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

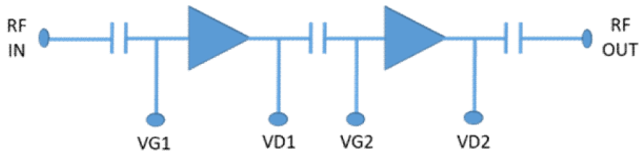
- S-Band Weather Radar & Military Radar Driver Amplifier Functions
- Radio Transmitters when Biased for Linearity
- Test & Measurement Systems

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.

Electrical Specifications:

Freq. = 2.7 - 3.5 GHz, T_A = +25°C, VD = 24 V; IDS= 324 mA (Iq), VG ~ -1.9 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	ºC/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°C to +100°C
Storage Temperature	-65°C to +150°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

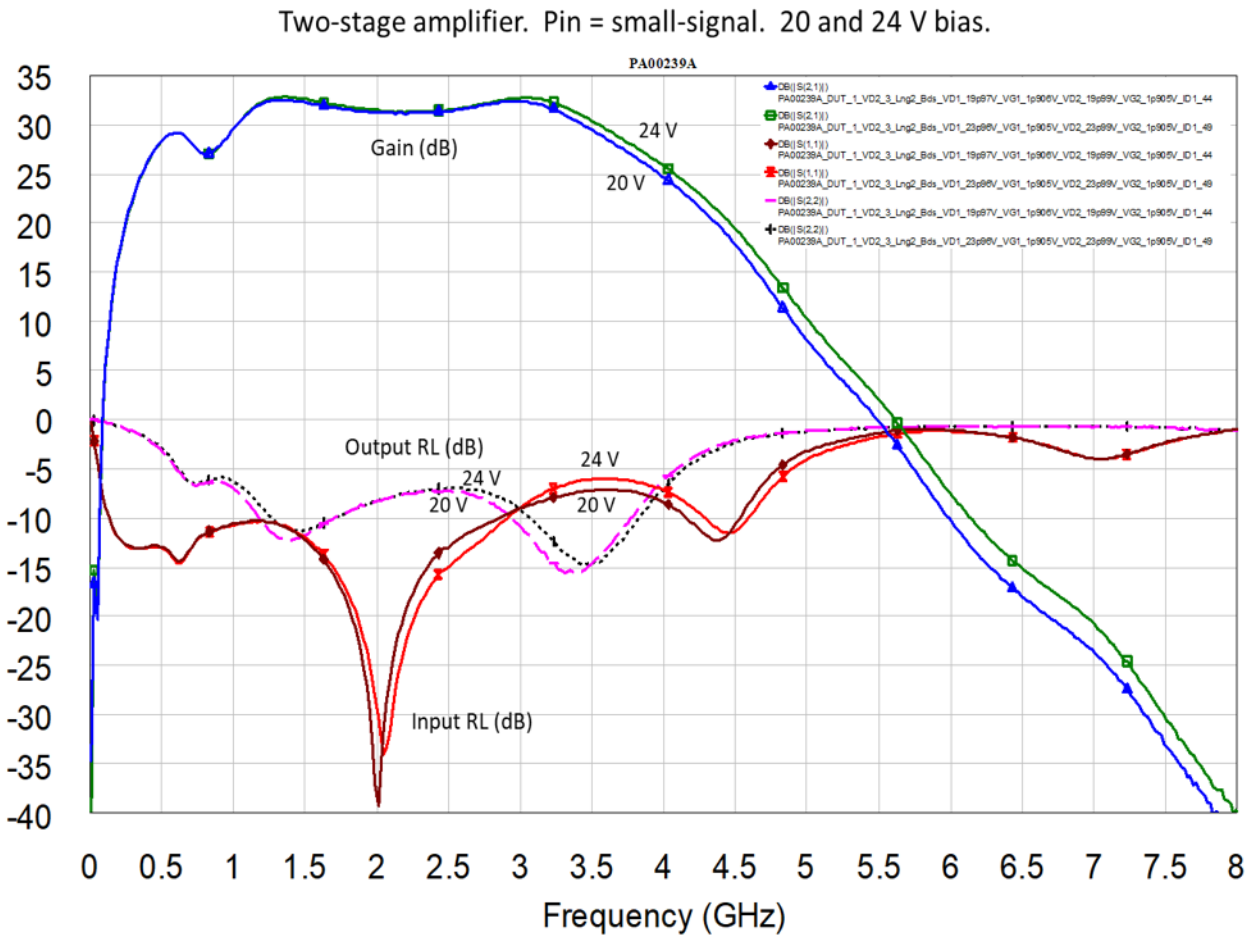
Please observe the following precautions to avoid damage:

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.

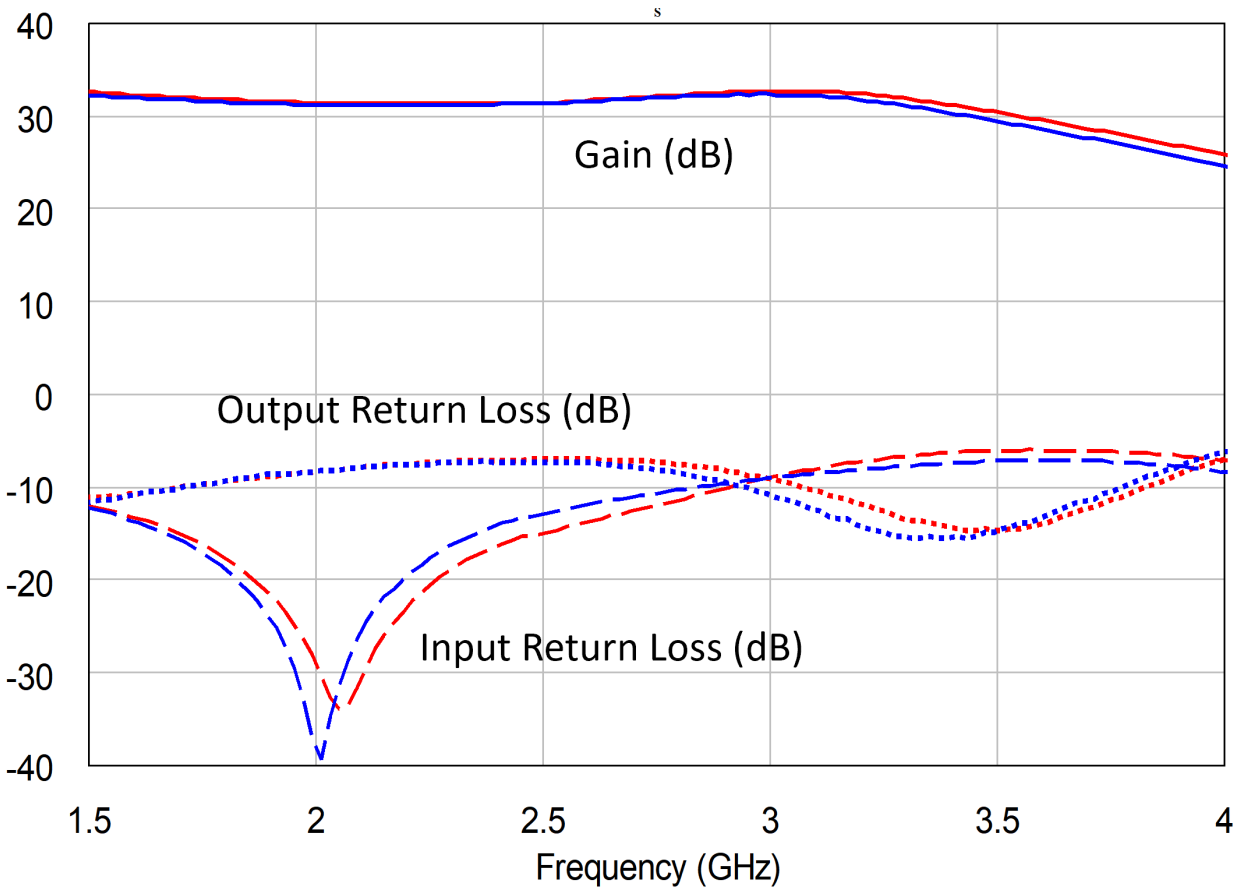
Measured S-Parameters – MMIC with bond wires and external microstrip flares; bond wire choke on output stage

Gain (|S21|), Input (|S11|) and Output (|S22}|) Return Loss
20 to 24 V, 284 - 324 mA (quiescent), ~ -1.9 Vg bias; 25 °C



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

Gain (|S21|), Input (|S11|) and Output (|S22}|) Return Loss
~ -1.8 Vg bias; 24 and 20 V bias 25 °C

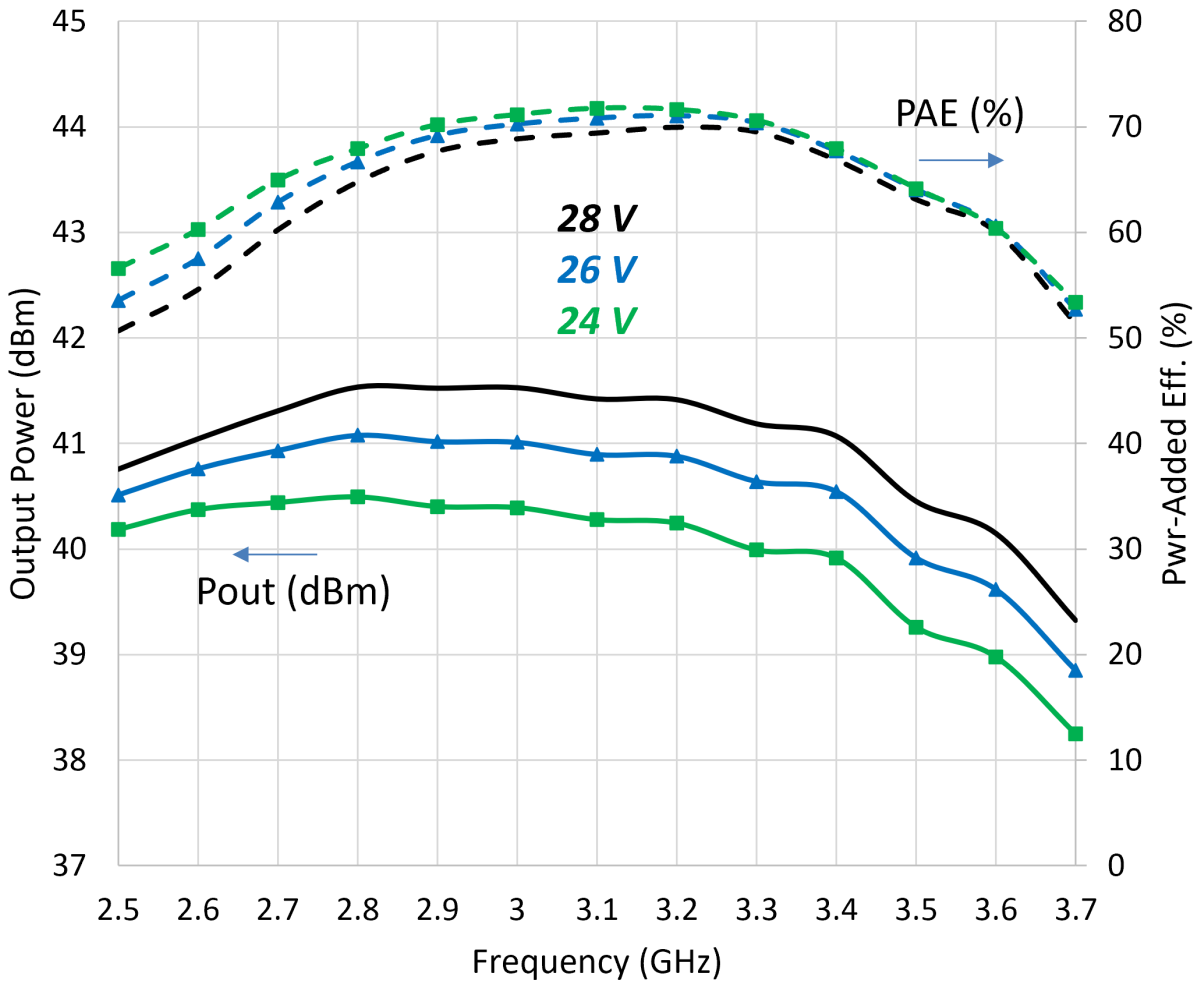


Quiescent current at:

20 V	284.4 mA
24 V	323.8 mA

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

Output Power & PAE, Vd = 24 - 28 V, Pin = 15 dBm
24 to 28 V, ~ 300 mA (quiescent), ~ -1.9 Vg bias; 25 °C



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

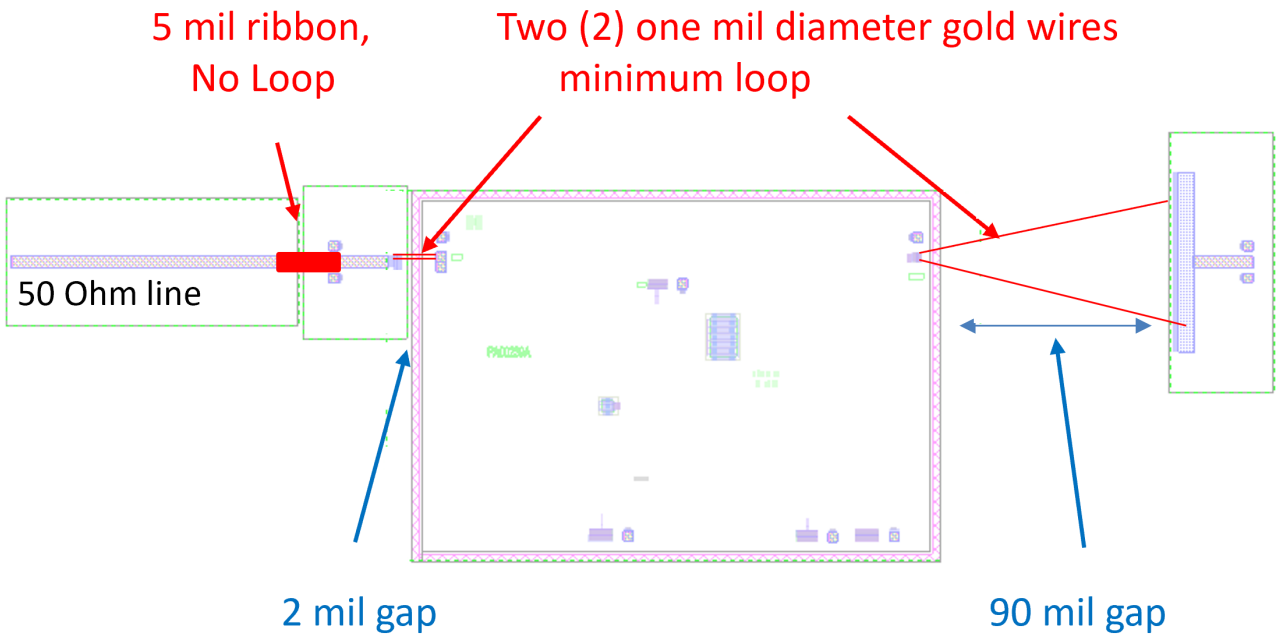
Measured S-Parameters – MMIC with bond wires and external microstrip flares

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

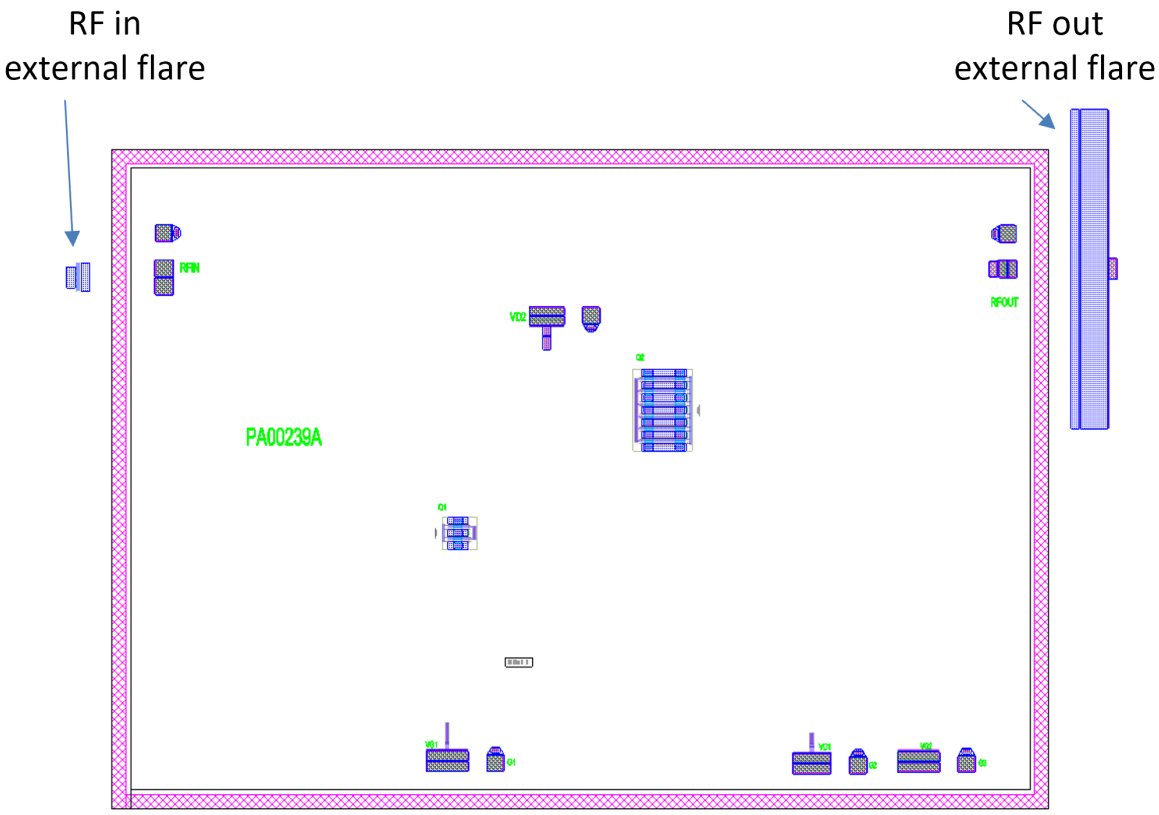
	S11		S21		S12		S22	
Freq	mag	ang	mag	ang	mag	ang	mag	ang
(GHZ)	(DB)	(deg)	(DB)	(deg)	(DB)	(deg)	(DB)	(deg)
2.59	-13.85	-7.26	31.64	148.28	-53.11	-148.87	-7.00	-35.32
2.61	-13.56	-8.40	31.71	143.23	-53.69	-128.47	-6.98	-40.46
2.67	-12.93	-11.91	31.85	128.33	-52.50	-146.00	-7.12	-54.73
2.71	-12.48	-13.90	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



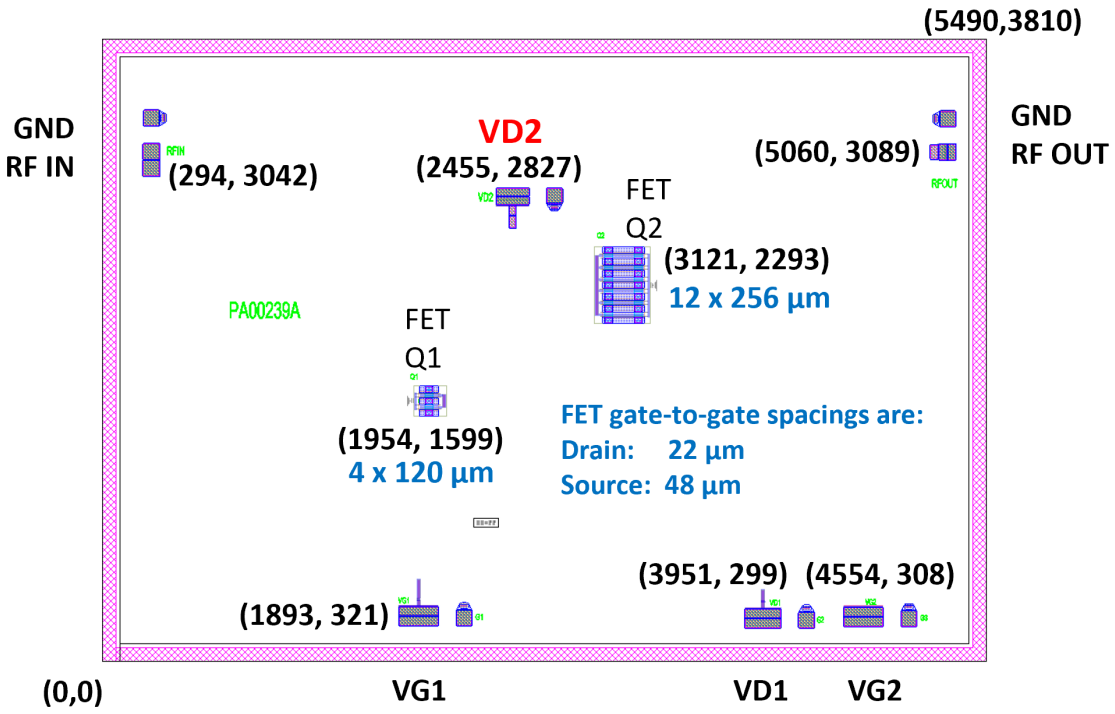
Assembly Drawing - MMIC



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

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