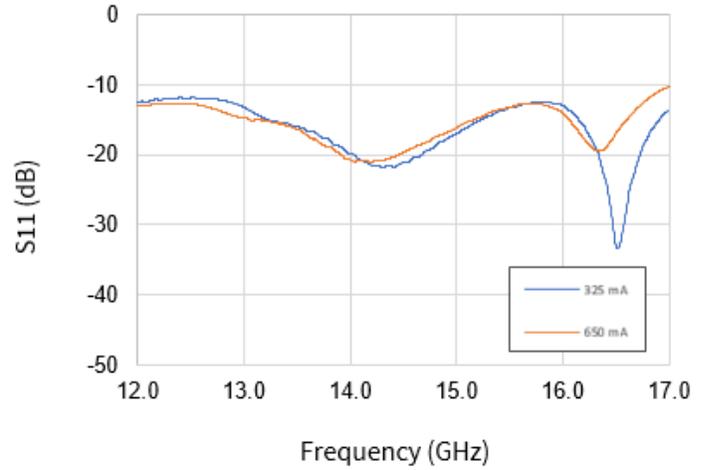
Typical Performance Curves - Small Signal over I_{DQ} :

$V_D = 28$ V, CW, $P_{IN} = -20$ dBm, $T_C = 25^\circ\text{C}$

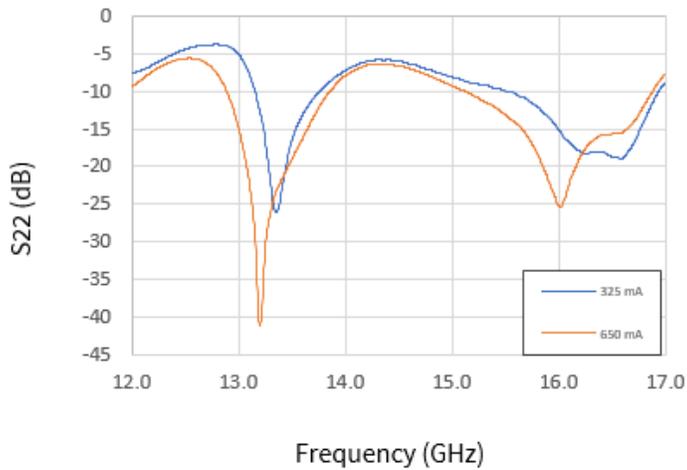
S21 vs. Frequency over I_{DQ}



S11 vs. Frequency over I_{DQ}



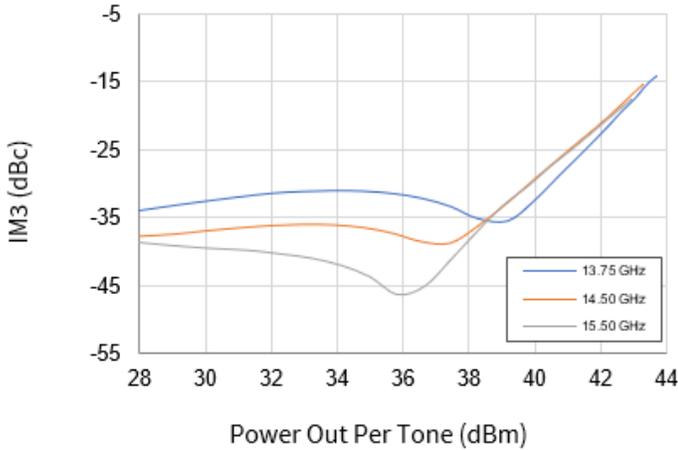
S22 vs. Frequency over I_{DQ}



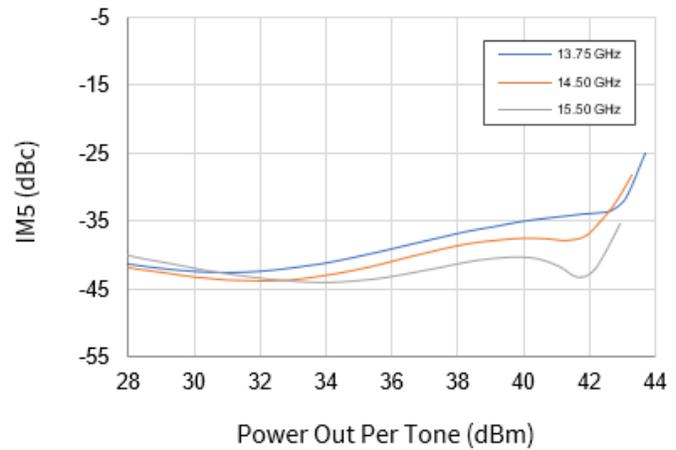
Typical Performance Curves - Linearity (IM3 and IM5)

$V_D = 28\text{ V}$, $I_{DQ} = 650\text{ mA}$, CW, Frequency = 14.5 GHz, Tone Spacing = 10 MHz, $T_C = 25^\circ\text{C}$ (unless otherwise stated)

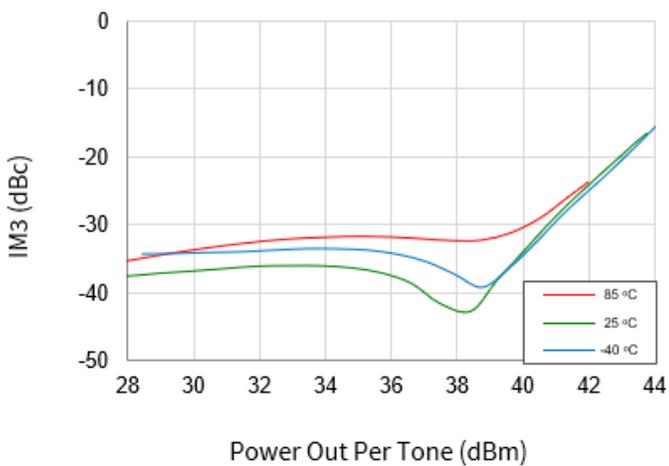
IM3 v. Output Power/Tone v. Frequency



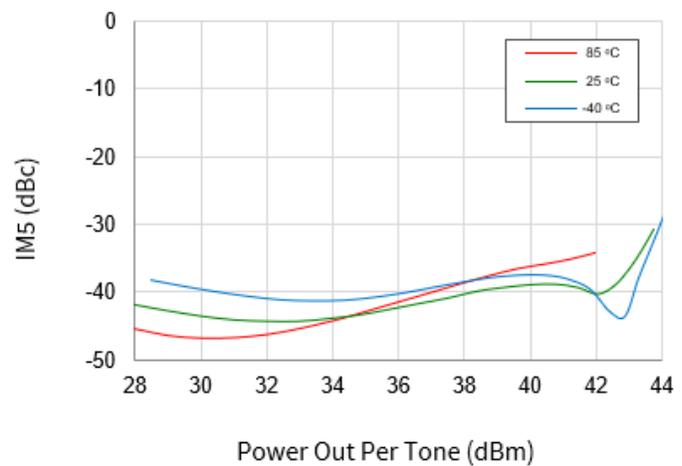
IM5 v. Output Power/Tone v. Frequency



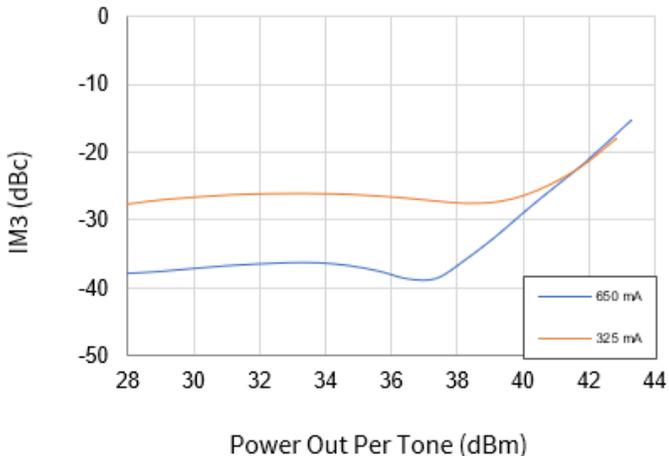
IM3 v. Output Power/Tone v. Temperature



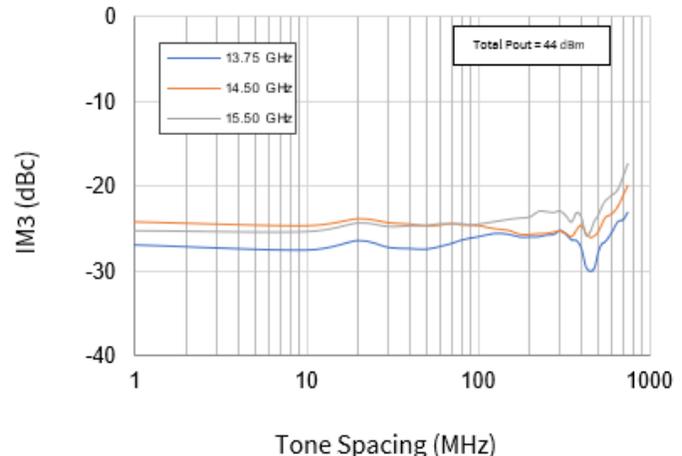
IM5 v. Output Power/Tone v. Temperature



IM3 v. Output Power/Tone v. I_{DQ}



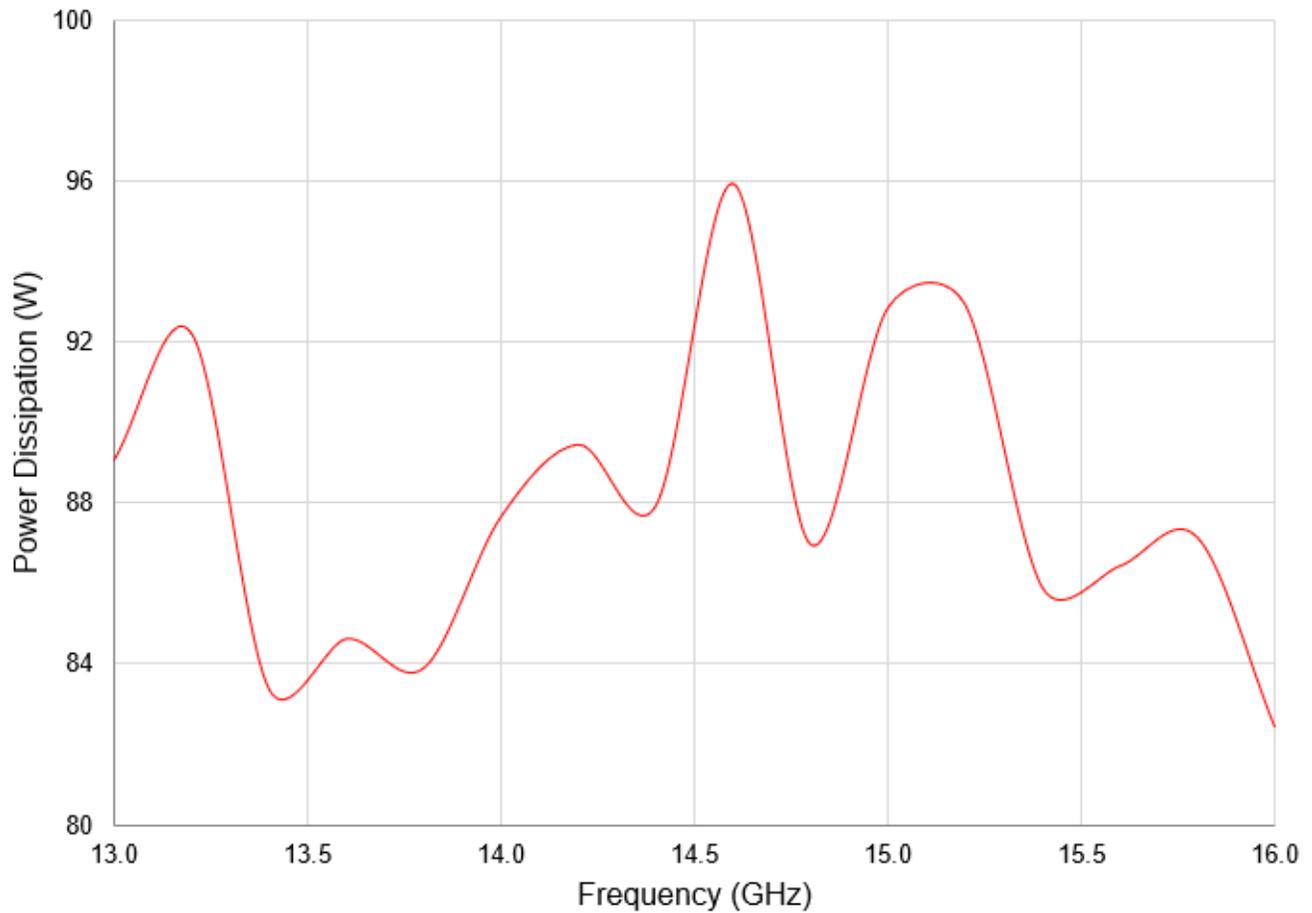
IM3 v. Tone Spacing v. Frequency



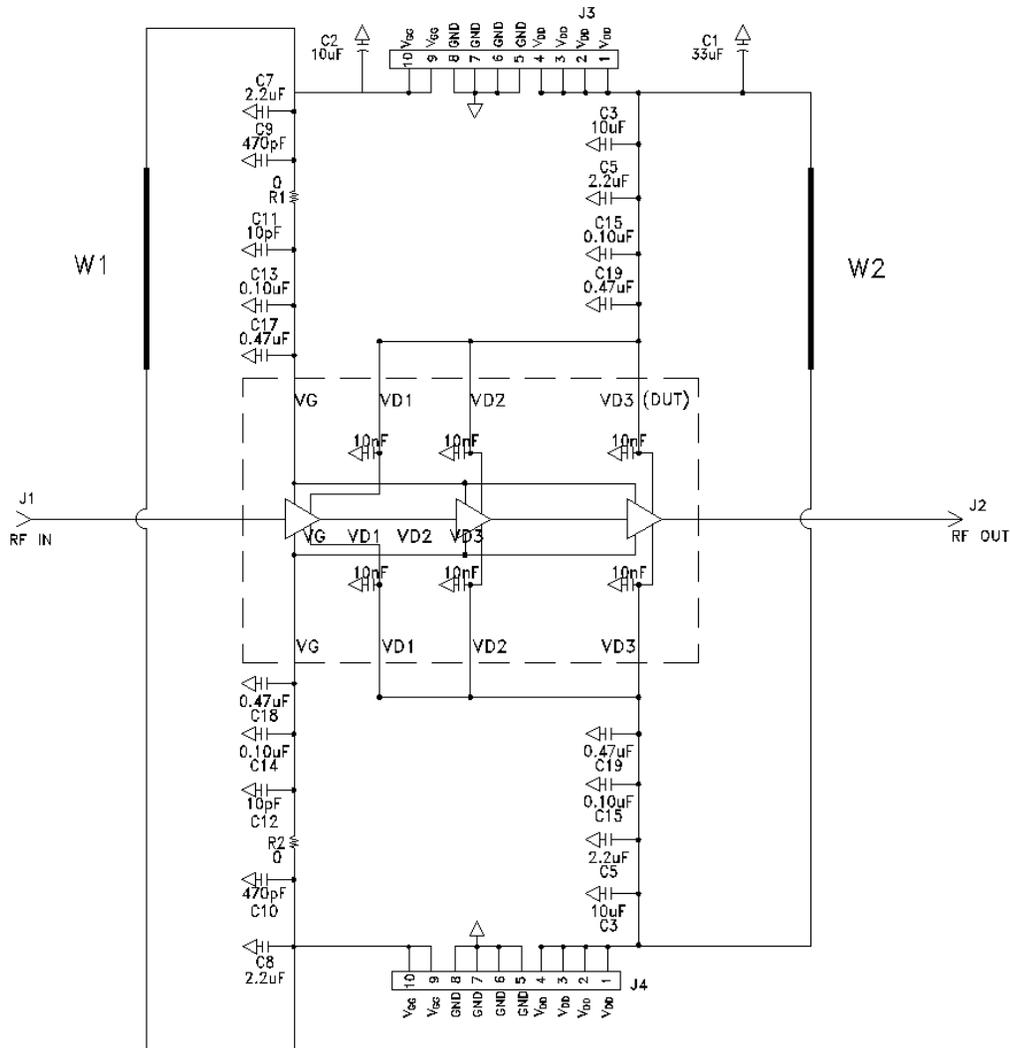
Thermal Characteristics

Parameter	Operating Conditions	Value
Operating Junction Temperature (T_J)	Freq = 14.5 GHz, $V_D = 28$ V, $I_{DQ} = 650$ mA, $I_{DRIVE} = 5.1$ A , $P_{IN} = 22$ dBm, $P_{OUT} = 47$ dBm, $P_{DISS} = 96$ W, $T_{CASE} = 85^\circ\text{C}$, CW	194°C
Thermal Resistance, Junction to Case ($R_{\theta JC}$)		1.14°C/W

Power Dissipation vs. Frequency ($T_C = 85^\circ\text{C}$)



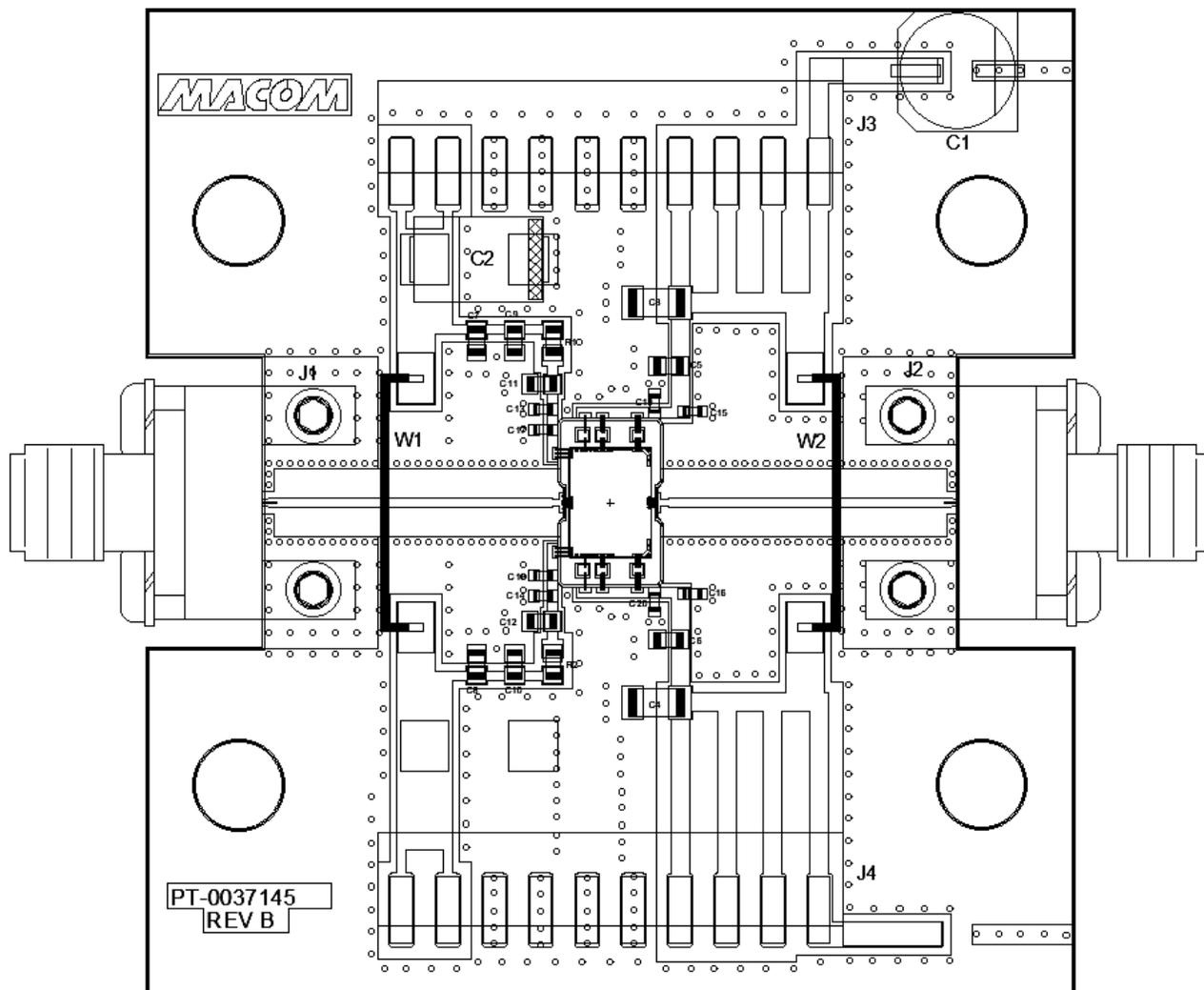
Evaluation Board Schematic (CMPA1E1F060T-AMP)



Parts List

Part	Value	Qty.
C1	CAP, Radial Can SMD, 33 uF, 50V, 20%	1
C2	CAP, 2312, 10uF, 16V, TANTALUM	1
C3,C4	CAP, 1206, 10uF, 50V, 20%, X5R	2
C5,C6,C7,C8	CAP, 0603, 2.2uF, 50V, 10%, X5R	4
C9,C10	CAP, 0603, 470pF, 100V, 5% X7R	2
C11,C12	CAP, 0603, 10pF, 250V, 5%, NP0	2
C13,C14,C15,C16	CAP, 0402, 0.10uF, 50V, 10%, X7R	4
C17,C18,C19,C20	CAP, 0402, 0.47uF, 50V, 10%, X5R	4
C21-C26	Cap, Vertical Bondable, 30x30x10 mil, 10 nF 100V	6
R1,R2	RES, 0603, 0 Ohm, Jumper, 1/10W	2
W1,W2	22 AWG Jumper Wire, Black, 3" Long	2
J1,J2	RF Connectors	2
J3,J4	10-Pin, Connector, Male, 90° SMT, 0.100" Pitch	2

Evaluation Board Assembly Drawing (CMPA1E1F060T-AMP)



Note:
Gate and drain should be biased on both sides of the die in order to achieve optimum video bandwidth performance.

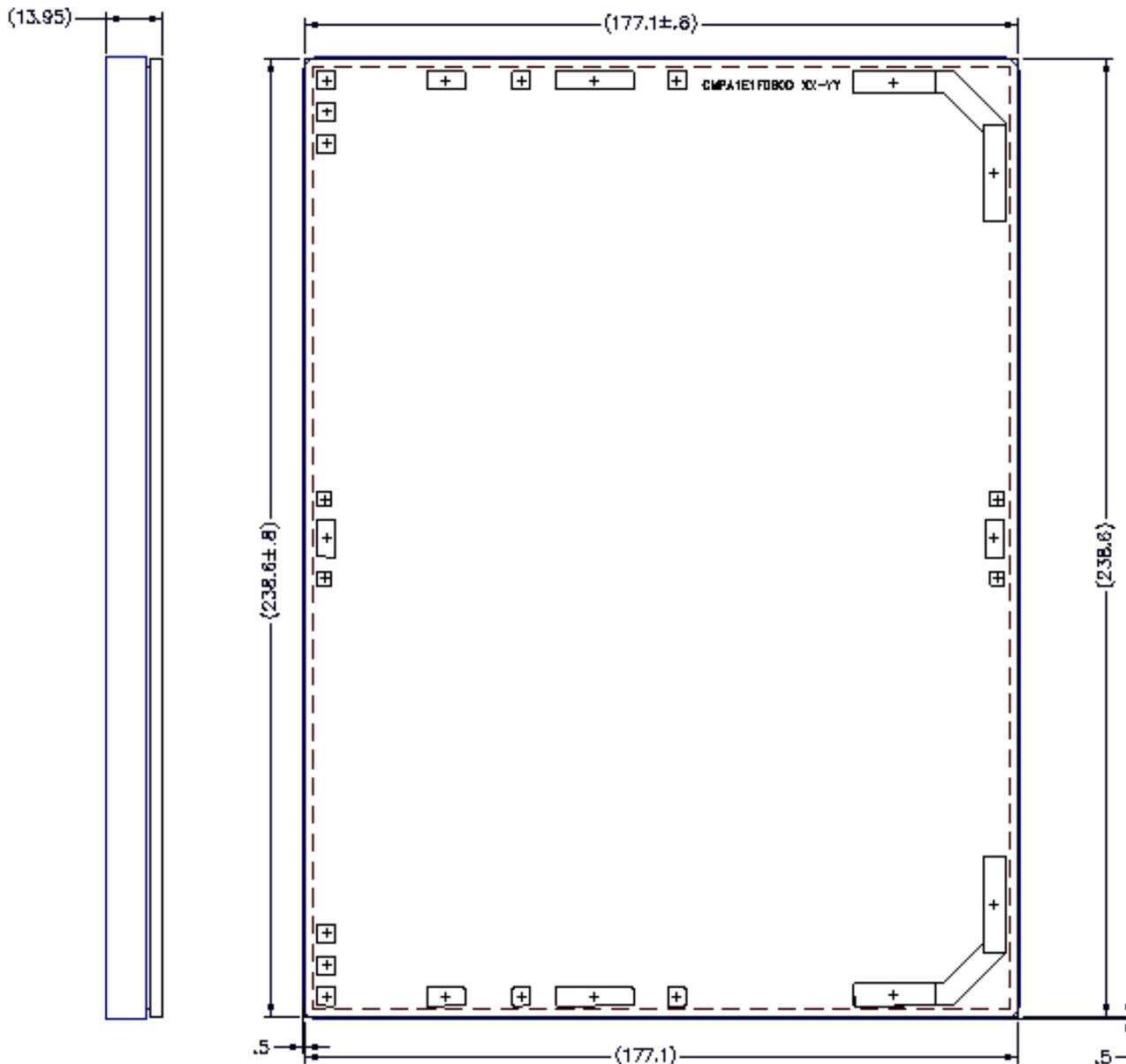
Bias On Sequence

1. Ensure RF is turned-off
2. Apply pinch-off voltage of -5 V to the gate (V_G)
3. Apply nominal drain voltage (V_D)
4. Adjust V_G to obtain desired quiescent drain current (I_{DQ})
5. Apply RF

Bias Off Sequence

1. Turn RF off
2. Apply pinch-off to the gate ($V_G = -5$ V)
3. Turn off drain voltage (V_D)
4. Turn off gate voltage (V_G)

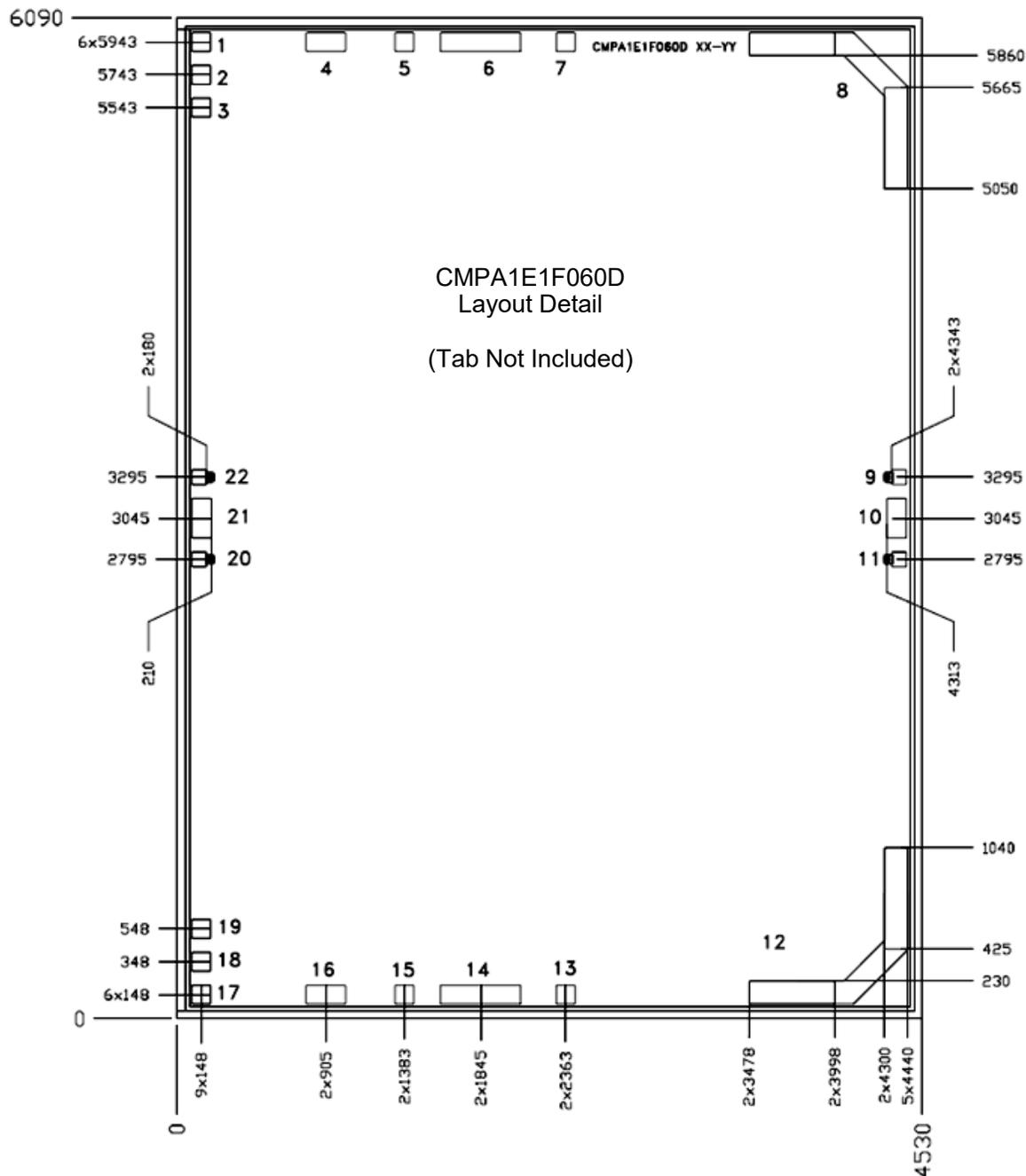
Mechanical Information—CMPA1E1F060T Tab Dimensions



Notes

1. Die size: 177.1 mils x 238.6 mils (+/- 0.8 mils)
2. Die thickness: 3 mils (+/- 0.4 mils)
3. Tab size: 178.1 mils x 239.6 mils (+/- 0.8 mils)
4. Tab thickness: 10 mils (+/- 0.5 mils)
5. Tab material: PCM30 (30% Cu, 70% Mo)
6. Tab plating: Ni - 50-200µin[1.27-5.08µm]
Au - 50-100µin[1.27-2.54µm]
7. Die attachment to tab uses AuSn solder (80/20)

Mechanical Information—CMPA1E1F060D Bond Pad Detail



Notes

1. Die size: 4530 μm x 6090 μm (+0/-50 μm)
2. Die size does not account for saw kerf which is 30 μm (+0/-15 μm). Sawn die dimension would be 30 μm less than shown above (+/- 30 μm in either dimension)
3. Die thickness: 75 μm (+/- 10 μm)
4. Unless otherwise specified, all dimensions shown are μm with a tolerance of +/- 5 μm.

GaN High Power Amplifier, 60 W 13.75 - 15.5 GHz



CMPA1E1F060T
Rev. V1

Revision History

Rev	Date	Change Description
V1	04/04/2025	Production release.

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