

10 W, 65% PAE GaN Power Amplifier, DIE

2.7 - 3.5 GHz



ENGPA00239A

Rev. V1

Features

- Operation Across 2.7 - 3.5 GHz
- Large Signal Gain: 24 dB
- 10 W Output; 65% PAE
- 2:1 Output SWR, 3.0 - 3.5 GHz
- Die Size:
 - 5.49 x 3.81 x 0.075 mm
 - 0.216 x 0.150 x 0.003 inch
- RoHS* Compliant

Applications

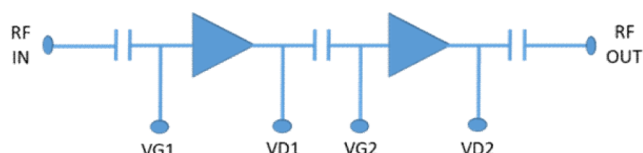
- S-Band Weather Radar & Military Radar Driver Amplifier Functions
- Radio Transmitters when Biased for Linearity
- Test & Measurement Systems

Description

The ENGPA00239A is a S-band GaN-on-SiC HEMT two-stage 10-W, 65% power added efficiency (PAE) amplifier, that operates across 2.7 to 3.5 GHz. The design is 50-ohm matched and does require an off-chip choke (2nd stage drain bias) for best performance below 1 GHz. The amplifier has a typical PAE of 65% or more across 2.7 to 3.5 GHz at 10 W output power, at 24 V bias, when assembled with a wire choke. The amplifier has gold backside metallization and is designed for gold tin eutectic or high thermal conductivity epoxy attachment.

Functional Block Diagram

MMIC RF ports are DC-blocked. RF ports designed for 50 ohms.



Ordering Information

Part Number	Package
ENGPA00239A	Die

* Restrictions on Hazardous Substances, compliant to current RoHS EU directive.

10 W, 65% PAE GaN Power Amplifier, DIE

2.7 - 3.5 GHz

**ENGPA00239A**

Rev. V1

Electrical Specifications:

Freq. = 2.7 - 3.5 GHz, $T_A = +25^{\circ}\text{C}$, $V_D = 24\text{ V}$; $I_{DS} = 324\text{ mA}$ (I_q), $V_G \sim -1.9\text{ V}$

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Gain	—	dB	27	32	—
Input Return Loss	—	dB	6	9	—
Output Return Loss	—	dB	6	9.5	—
Output P5dB	—	dBm	37	40	—
PAE @ P5dB	—	dBm	55	65	—
Supply Current	@ 15 dBm RF Input	mA	430	660	860
Thermal Resistance	includes 25- μm thick AuSn solder mount	$^{\circ}\text{C/W}$	—	2.8	—

Recommended Operating Conditions

Parameter	Min.	Typ.	Max.	Units
Drain Voltage	18	24	25	V
Gate Voltage	-2.4	-1.8	-1.2	V
Drain Current	—	300	—	mA

Absolute Maximum Ratings^{1,2}

Parameter	Absolute Maximum
Drain Voltage	30 V
Gate Voltage	-8 V
RF Input Power	33 dBm
Operating Temperature	-55 $^{\circ}\text{C}$ to +100 $^{\circ}\text{C}$
Storage Temperature	-65 $^{\circ}\text{C}$ to +150 $^{\circ}\text{C}$

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

Handling Procedures

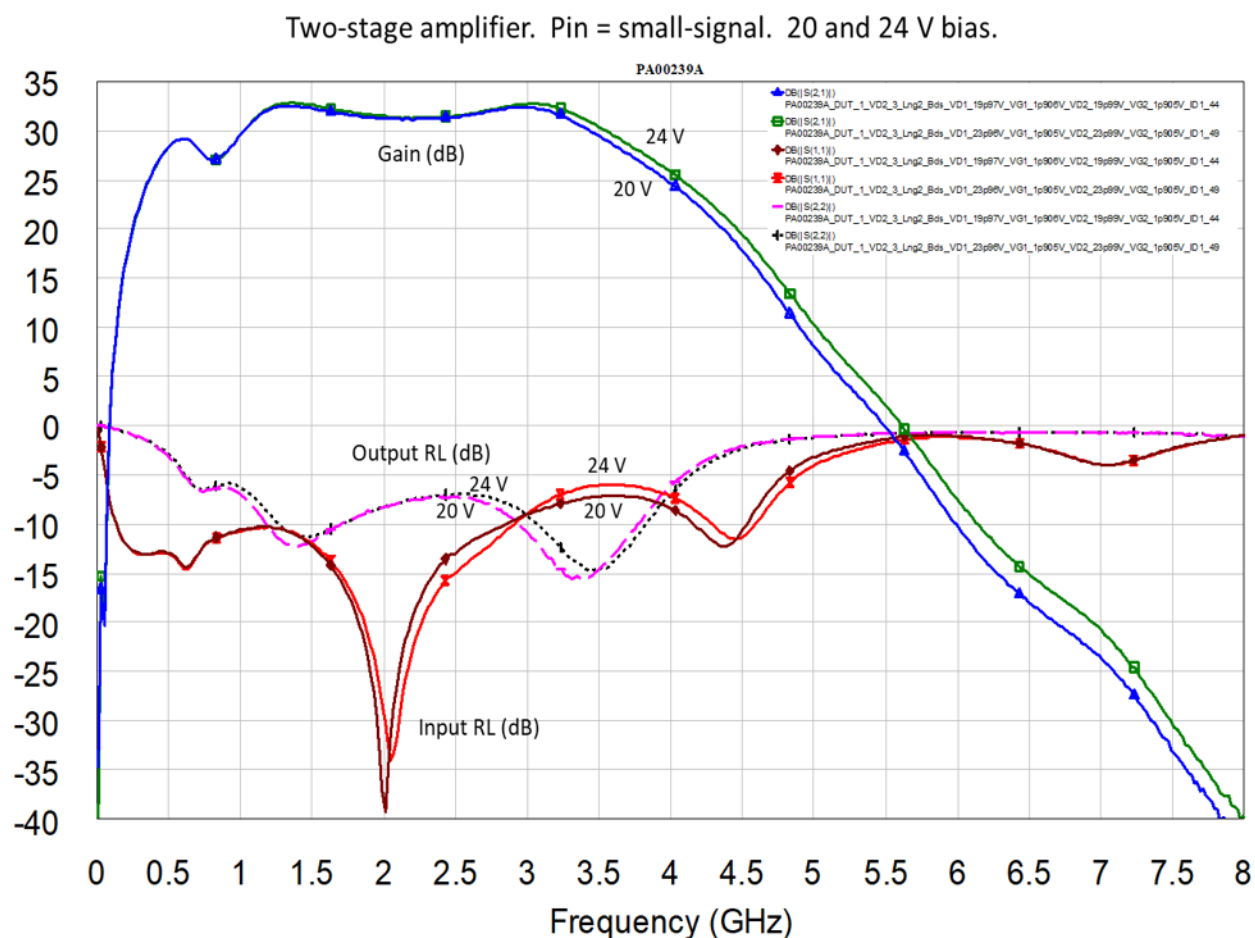
Please observe the following precautions to avoid damage:

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 devices.

Measured S-Parameters – MMIC with bond wires and external microstrip flares; bond wire choke on output stage

*Gain ($|S_{21}|$), Input ($|S_{11}|$) and Output ($|S_{22}|$) Return Loss
20 to 24 V, 284 - 324 mA (quiescent), ~ -1.9 Vg bias; 25 °C*



10 W, 65% PAE GaN Power Amplifier, DIE

2.7 - 3.5 GHz

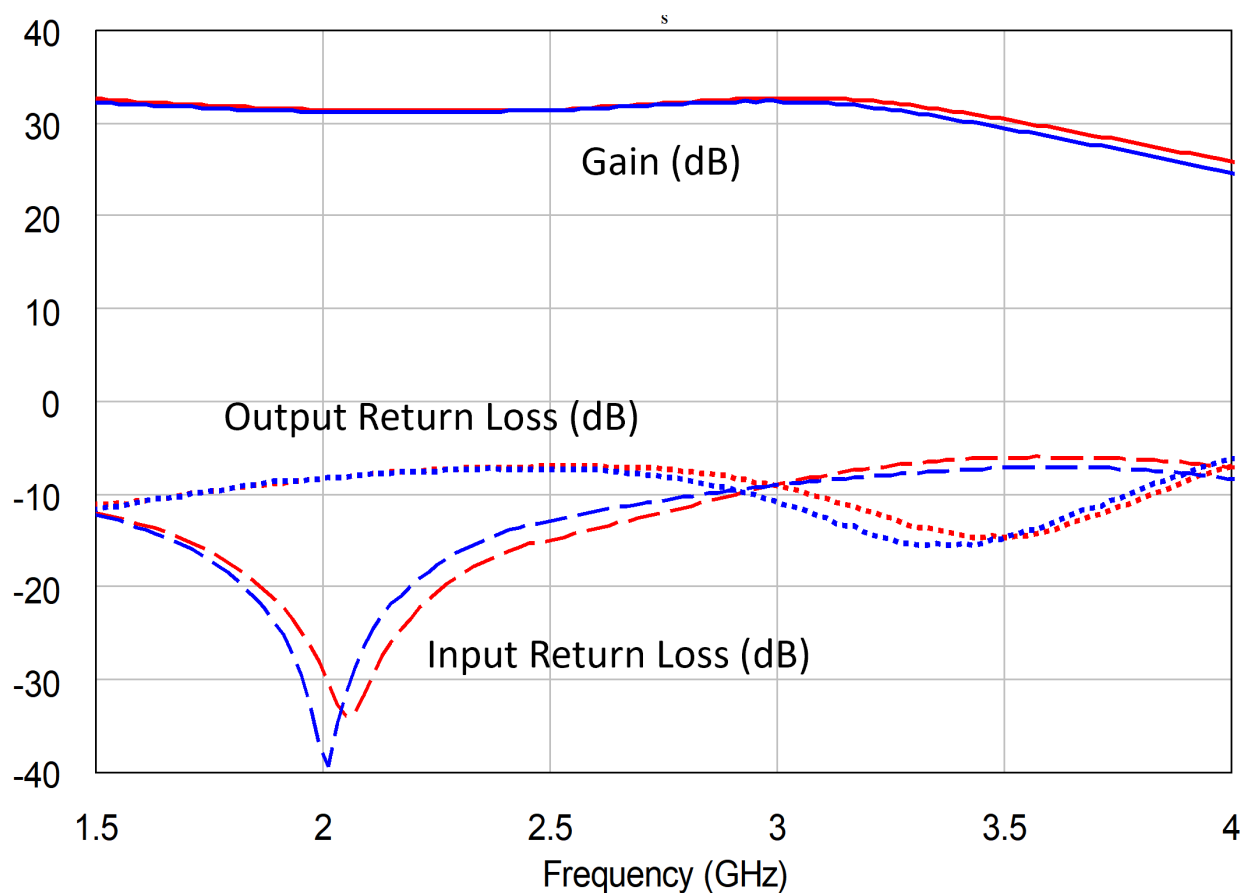


ENGPA00239A

Rev. V1

Measured S-Parameters – MMIC with bond wires and external microstrip flares

Gain ($|S_{21}|$), Input ($|S_{11}|$) and Output ($|S_{22}|$) Return Loss
~ -1.8 Vg bias; **24** and **20 V** bias 25 °C



Quiescent current at:

20 V **284.4 mA**

24 V **323.8 mA**

10 W, 65% PAE GaN Power Amplifier, DIE 2.7 - 3.5 GHz

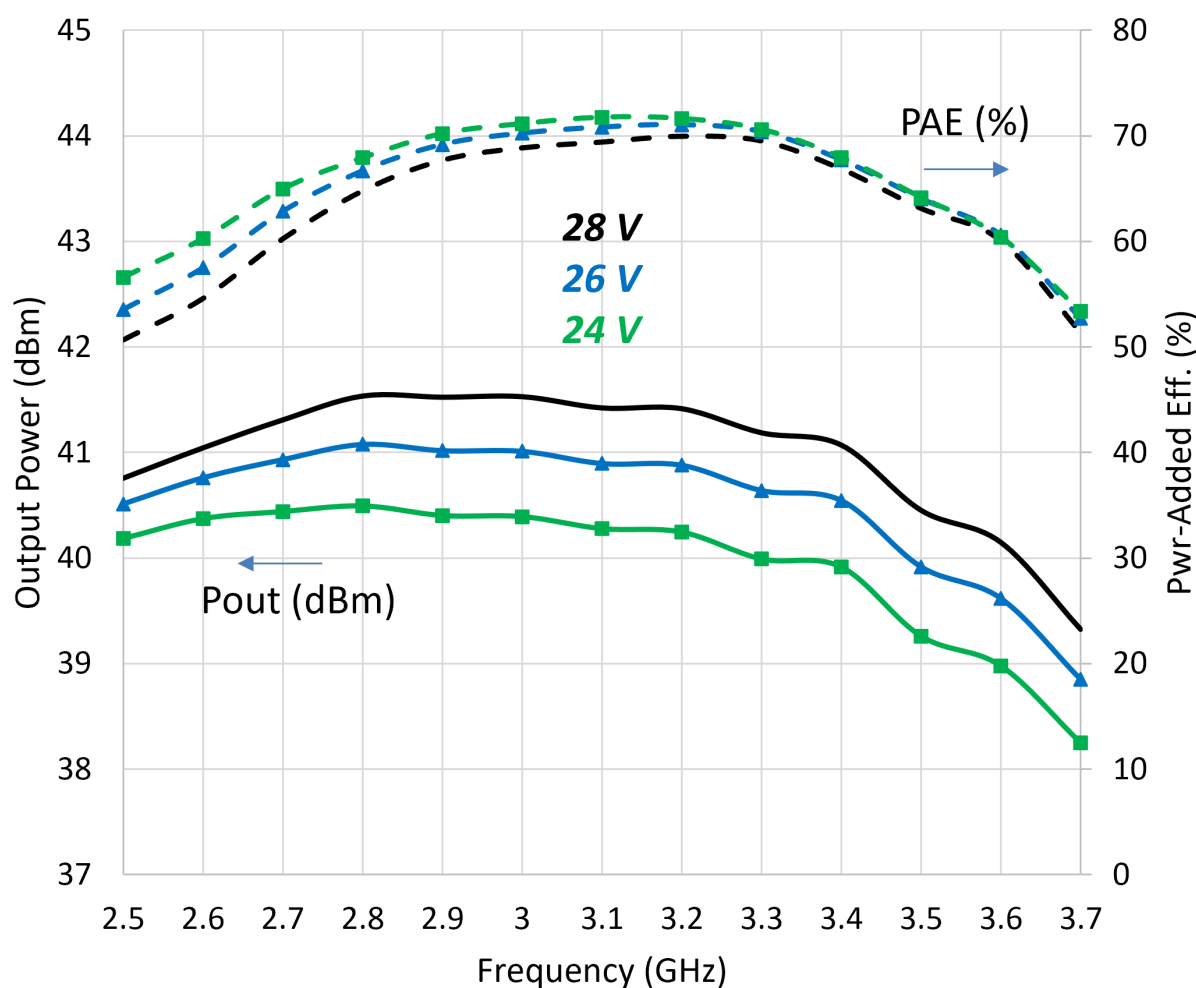


ENGPA00239A

Rev. V1

Measured S-Parameters – MMIC with bond wires and external microstrip flares

*Output Power & PAE, $V_d = 24 - 28$ V, $P_{in} = 15$ dBm
24 to 28 V, ~ 300 mA (quiescent), ~ -1.9 Vg bias; 25 °C*



10 W, 65% PAE GaN Power Amplifier, DIE

2.7 - 3.5 GHz



ENGPA00239A

Rev. V1

Measured S-Parameters – MMIC with bond wires and external microstrip flares

20 V, 284.4 mA (quiescent), ~ -1.9 Vg bias; 25 °C

	S11		S21		S12		S22	
Freq	mag	ang	mag	ang	mag	ang	mag	ang
(GHZ)	(DB)	(deg)	(DB)	(deg)	(DB)	(deg)	(DB)	(deg)
2.59	-11.97	-14.08	31.53	142.07	-56.94	-161.39	-7.41	-30.84
2.61	-11.76	-15.73	31.60	136.87	-55.23	-165.45	-7.46	-35.53
2.67	-11.31	-20.79	31.73	121.57	-54.21	-143.27	-7.72	-49.86
2.71	-11.01	-23.73	31.85	111.08	-53.40	-144.38	-7.92	-59.92
2.77	-10.54	-28.23	32.05	94.73	-57.64	-137.66	-8.21	-75.26
2.81	-10.27	-31.36	32.12	83.63	-62.45	-141.07	-8.57	-85.03
2.87	-9.85	-35.75	32.25	66.60	-59.78	-161.53	-9.16	-100.25
2.91	-9.58	-38.72	32.31	55.17	-57.75	-170.25	-9.66	-110.13
2.97	-9.20	-43.32	32.33	37.52	-55.50	175.22	-10.48	-124.62
3.01	-8.99	-46.53	32.32	25.38	-58.22	-152.58	-11.05	-135.55
3.07	-8.68	-51.20	32.23	7.30	-55.26	174.89	-11.91	-149.21
3.11	-8.49	-54.22	32.14	-5.00	-56.85	176.85	-12.70	-157.63
3.17	-8.21	-58.93	31.90	-23.31	-53.51	163.51	-13.54	-170.05
3.21	-8.04	-61.96	31.68	-35.47	-54.26	173.43	-14.41	-179.64
3.27	-7.84	-66.74	31.29	-53.79	-53.24	166.96	-15.28	169.14
3.31	-7.70	-69.84	30.99	-65.55	-54.56	155.44	-15.63	161.60
3.37	-7.48	-74.62	30.53	-83.39	-54.38	165.15	-15.50	148.84
3.41	-7.37	-78.05	30.22	-95.00	-50.18	144.24	-15.43	143.48
3.47	-7.25	-82.92	29.67	-111.97	-54.24	122.70	-14.93	127.07
3.51	-7.19	-86.37	29.34	-123.43	-50.70	119.28	-14.53	117.63
3.57	-7.12	-91.43	28.82	-140.35	-52.92	109.80	-13.81	100.51
3.61	-7.12	-94.82	28.45	-151.68	-51.74	108.86	-13.10	88.60

10 W, 65% PAE GaN Power Amplifier, DIE

2.7 - 3.5 GHz



ENGPA00239A

Rev. V1

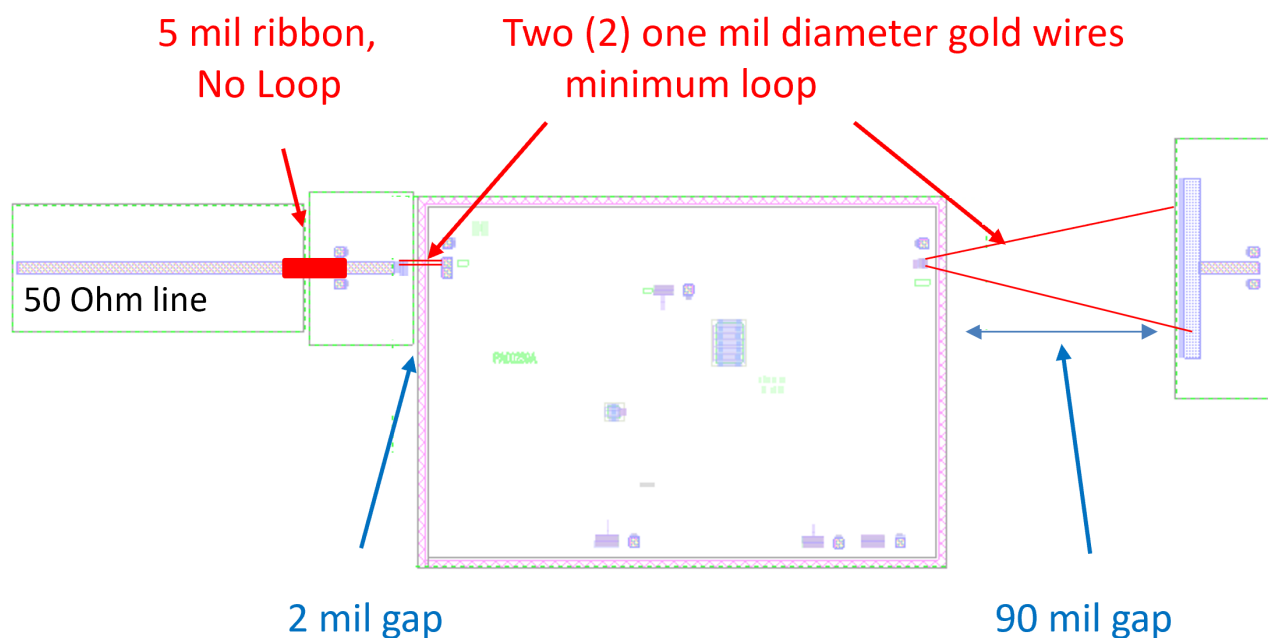
Measured S-Parameters – MMIC with bond wires and external microstrip flares

24 V, 323.8 mA (quiescent), ~ -1.9 Vg bias; 25 °C

	S11		S21		S12		S22	
Freq	mag	ang	mag	ang	mag	ang	mag	ang
(GHZ)	(DB)	(deg)	(DB)	(deg)	(DB)	(deg)	(DB)	(deg)
2.59	-13.85	-7.26	31.64	148.28	-53.11	-148.87	-7.00	-35.32
2.61	-13.56	-8.40	31.71	143.23	-53.69	-128.47	-6.98	-40.46
2.67	-12.93	-11.91	31.85	128.33	-52.50	-146.00	-7.12	-54.73
2.71	-12.48	-13.90	31.98	118.14	-57.04	-147.91	-7.18	-65.08
2.77	-11.74	-16.86	32.19	102.33	-52.75	-170.54	-7.41	-80.98
2.81	-11.26	-19.32	32.29	91.59	-57.05	-155.09	-7.64	-90.95
2.87	-10.52	-22.97	32.47	75.01	-58.03	-160.13	-8.06	-107.29
2.91	-10.02	-25.81	32.56	63.86	-54.70	-171.98	-8.33	-118.63
2.97	-9.31	-30.57	32.64	46.64	-57.91	179.18	-8.80	-134.97
3.01	-8.90	-33.98	32.67	34.77	-58.46	169.80	-9.28	-146.57
3.07	-8.29	-39.37	32.69	17.03	-57.62	175.86	-10.06	-163.74
3.11	-7.93	-43.09	32.65	4.83	-57.76	156.77	-10.54	-174.83
3.17	-7.44	-48.85	32.50	-13.36	-55.13	162.58	-11.41	167.81
3.21	-7.16	-52.91	32.34	-25.53	-54.30	145.81	-11.99	156.09
3.27	-6.84	-58.96	32.02	-43.83	-53.91	147.54	-13.08	139.95
3.31	-6.64	-62.99	31.77	-55.66	-53.36	130.82	-13.57	129.77
3.37	-6.64	-62.99	31.77	-55.66	-53.36	130.82	-13.57	129.77
3.41	-6.25	-73.11	31.09	-85.31	-54.32	113.19	-14.58	105.18
3.47	-6.12	-79.01	30.59	-102.47	-55.98	108.50	-14.59	90.93
3.51	-6.06	-83.02	30.28	-113.98	-53.98	110.32	-14.62	82.59
3.57	-6.01	-88.87	29.78	-131.04	-53.89	103.49	-14.35	69.13
3.61	-6.02	-92.68	29.42	-142.36	-54.22	90.14	-13.81	60.30

Bonding Diagram

RF Path Detail based on 0.2 nH inductance input wire bonds,
and 1.2 nH inductance output wire bonds



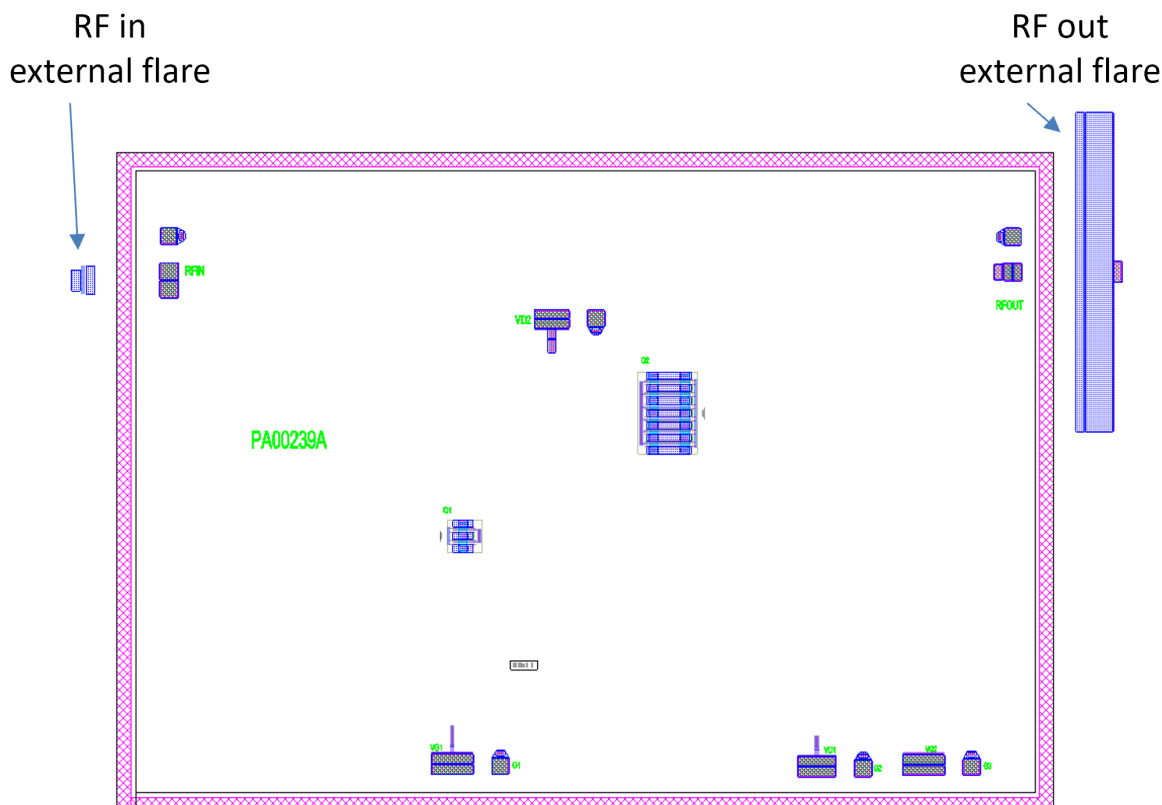
10 W, 65% PAE GaN Power Amplifier, DIE 2.7 - 3.5 GHz



ENGPA00239A

Rev. V1

Assembly Drawing - MMIC



External Microstrip Flare dimensions on 5-mil alumina:

RF in: 81 (x) x 160 (y) (μm)
RF out: 209 (x) x 1800 (y)
50 ohm line: 120 (y) wide

10 W, 65% PAE GaN Power Amplifier, DIE

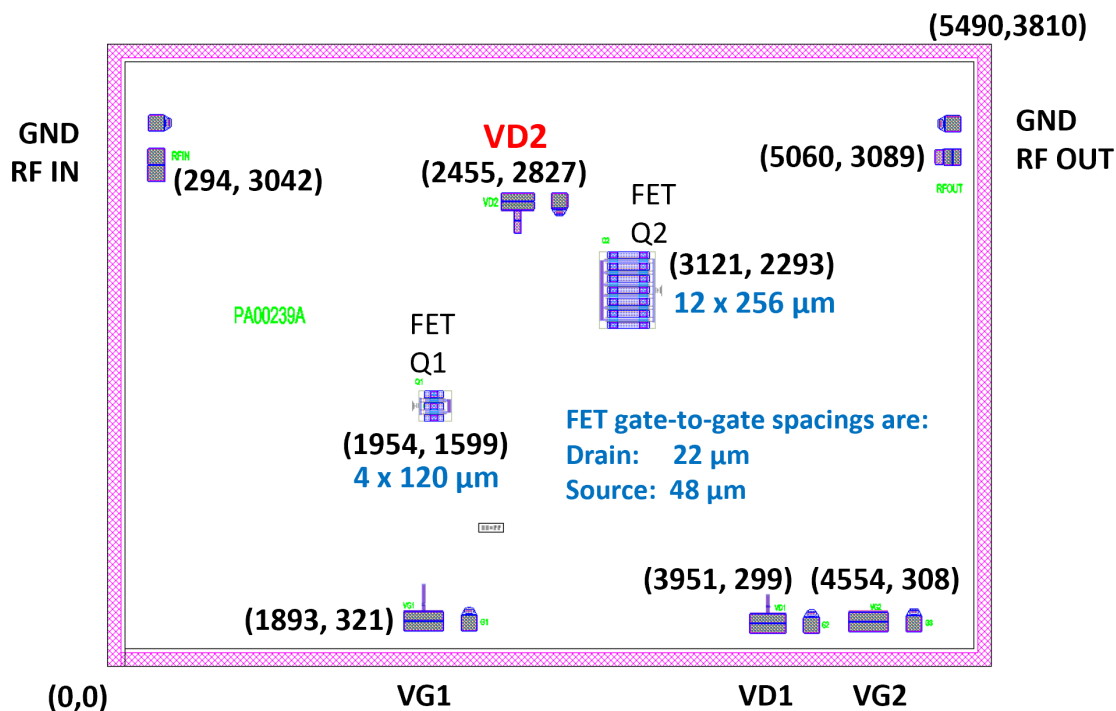
2.7 - 3.5 GHz



ENGPA00239A

Rev. V1

Outline Drawing



Bond pad dimensions:

RF in	106 x 200 (μm)
VG1	240 x 120
VD1	220 x 120
VG2	240 x 120
VD2	200 x 106
RF out	106 x 100

MACOM Technology Solutions Inc. ("MACOM"). All rights reserved.

These materials are provided in connection with MACOM's products as a service to its customers and may be used for informational purposes only. Except as provided in its Terms and Conditions of Sale or any separate agreement, MACOM assumes no liability or responsibility whatsoever, including for (i) errors or omissions in these materials; (ii) failure to update these materials; or (iii) conflicts or incompatibilities arising from future changes to specifications and product descriptions, which MACOM may make at any time, without notice. These materials grant no license, express or implied, to any intellectual property rights.

THESE MATERIALS ARE PROVIDED "AS IS" WITH NO WARRANTY OR LIABILITY, EXPRESS OR IMPLIED, RELATING TO SALE AND/OR USE OF MACOM PRODUCTS INCLUDING FITNESS FOR A PARTICULAR PURPOSE, MERCHANTABILITY, INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHT, ACCURACY OR COMPLETENESS, OR SPECIAL, INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES WHICH MAY RESULT FROM USE OF THESE MATERIALS.

MACOM products are not intended for use in medical, lifesaving or life sustaining applications. MACOM customers using or selling MACOM products for use in such applications do so at their own risk and agree to fully indemnify MACOM for any damages resulting from such improper use or sale.