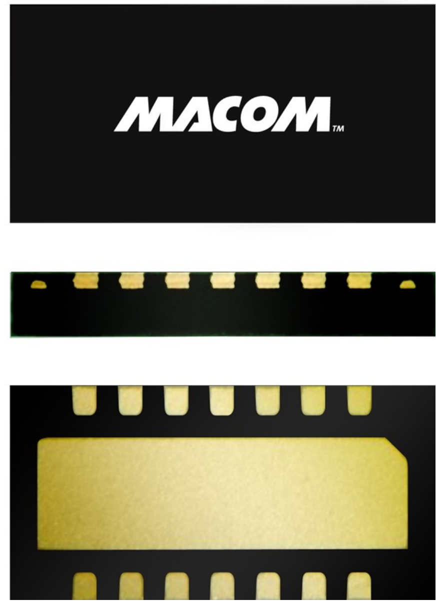
MAGX-000035-09000P

GaN Wideband 90 W Pulsed Transistor in Plastic Package
DC - 3.5 GHz

Features

- GaN on SiC D-Mode Transistor Technology
- Unmatched, Ideal for Pulsed Applications
- 50 V Typical Bias, Class AB
- Common-Source Configuration
- Thermally-Enhanced 3 x 6 mm 14-Lead DFN
- MTTF = 600 years (T_J < 200°C)
- Halogen-Free “Green” Mold Compound
- RoHS* Compliant and 260°C Reflow Compatible
- MSL-1



Description

The MAGX-000035-09000P is a GaN on SiC unmatched power device offering the widest RF frequency capability, most reliable high voltage operation, lowest overall power transistor size, cost and weight in a “TRUE SMT” plastic-packaging technology.

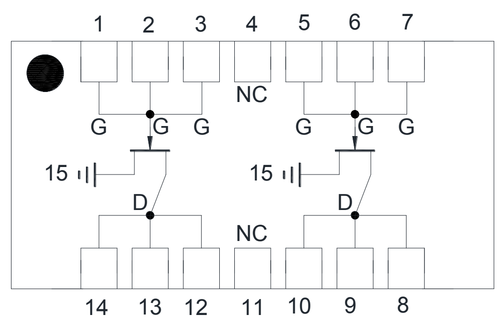
Use of an internal stress buffer technology allows reliable operation at junction temperatures up to 200°C. The small package size and excellent RF performance make it an ideal replacement for costly flanged or metal-backed module components.

Ordering Information[1,2]

Part Number	Package
MAGX-000035-09000P	Bulk Packaging
MAGX-000035-0900TP	100 Piece Reel
MAGX-000035-PB3PPR	Sample Board

1. Reference Application Note M513 for reel size information.
2. When ordering sample evaluation boards, choose a standard frequency range indicated on page 4/5 or specify a desired custom range. Custom requests may increase lead times.

Functional Schematic



Pin Configuration[3]

Pin No.	Function	Pin No.	Function
1	V_{GG}/RF_{IN}	8	V_{DD}/RF_{OUT}
2	V_{GG}/RF_{IN}	9	V_{DD}/RF_{OUT}
3	V_{GG}/RF_{IN}	10	V_{DD}/RF_{OUT}
4	No Connection	11	No Connection
5	V_{GG}/RF_{IN}	12	V_{DD}/RF_{OUT}
6	V_{GG}/RF_{IN}	13	V_{DD}/RF_{OUT}
7	V_{GG}/RF_{IN}	14	V_{DD}/RF_{OUT}
		15	Paddle[4]

3. MACOM recommends connecting unused package pins to ground.
4. The exposed pad centered on the package bottom must be connected to RF and DC ground.

* Restrictions on Hazardous Substances, European Union Directive 2002/95/EC.

Typical Performance[5]: V_{DD} = 50 V, I_{DQ} = 200 mA, T_A = 25°C

Parameter	30 MHz	1 GHz	2.5 GHz	3.5 GHz	Units
Gain	25	21	15	13	dB
Saturated Power (P_{SAT})	100	98	90	85	W
Power Gain at P_{SAT}	22	20	15	11	dB
PAE @ P_{SAT}	75	65	55	52	%

5. Typical RF performance measured in M/A-COM Technology Solutions RF evaluation boards. See recommended tuning solutions on pages 4 and 5.

Electrical Specifications: Freq. = 1.6 GHz, T_A = 25°C, V_{DD} = +50 V, Z_0 = 50 Ω

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
RF FUNCTIONAL TESTS						
CW Output Power (P2.5 dB)	V_{DD} = 28 V, I_{DQ} = 200 mA	P_{OUT}	-	14	-	W
Pulsed Output Power (P2.5 dB) 100 µs and 10% Duty Cycle	V_{DD} = 50 V, I_{DQ} = 200 mA	P_{OUT}	75	95	-	W
Pulsed Power Gain (P2.5 dB)	V_{DD} = 50 V, I_{DQ} = 200 mA	G_P	16	17.5	-	dB
Pulsed Drain Efficiency (P2.5 dB)	V_{DD} = 50 V, I_{DQ} = 200 mA	η_D	55	65	-	%
Load Mismatch Stability (P2.5 dB)	V_{DD} = 50 V, I_{DQ} = 200 mA	VSWR-S	-	5:1	-	-
Load Mismatch Tolerance (P2.5 dB)	V_{DD} = 50 V, I_{DQ} = 200 mA	VSWR-T	-	10:1	-	-

Electrical Characteristics: T_A = 25°C

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
DC CHARACTERISTICS						
Drain-Source Leakage Current	V_{GS} = -8 V, V_{DS} = 175 V	I_{DS}	-	-	6.0	mA
Gate Threshold Voltage	V_{DS} = 5 V, I_D = 6 mA	$V_{GS\ (th)}$	-5	-3	-2	V
Forward Transconductance	V_{DS} = 5 V, I_D = 3000 mA	G_M	1.1	-	-	S
DYNAMIC CHARACTERISTICS						
Input Capacitance	V_{DS} = 0 V, V_{GS} = -8 V, F = 1 MHz	C_{ISS}	-	22	-	pF
Output Capacitance	V_{DS} = 50 V, V_{GS} = -8 V, F = 1 MHz	C_{OSS}	-	9.8	-	pF
Reverse Transfer Capacitance	V_{DS} = 50 V, V_{GS} = -8 V, F = 1 MHz	C_{RSS}	-	0.9	-	pF

Absolute Maximum Ratings [6,7,8,9,10]

Parameter	Absolute Max.
Input Power	P_{OUT} - G_P + 2.5 dBm
Drain Supply Voltage, V_{DD}	+65 V
Gate Supply Voltage, V_{GG}	-8 V to 0 V
Supply Current, I_{DD}	4500 mA
Power Dissipation, CW @ 85ºC	27 W
Power Dissipation (P_{AVG}), Pulsed @ 85°C	85 W
Junction Temperature[11]	200°C
Operating Temperature	-40°C to +95°C
Storage Temperature	-65°C to +150°C

6. Exceeding any one or combination of these limits may cause permanent damage to this device.
7. M/A-COM Technology Solutions does not recommend sustained operation near these survivability limits.
8. For saturated performance it is recommended that the sum of (3 * V_{DD} + abs (V_{GG})) $\leq$ 175 V.
9. CW operation at V_{DD} voltages above 28 V is not recommended.
10. Operating at nominal conditions with $T_J \leq$ 200°C will ensure MTTF > 1 x 10^6 hours. Junction temperature directly affects device MTTF and should be kept as low as possible to maximize lifetime.
11. Junction Temperature (T_J) = T_C + Θ_{JC} * ((V * I) - (P_{OUT} - P_{IN}))

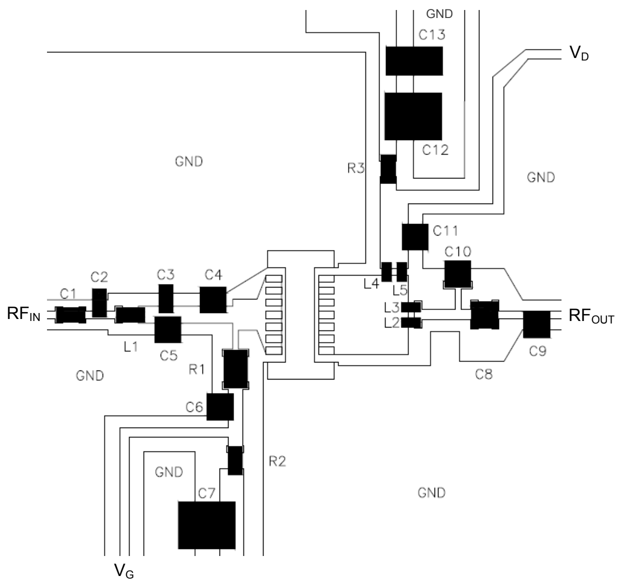
Typical CW thermal resistance (Θ_{JC}) = 5.69°C/W
a) For T_C = 79°C,
T_J = 200°C @ 28 V, 1224 mA, P_{OUT} = 15 W, P_{IN} = 0.25 W

Typical transient thermal resistances:
b) 300 µs pulse, 10% duty cycle, Θ_{JC} = 0.96°C/W
For T_C = 79°C,
T_J = 131°C @ 50 V, 2500 mA, P_{OUT} = 74 W, P_{IN} = 2 W

c) 1 ms pulse, 10% duty cycle, Θ_{JC} = 1.38°C/W
For T_C = 80°C,
T_J = 173°C @ 50 V, 2780 mA, P_{OUT} = 74 W, P_{IN} = 2 W

d) 1 ms pulse, 10% duty cycle, Θ_{JC} = 1.35°C/W
For T_C = 80°C,
T_J = 173°C @ 50 V, 3160 mA, P_{OUT} = 93 W, P_{IN} = 4 W

Evaluation Board Details and Recommended Tuning Solutions



Parts measured on evaluation board (8-mils thick RO4003C). Electrical and thermal ground is provided using copper-filled via hole array (not pictured), and evaluation board is mounted to a metal plate.

Matching is provided using lumped elements as shown at left. Recommended tuning solutions for 2 frequency ranges are detailed in the parts list below.

Bias Sequencing

Turning the device ON

1. Set V_G to the pinch-off (V_P), typically -5 V.
2. Turn on V_D to nominal voltage (50 V).
3. Increase V_{GS} until the I_{DS} current is reached.
4. Apply RF power to desired level.

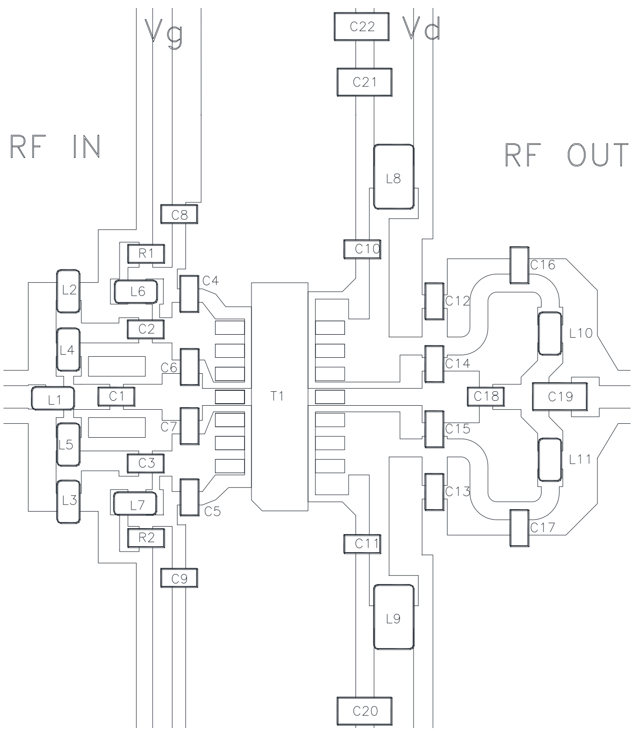
Turning the device OFF

1. Turn the RF power off.
2. Decrease V_G down to V_P.
3. Decrease V_D down to 0 V.
4. Turn off V_G.

Parts List
(N/A = not applicable for this tuning solution)

Part	Frequency = 1.2 - 1.4 GHz	Frequency = 1.6 GHz
C1	0505, 56 pF, ±5%, 250 V, ATC	0505, 36 pF, ±5%, 250 V, ATC
C2	0603, 4.7 pF, ±0.1 pF, 250 V, ATC	N/A
C3	0603, 10 pF, ±5%, 250 V, ATC	N/A
C4	0505, 15 pF, ±5%, 250 V, ATC	N/A
C5	N/A	0505, 8.2 pF, ±0.1 pF, 250 V, ATC
C6	N/A	0505, 100 pF, ±10%, 200 V, ATC
C7	0805, 1000 pF, 100 V, 5%, AVX	0805, 1000 pF, 100 V, 5%, AVX
C8	0505, 56 pF, ±5%, 250 V, ATC	0505, 36 pF, ±5%, 250 V, ATC
C9	0505, 2.2 pF, ±0.1 pF, 250 V, ATC	0505, 3.0 pF, ±0.1 pF, 250 V, ATC
C10	0505, 1.0 pF, ±0.1 pF, 250 V, ATC	N/A
C11	0505, 91 pF, ±5%, 250 V, ATC	0505, 36 pF, ±5%, 250 V, ATC
C12	0805, 1000 pF, 100 V, 5%, AVX	0805, 1000 pF, 100 V, 5%, AVX
C13	1210, 1 µF, 100 V, 20%, ATC	1210, 1 µF, 100 V, 20%, ATC
R1	12 Ω, 0805, 5%	12 Ω, 0805, 5%
R2	1.0 Ω, 0603, 5%	1.0 Ω, 0603, 5%
R3	0.33 Ω, 0603, 5%	1.0 Ω, 0603, 5%
L1	0603 CS, 1.6 nH (1.8 nH)	N/A
L2	0402 HP, 2.7 nH	N/A
L3	0402 HP, 2.7 nH	N/A
L4	0402 PA, 1.9 nH (0402 HP, 2.0 nH)	N/A
L5	0402 PA, 1.9 nH (0402 HP, 2.0 nH)	N/A

Evaluation Board Details and Recommended Tuning Solutions (Freq. = 2.7 - 3.5 GHz)



Parts measured on evaluation board (12-mil thick RO4003C). Electrical and thermal ground is provided using a copper-filled via hole array (not pictured), and evaluation board is mounted to a metal plate.

Matching is provided using lumped elements. Recommended tuning solutions for 1 frequency range is detailed in the parts list below.

Parts List

Part	Value	Case Style
C1	0.7 pF	0402
C2, C3	1.1 pF	0402
C4, C5, C6, C7	2.0 pF	0402
C8, C9	100 pF	0402
C10, C11	6.8 pF	0402
C12, C13, C14, C15	1.3 pF	0402
C16, C17	0.3 pF	0402
C18	0.5 pF	0402
C19	12 pF	0603
C20, C21	100 pF	0603
C22	10 nF	0603
L1, L2, L3, L10, L11	1 nH	0402
L6, L7	12 nH	0402
L8, L9	12 nH	0603
L4, L5	2.2 nH	0402
R1, R2	200 Ω	0402
T1	MAGX-000035-09000P	3x6 mm DFN

Bias Sequencing

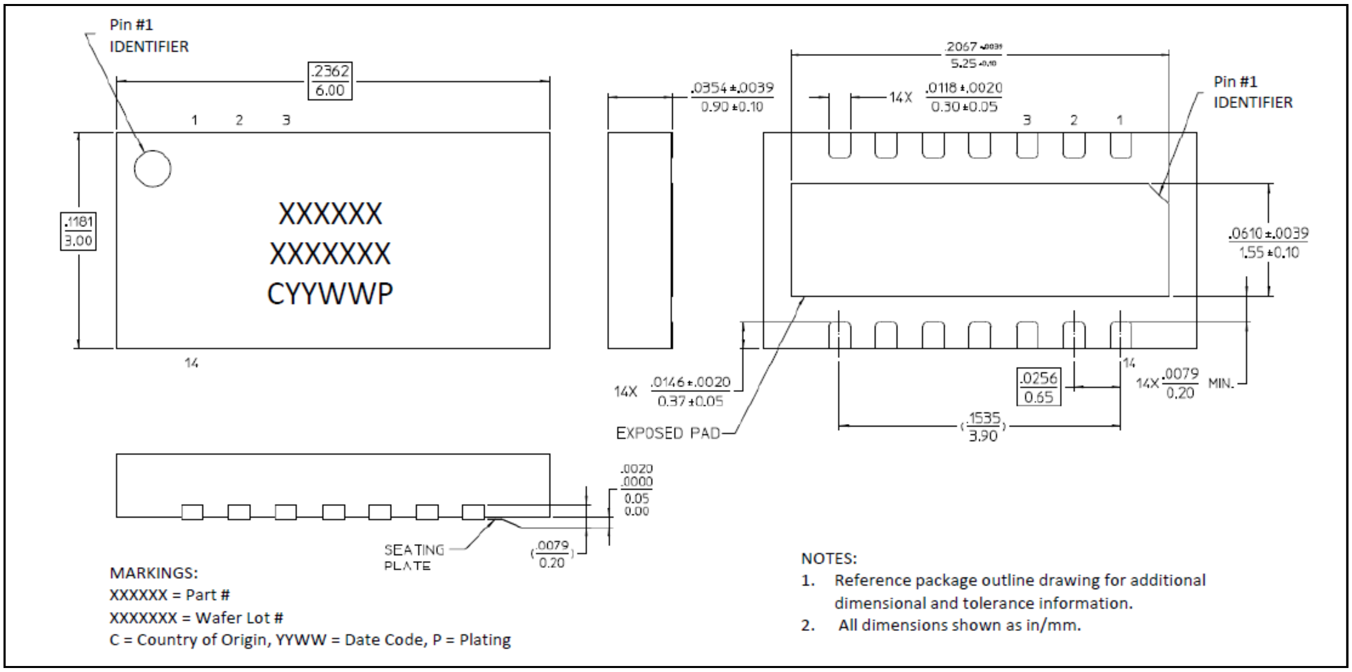
Turning the device ON

1. Set V_G to the pinch-off (V_P), typically -5 V.
2. Turn on V_D to nominal voltage (50 V).
3. Increase V_{GS} until the I_{DS} current is reached.
4. Apply RF power to desired level.

Turning the device OFF

1. Turn the RF power off.
2. Decrease V_G down to V_P.
3. Decrease V_D down to 0 V.
4. Turn off V_G.

Lead-Free 3x6 mm 14-Lead DFN†



† Reference Application Note S2083 for lead-free solder reflow recommendations.
Meets JEDEC moisture sensitivity level 1 requirements.
Plating is Ni/Pd/Au.

Handling Procedures

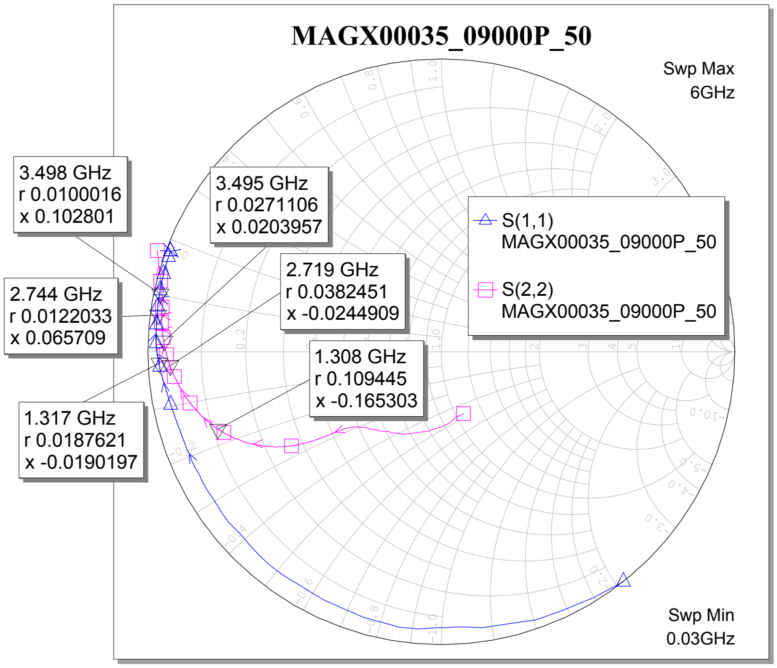
Please observe the following precautions to avoid damage:

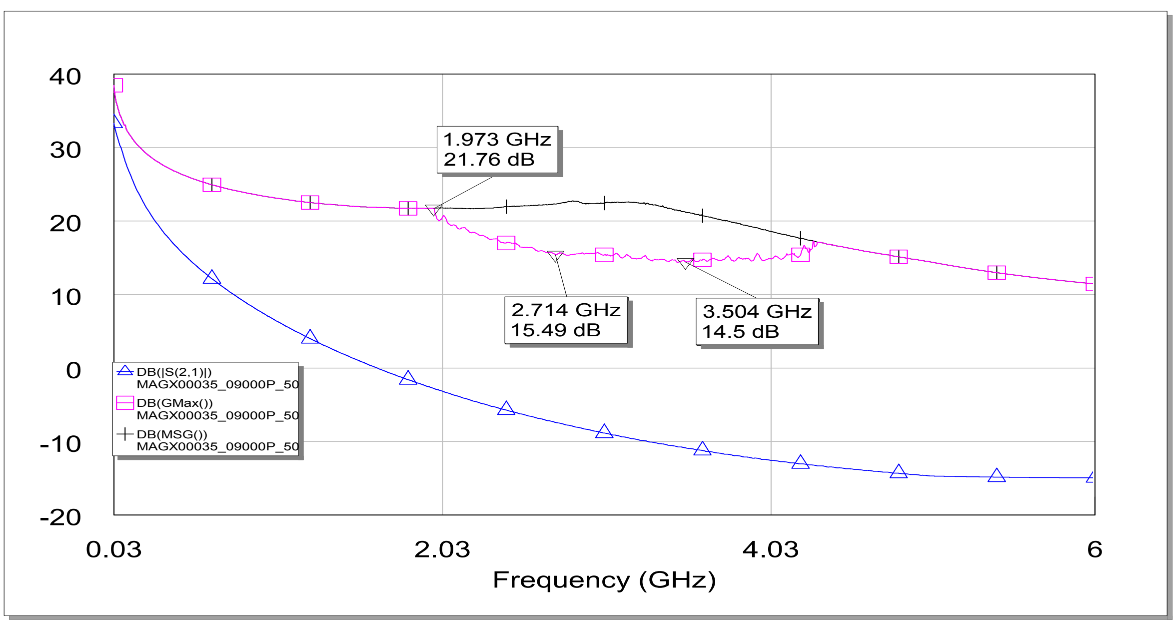
Static Sensitivity

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

Applications Section

S-Parameter Data: T_A = 25°C, V_{DD} = +50 V, I_{DQ} = 200 mA

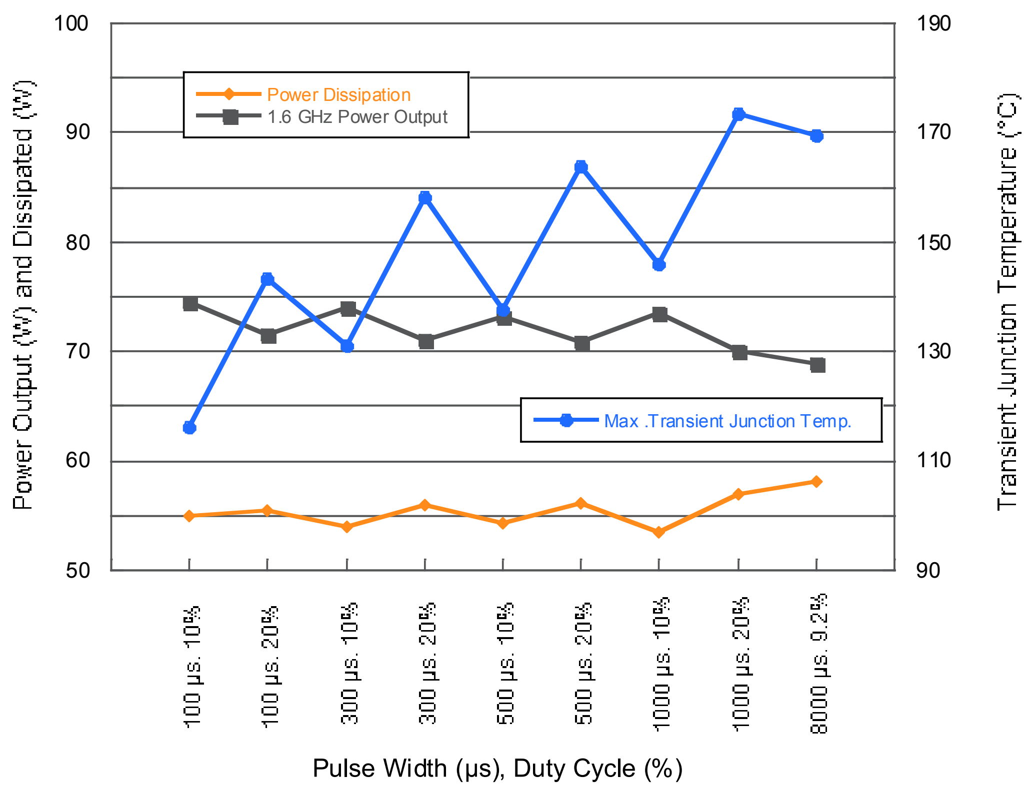




Applications Section

Thermal Performance: Freq. = 1.6 GHz, T_C = 85°C, V_{DD} = +50 V, I_{DQ} = 100 mA, Z_0 = 50 Ω

Power (Output & Dissipated) vs. Transient Junction Temperature, Pulse Duration and Duty Cycle



Pulse Width, Duty Cycle	100 µs, 10%	100 µs, 20%	300 µs, 10%	300 µs, 20%	500 µs, 10%	500 µs, 20%	1000 µs, 10%	1000 µs, 20%	8000 µs, 9.2%
Power Dissipation (W)	55	55.4	54	55.9	54.3	56.2	53.5	57	58.2
1.6 GHz P_{OUT} (W)	74.5	71.6	74	71.1	73.2	70.8	73.5	70	68.8
Max. Transient Junction Temp. (°C)	116.3	143.4	131.0	158.2	137.6	164.0	146.0	173.4	169.4

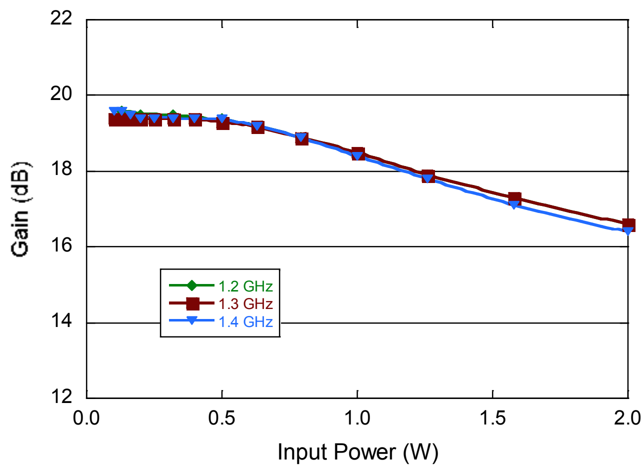
Junction temperature measured using High-Speed Transient (HST) temperature detection microscopy.

Applications Section

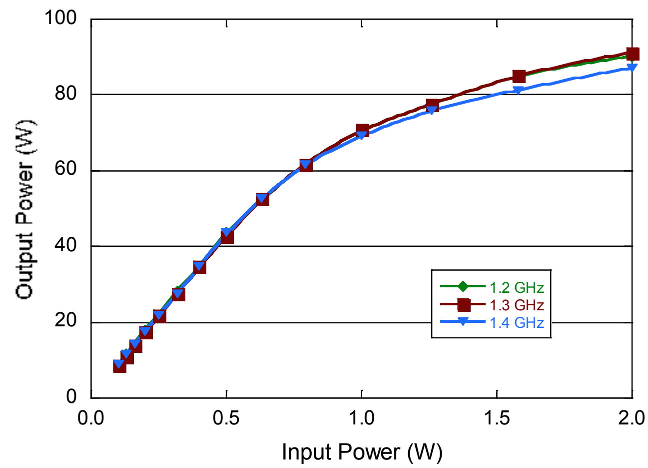
Typical Performance Curves (reference 1.2 - 1.4 GHz parts list):

1.2 - 1.4 GHz, 3 ms Pulse, 10% Duty Cycle, V_{DD} = +50 V, T_A = 25°C, Z_0 = 50 Ω

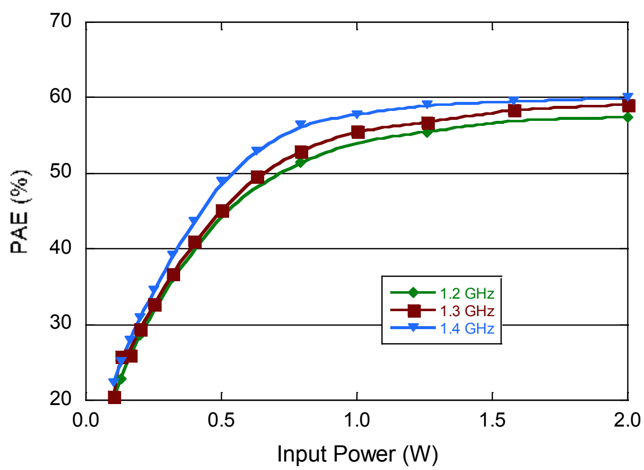
Gain vs. Input Power



Output Power vs. Input Power



PAE vs. Input Power

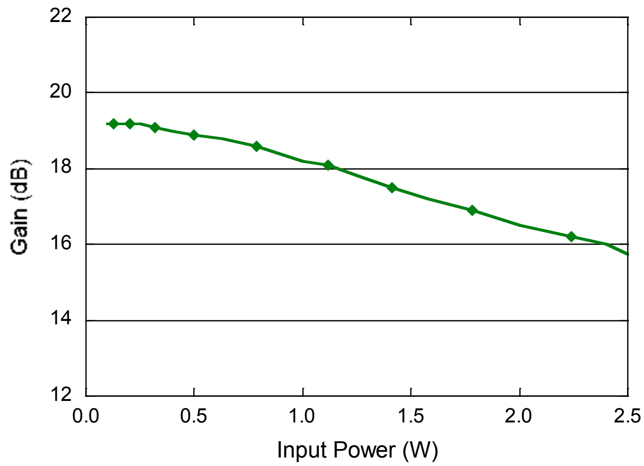


Applications Section

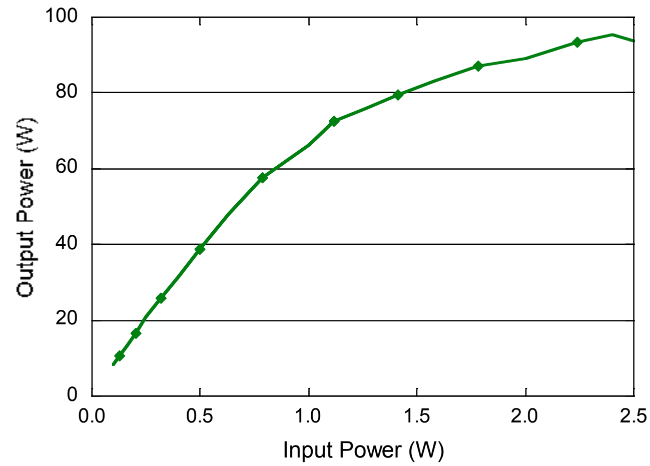
Typical Performance Curves (reference 1.6 GHz parts list):

1.6 GHz, 1 ms Pulse, 10% Duty Cycle, V_{DD}= +50 V, T_A = 25°C, Z_0 = 50 Ω

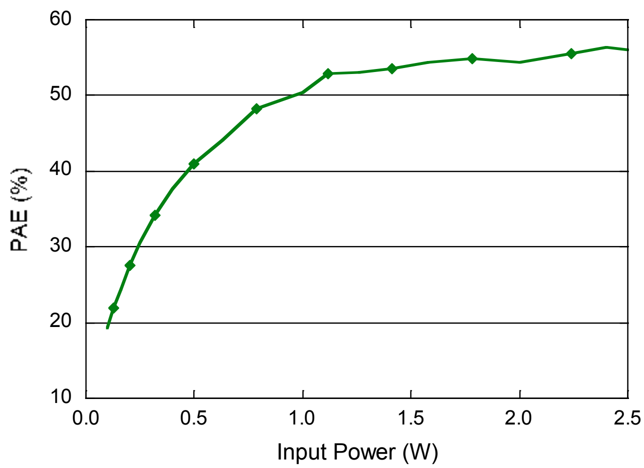
Gain vs. Input Power



Output Power vs. Input Power



PAE vs. Input Power

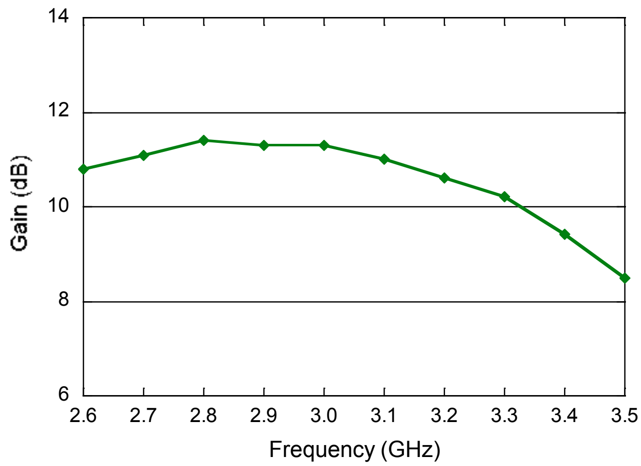


Applications Section

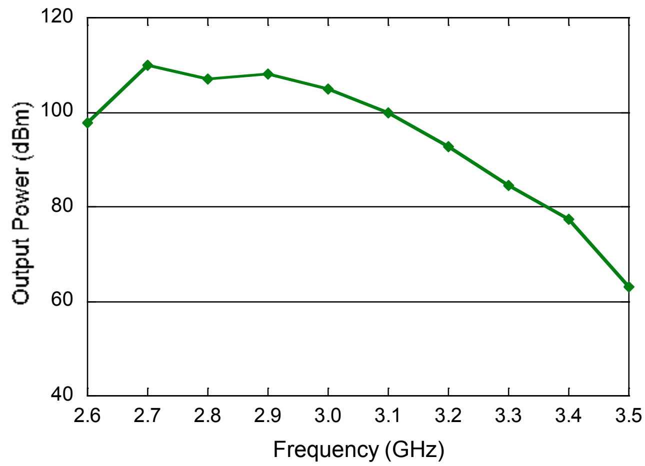
Typical Performance Curves (reference 2.7 - 3.1 GHz parts list):

2.7 - 3.1 GHz, 1 ms Pulse, 10% Duty Cycle, V_{DD} = +50 V, T_A = 25°C, Z_0 = 50 Ω

Gain vs. Frequency



Output Power vs. Frequency



PAE vs. Frequency