MAGX-000035-01500P

GaN Wideband 15 W Pulsed Transistor in Plastic Package
DC - 3.5 GHz

Rev. V4

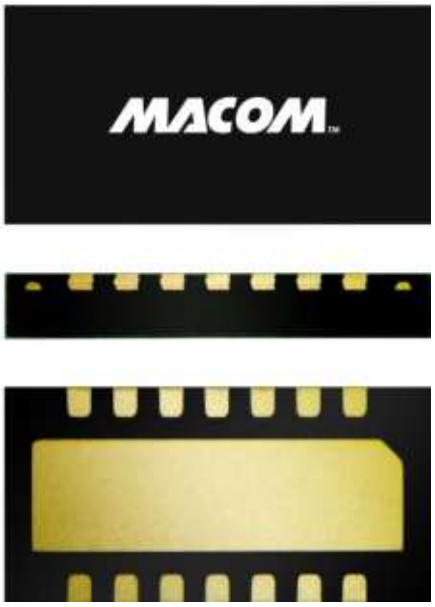
Features

- 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
- MSL-1

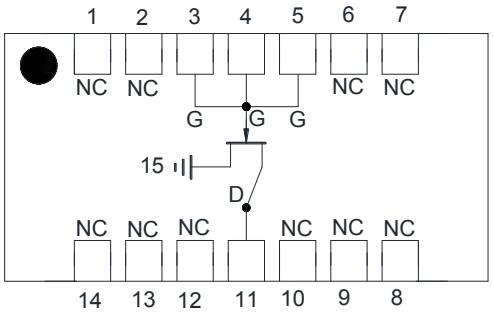
Description

The MAGX-000035-01500P 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.



Functional Schematic



Ordering Information[1,2]

Part Number	Package
MAGX-000035-01500P	Bulk Packaging
MAGX-000035-0150TP	250 Piece Reel
MAGX-000035-PB1PPR	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 or specify a desired custom range. Custom requests may increase lead times.

Pin Configuration[3]

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

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Typical Performance[5]: V_{DD} = 50 V, I_{DQ} = 35 mA, T_A = 25°C

Parameter	30 MHz	1 GHz	2.5 GHz	3.5 GHz	Units
Gain	25	23	17	14	dB
Saturated Power (P_{SAT})	18	16.5	15	14	W
Power Gain at P_{SAT}	22	18	14	11	dB
PAE @ P_{SAT}	75	68	60	55	%

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

Electrical Specifications: Freq. = 1.6 GHz, T_A = 25°C, Z_0 = 50 Ω

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
RF FUNCTIONAL TESTS						
CW Output Power (P2.5 dB)	V_{DD} = 36 V, I_{DQ} = 35 mA	P_{OUT}	-	7	-	W
Pulsed Output Power (P2.5 dB) 1 ms and 10% Duty Cycle	V_{DD} = 50 V, I_{DQ} = 35 mA	P_{OUT}	12.5	17	-	W
Pulsed Power Gain (P2.5 dB)	V_{DD} = 50 V, I_{DQ} = 35 mA	G_P	17	19.5	-	dB
Pulsed Drain Efficiency (P2.5 dB)	V_{DD} = 50 V, I_{DQ} = 35 mA	η_D	55	65	-	%
Load Mismatch Stability (P2.5 dB)	V_{DD} = 50 V, I_{DQ} = 35 mA	VSWR-S	-	5:1	-	-
Load Mismatch Tolerance (P2.5 dB)	V_{DD} = 50 V, I_{DQ} = 35 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}	-	-	1.0	mA
Gate Threshold Voltage	V_{DS} = 5 V, I_D = 2 mA	$V_{GS\ (th)}$	-5	-3	-2	V
Forward Transconductance	V_{DS} = 5 V, I_D = 500 mA	G_M	0.35	-	-	S
DYNAMIC CHARACTERISTICS						
Input Capacitance	V_{DS} = 0 V, V_{GS} = -8 V, F = 1 MHz	C_{ISS}	-	4.2	-	pF
Output Capacitance	V_{DS} = 50 V, V_{GS} = -8 V, F = 1 MHz	C_{OSS}	-	1.8	-	pF
Reverse Transfer Capacitance	V_{DS} = 50 V, V_{GS} = -8 V, F = 1 MHz	C_{RSS}	-	0.2	-	pF

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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}	800 mA
Power Dissipation, CW @ 85ºC	13 W
Power Dissipation (P_{AVG}), Pulsed @ 85°C	17 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 $(3 * V_{DD} + \text{abs}(V_{GG})) \leq 175$ V.
9. CW operation at V_{DD} voltages above 36 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}) = 15.7°C/W
a) For T_C = 83°C,
T_J = 200°C @ 36 V, 398 mA, P_{OUT} = 7.2 W, P_{IN} = 0.22 W

Typical transient thermal resistances:
b) 300 µs pulse, 10% duty cycle, Θ_{JC} = 5.33°C/W
For T_C = 83°C,
T_J = 170°C @ 50 V, 603 mA, P_{OUT} = 14.3 W, P_{IN} = 0.41 W

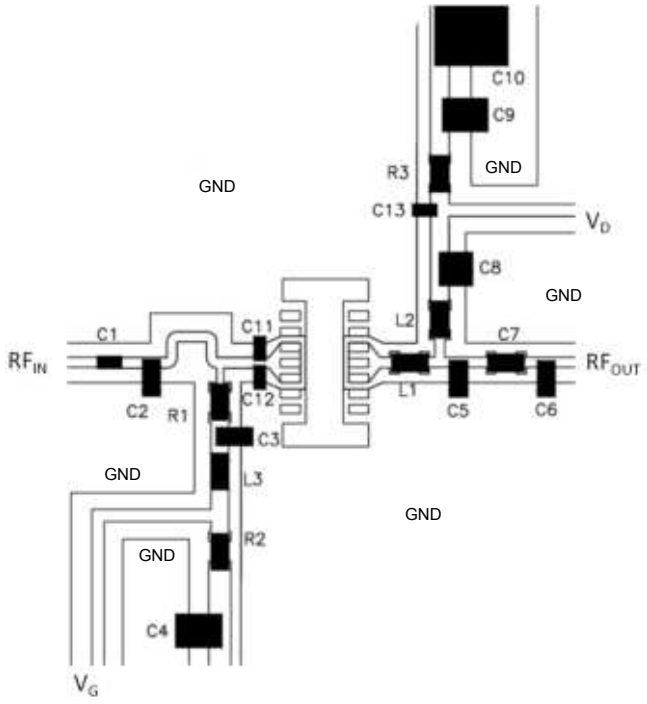
c) 1 ms pulse, 10% duty cycle, Θ_{JC} = 5.85°C/W
For T_C = 83°C,
T_J = 172°C @ 50 V, 576 mA, P_{OUT} = 14.0 W, P_{IN} = 0.41 W

d) 1 ms pulse, 20% duty cycle, Θ_{JC} = 6.81°C/W
For T_C = 83°C,
T_J = 186°C @ 50 V, 570 mA, P_{OUT} = 13.8 W, P_{IN} = 0.41 W

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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 3 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.

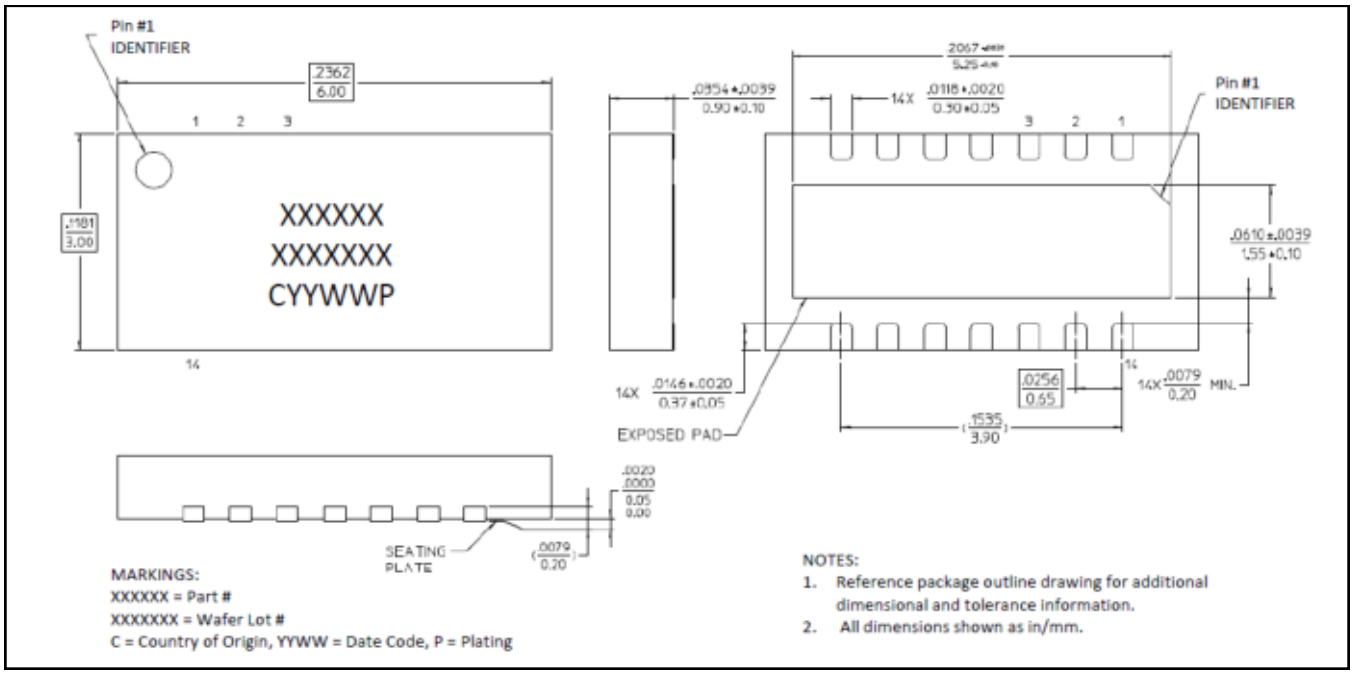
Parts List (N/A = not applicable for this tuning solution)

Part	Frequency = 1.6 GHz	Frequency = 2.2 - 2.5 GHz	Frequency = 2.6 - 3.6 GHz
C1	0402 27 pF, ±5%, 200 V, ATC	0402 18 pF, ±5%, 200 V, ATC	0402 18 pF, ±5%, 200 V, ATC
C2	0603, 5.6 pF, ±0.1 pF, 250 V, ATC	0402, 2.2 pF, ±0.1pF, 200 V, ATC	0402, 1.2 pF, ±0.1 pF, 200 V, ATC
C3	0603, 18 pF, ±10%, 250 V, ATC	N/A	N/A
C4	0805, 1000 pF, 100 V, 5%, AVX	0805, 1000 pF, 100 V, 5%, AVX	0805, 1000 pF, 100 V, 5%, AVX
C5	0505, 2.2 pF, ±5%, 250 V, ATC (Vertical)	0603, 0.8 pF, ±0.1 pF, 250 V, ATC	N/A
C6	N/A	0603, 1.5 pF, ±0.1 pF, 250 V, ATC	0402, 1.0 pF, ±0.1 pF, 200 V, ATC
C7	0505, 36 pF, ±5%, 250 V, ATC (Vertical)	0402 18 pF, ±5%, 200 V, ATC	0402 18 pF, ±5%, 200 V, ATC
C8	0505, 18 pF, ±5%, 250 V, ATC	0402 10 pF, ±5%, 200 V, ATC	N/A
C9	0805, 1000 pF, 100 V, 5%, AVX	0805, 1000 pF, 100 V, 5%, AVX	0805, 1000pF, 100V, 5%, AVX
C10	1210, 1 µF, 100 V, 20%, ATC	1210, 1 µF, 100 V, 20%, ATC	1210, 1 µF, 100 V, 20%, ATC
C11	N/A	0402, 3.9 pF, ±0.1 pF, 200 V, ATC	0402, 2.0 pF, ±0.1 pF, 200 V, ATC
C12	N/A	0402, 3.9 pF, ±0.1 pF, 200 V, ATC	0402, 2.0 pF, ±0.1 pF, 200 V, ATC
C13	N/A	N/A	0402 10 pF, ±5%, 200 V, ATC
R1	12 Ω, 0603, 5%	200 Ω, 0603, 5%	100 Ω, 0603, 5%
R2	1.2 Ω, 0603, 5%	1.0 Ω, 0603, 5%	1.0 Ω, 0603, 5%
R3	1.2 Ω, 0603, 5%	9.1 Ω, 0603, 5%	9.1 Ω, 0603, 5%
L1	0603 HP, 5.1 nH, 5%	0402, 0.8 nH,10%	Shorting tab
L2	0603 HP, 24 nH, 5%	0603, 1.8 nH, 10%	Shorting tab
L3	N/A	N/A	0603, 10nH, 10%

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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

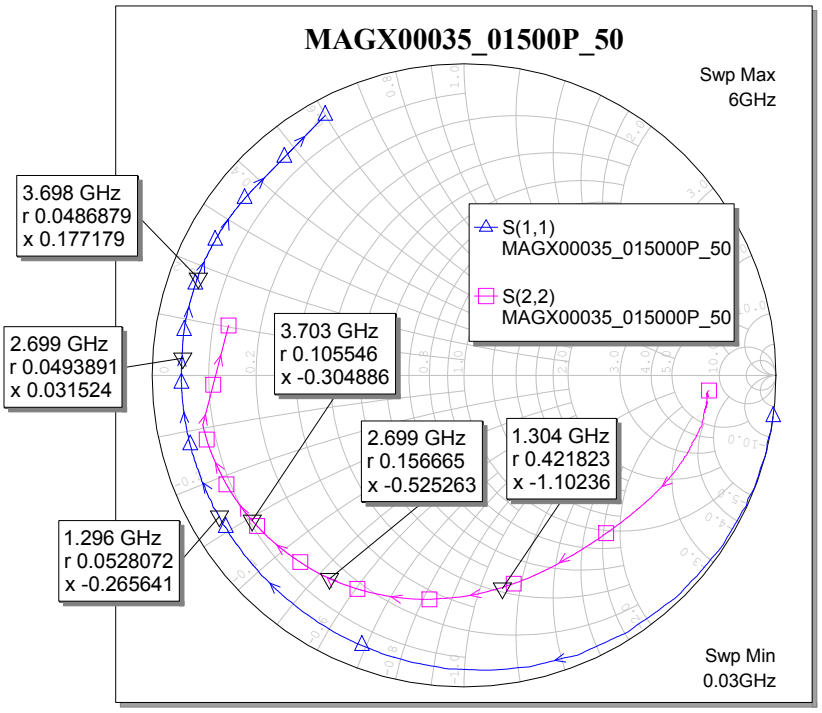
Gallium Nitride Devices and Circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these Class 1B devices.

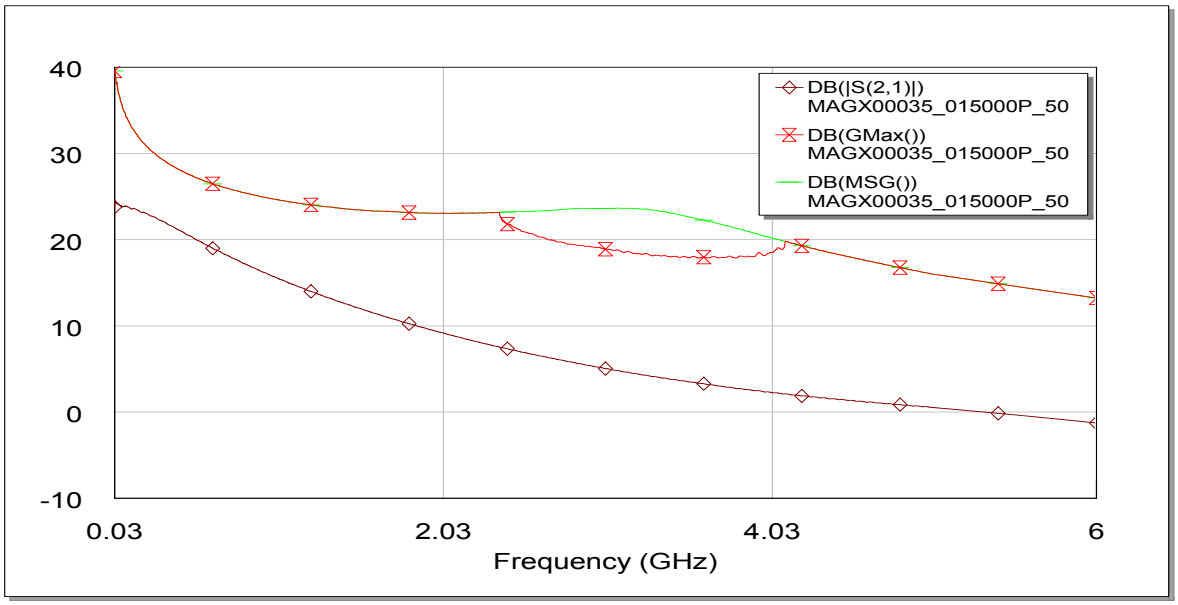
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S-Parameter Data: T_A = 25°C, V_{DD} = +50 V, I_{DQ} = 35 mA





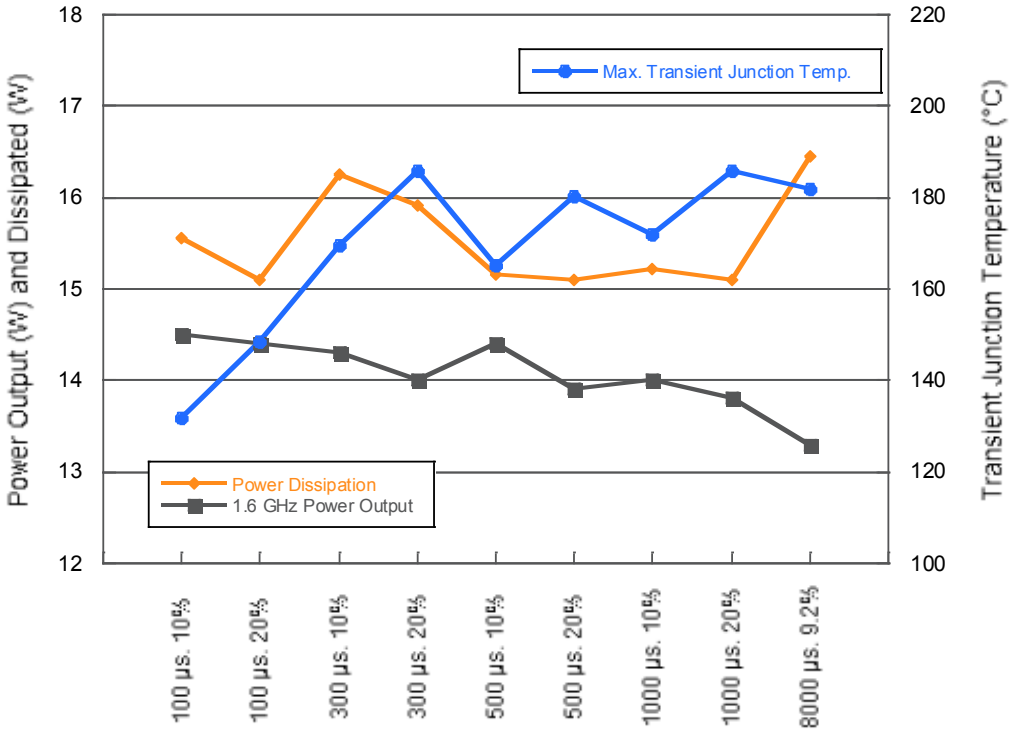
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Thermal Performance: Freq. = 1.6 GHz, T_C = 85°C, V_{DD} = +50 V, I_{DQ} = 25 mA, Z_0 = 50 Ω

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)	15.6	15.1	16.3	15.9	15.2	15.1	15.2	15.1	16.5
1.6 GHz P_{OUT} (W)	14.5	14.4	14.3	14	14.4	13.9	14	13.8	13.3
Max. Transient Junction Temp. (°C)	131.9	148.3	169.6	185.9	165.1	180.2	172	185.9	182

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

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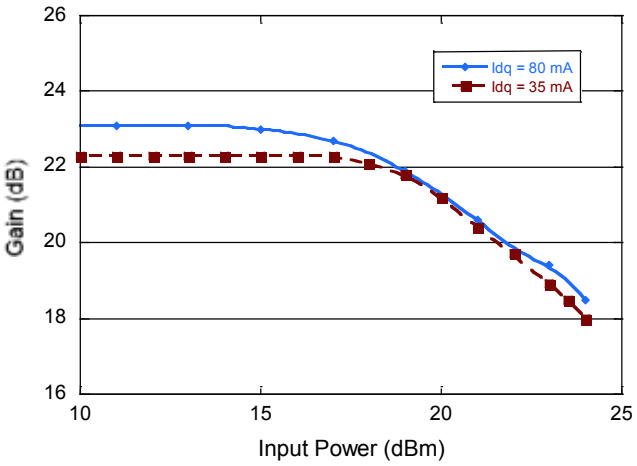
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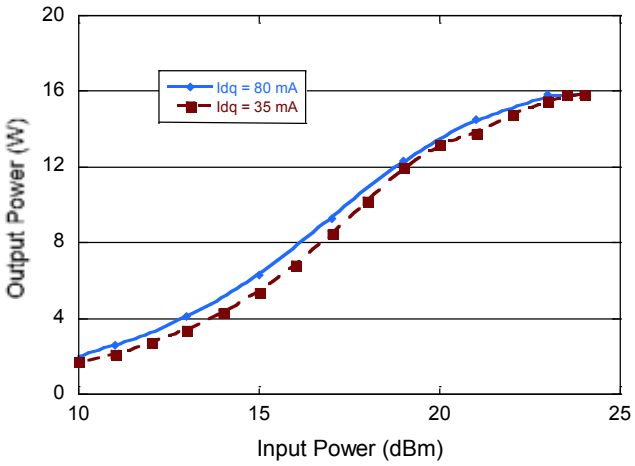
Typical Performance Curves (reference 1.6 GHz parts list):

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

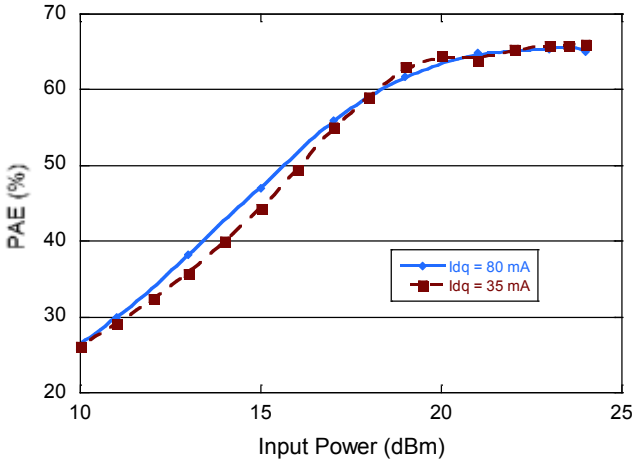
Gain vs. Input Power



Output Power vs. Input Power



PAE vs. Input Power



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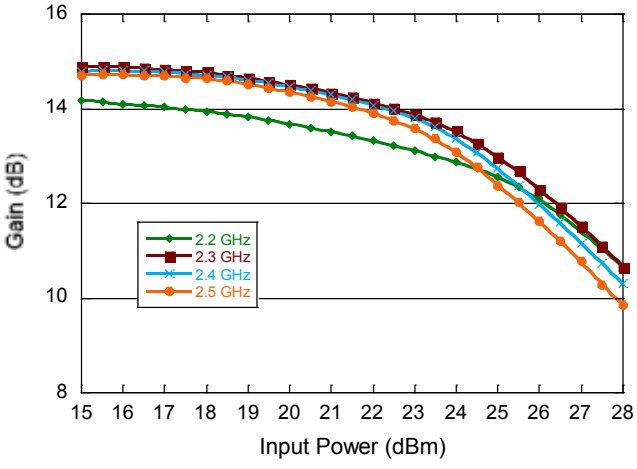
Pulsed OIP3 data
Pulse width 8.28 ms, Duty cycle 9%
V_{DD} = 50 V, I_{DQ} = 70 mA, Freq = 1.62 GHz, 1 MHz spacing on tones

P_{IN} (dBm)	P_{OUT} per tone (dBm)	OIP3 (dBm)
8	31.1	46
9	32.0	47
10	32.9	50
11	33.7	50
12	34.5	47

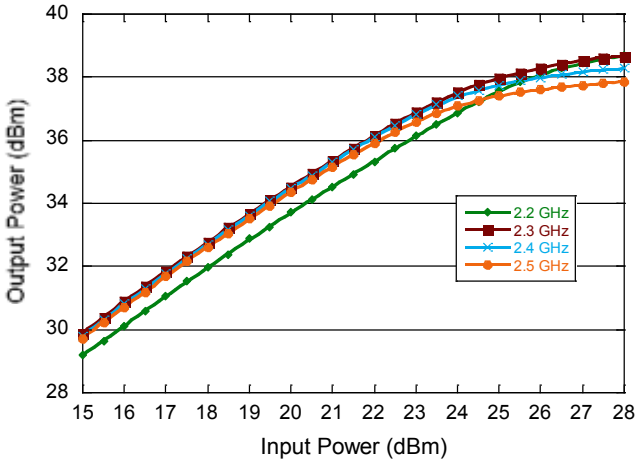
Typical Performance Curves (reference 2.2 - 2.5 GHz parts list):

2.2 - 2.5 GHz, CW, V_{DD} = 28 V, I_{DQ} = 35 mA, T_A = 25°C, Z_0 = 50 Ω

Gain vs. Input Power



Output Power vs. Input Power



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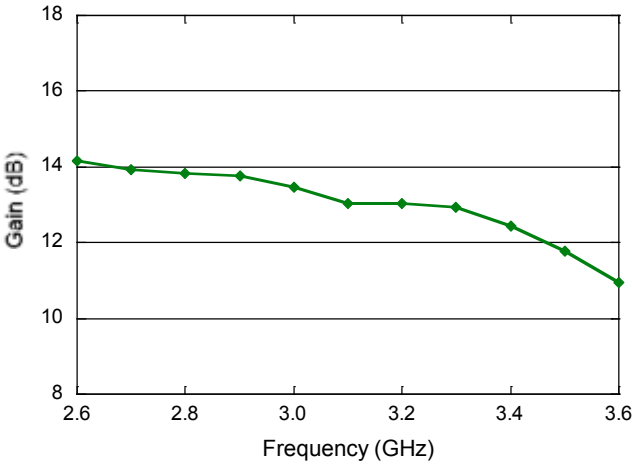
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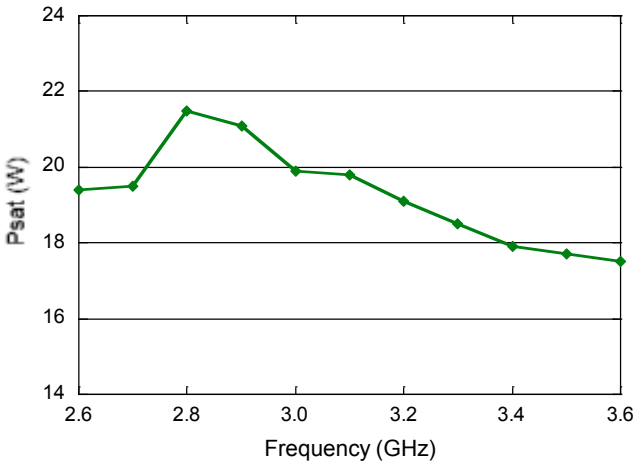
Typical Performance Curves (reference 2.6 - 3.6 GHz parts list):

2.6 - 3.6 GHz, 3 ms Pulse, 10% Duty Cycle, V_{DD} = 50 V, I_{DQ} = 35 mA, T_A = 25°C, Z_0 = 50 Ω

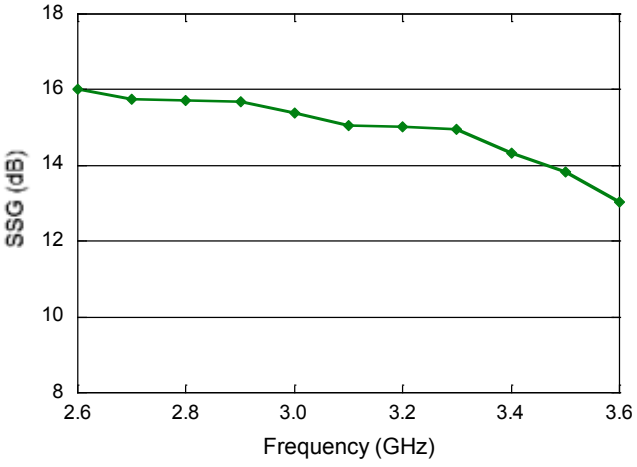
Gain vs. Frequency



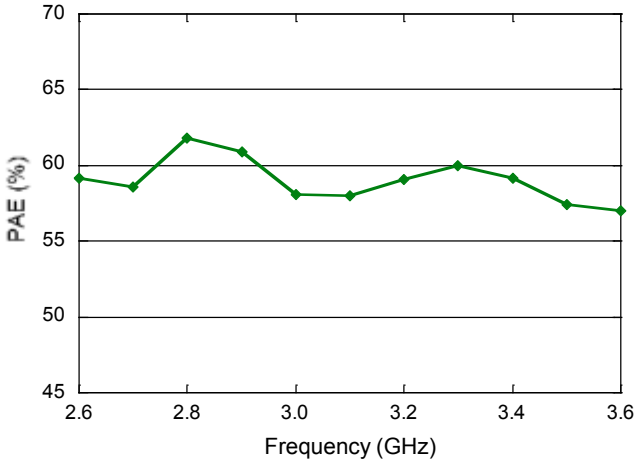
P_{SAT} vs. Frequency



Small Signal Gain vs. Frequency



PAE vs. Frequency



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