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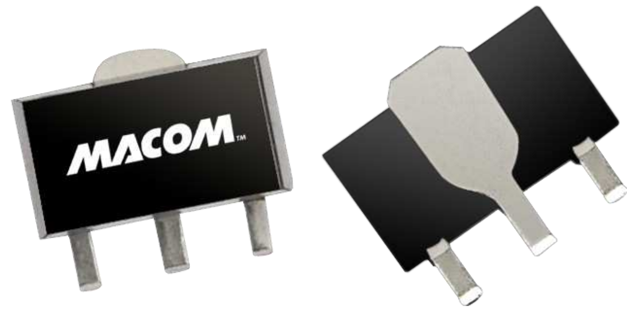
MAGX-000040-00500P

GaN Wideband 5 W CW / Pulsed Transistor in Plastic Package
DC - 4.0 GHz

Rev. V2



Features

- GaN on SiC D-Mode Transistor Technology
- Common-Source Configuration
- Unmatched, Coupled DC and RF
- Ideal for Pulsed and CW Applications up to 50 V
- 50 V Typical Bias, Class AB
- Excellent Thermal Resistance
- Thermally-Enhanced Plastic SOT-89 Package
- MTTF = 600 years (T_J < 200°C)
- Halogen-Free "Green" Mold Compound
- RoHS* Compliant and 260°C Reflow Compatible
- MSL1

Description

The MAGX-000040-00500P is a GaN on SiC unmatched power device offering the widest RF frequency capability, most reliable high voltage operation, lowest overall transistor size, cost and weight in a "TRUE SMT"™ plastic package.

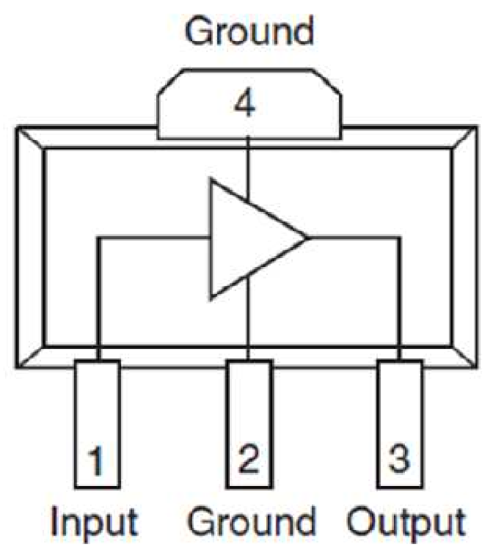
Use of an internal stress buffer technology allows reliable operation at junction temperatures up to 200°C. The small package size and excellent RF performance make it an ideal replacement for costly flanged or metal-backed module components.

Ordering Information[1]

Part Number	Package
MAGX-000040-00500P	Bulk Packaging
MAGX-000040-0050TP	500 Piece Reel
MAGX-000040-SB2PPR	Sample Board

1. Reference Application Note M513 for reel size information.

Functional Schematic



Pin Configuration

Pin No.	Function
1	V_{GG}/RF_{IN}
2	GND
3	V_{DD}/RF_{OUT}
4	GND

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

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Typical Narrowband RF Performance[2]: V_{DD} = 50 V, I_{DQ} = 17 mA, T_A = 25°C

Parameter	1 GHz	1.6 GHz	3.0 GHz	3.5 GHz	Units
Linear Gain	18	17	14	13.5	dB
Pulsed Peak Output Power (P3dB)	5.3	5.3	5.3	5.3	W
Pulsed Power Gain (P3dB)	15	14	11	10.5	dB
Drain Efficiency (P3dB)	61	55	53	50	%

2. Device optimally matched in narrowband load-pull test system.

Electrical Specifications[3]: Freq. = 1.6 GHz, V_{DD} = 50 V, I_{DQ} = 17 mA, T_A = 25°C, Z_0 = 50 Ω

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
RF FUNCTIONAL TESTS: Pulse Width = 1 ms, 10% Duty Cycle						
Pulsed Peak Output Power	P_{IN} = 0.28 W Peak	P_{OUT}	4.5	5.3	-	Wpk
Pulsed Power Gain	P_{IN} = 0.28 W Peak	G_P	12	13	-	dB
Pulsed Drain Efficiency	P_{IN} = 0.28 W Peak	η_D	47	51.3	-	%
Load Mismatch Stability	P_{IN} = 0.28 W Peak	VSWR-S	-	5:1	-	-
Load Mismatch Tolerance	P_{IN} = 0.28 W Peak	VSWR-T	-	10:1	-	-
RF FUNCTIONAL TESTS: CW						
CW Output Power	P3dB	P_{OUT}	-	4	-	W

3. Device measured in MACOM 1.4-1.6 GHz evaluation board. See tuning information on page 4.

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}	-	-	200	µA
Gate Threshold Voltage	V_{DS} = 5 V, I_D = 0.6 mA	$V_{GS\ (TH)}$	-5	-3	-2	V
Forward Transconductance	V_{DS} = 5 V, I_D = 1500 mA	G_M	0.1	-	-	S
DYNAMIC CHARACTERISTICS						
Input Capacitance	V_{DS} = 0 V, V_{GS} = -8 V, F = 1 MHz	C_{ISS}	-	0.5	-	pF
Output Capacitance	V_{DS} = 50 V, V_{GS} = -8 V, F = 1 MHz	C_{OSS}	-	0.18	-	pF
Reverse Transfer Capacitance	V_{DS} = 50 V, V_{GS} = -8 V, F = 1 MHz	C_{RSS}	-	0.05	-	pF

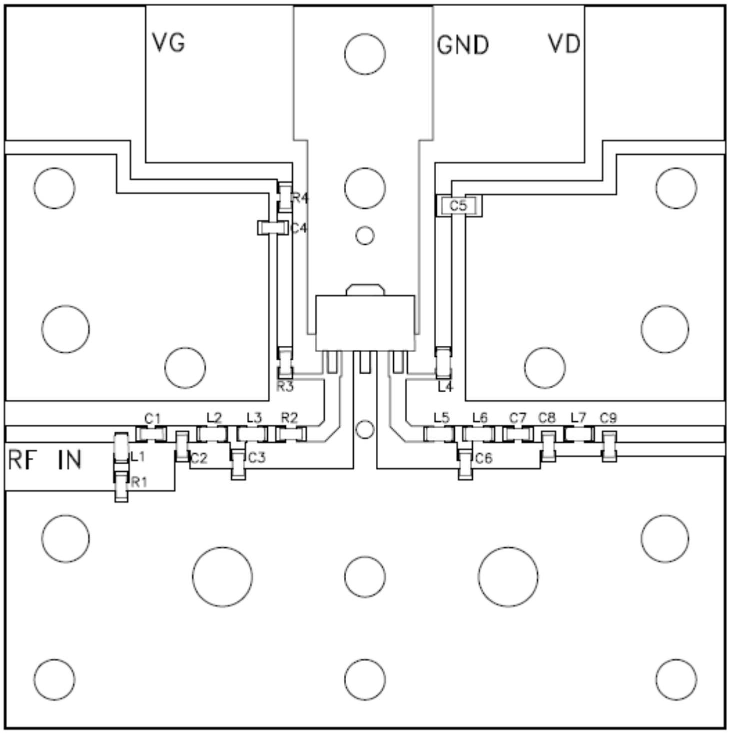
Absolute Maximum Ratings [4,5,6,7,8]

Parameter	Absolute Max.
Input Power	30 dBm
Drain Supply Voltage, V_{DD}	+65 V
Gate Supply Voltage, V_{GG}	-8 V to 0 V
Supply Current, I_{DD}	300 mA
Power Dissipation, CW (85ºC)	12 W
Power Dissipation, Pulsed Mode (85°C)	31 W
Junction Temperature[7]	200°C
Operating Temperature	-40°C to +95°C
Storage Temperature	-65°C to +150°C

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

   Typical CW thermal resistance (Θ_{JC}) = 11.1°C/W.
   Typical transient thermal resistance (Θ_{JC}) = Θ_{JC} = 4.0°C/W (1 ms pulse, 10% duty cycle).

L-Band Evaluation Board Details and Recommended Tuning Solutions



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 2 frequency ranges are detailed in the parts list below.

Bias Sequencing

Turning the device ON

1. Set V_G to the pinch-off value (V_P), typically -5 V.
2. Turn on V_D to nominal voltage (50 V).
3. Increase V_{GS} to desired quiescent current.
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. Turn off V_D.
4. Turn off V_G.

Parts List

Part	Frequency = 1.0 - 1.2 GHz	Frequency = 1.4 - 1.6 GHz
C1	10 pF, 600L, ATC	10 pF, 600L, ATC
C2	3.9 pF || 0.5 pF, 600L, ATC[9]	2.4 pF, 600L, ATC
C3	6.8 pF || 1 pF, 600L, ATC[9]	5.6 pF, 600L, ATC
C4	10 nF, 0402, Murata	10 nF, 0402, Murata
C5	10 nF, 0603, Murata	10 nF, 0603, Murata
C6	3.3 pF, 600L, ATC	2.4 pF, 600L, ATC
C7	10 pF, 600L, ATC	10 pF, 600L, ATC
C8	1.3 pF, 600L, ATC	1.3 pF, 600L, ATC
C9	2 pF, 600L, ATC	1.6 pF, 600L, ATC
L1	27 nH, 0402HP, Coilcraft	27 nH, 0402HP, Coilcraft
L2	4.3 nH, 0402HP, Coilcraft	3.3 nH, 0402HP, Coilcraft
L3	3.3 nH, 0402HP, Coilcraft	1 nH, 0402HP, Coilcraft
L4	30 nH, 0402HP, Coilcraft	12 nH, 0402HP, Coilcraft
L5	16 nH, 0402HP, Coilcraft	8.2 nH, 0402HP, Coilcraft
L6	8.2 nH, 0402HP, Coilcraft	3.9 nH, 0402HP, Coilcraft
L7	2.7 nH, 0402HP, Coilcraft	3.3 nH, 0402HP, Coilcraft
R1	49.9 Ω, 0402, Panasonic	49.9 Ω, 0402, Panasonic
R2	5.1 Ω, 0402, Panasonic	5.1 Ω, 0402, Panasonic
R3	200 Ω, 0402, Panasonic	200 Ω, 0402, Panasonic
R4	1 kΩ, 0402, Panasonic	1 kΩ, 0402, Panasonic

9. Parallel combination of two capacitors.

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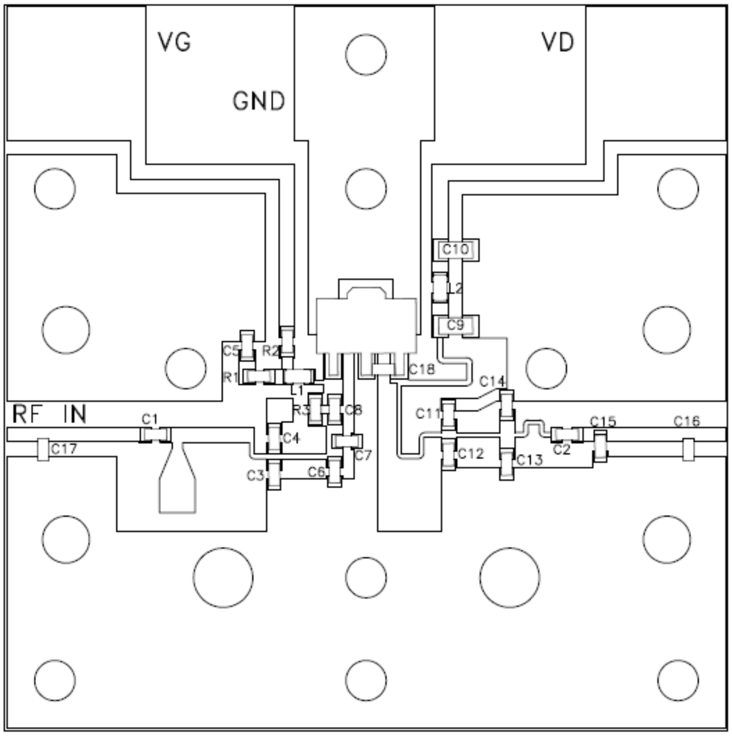
S-Band Evaluation Board Details and Recommended Tuning Solutions



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 solution for the 2.9-3.3 GHz frequency band is detailed in the parts list below.

Parts List, 2.9 - 3.3 GHz

Part	Description
C1	5.6 pF, 600L, ATC
C2	5.6 pF, 600L, ATC
C3	1 pF || 0.02 pF, 600L, ATC[10]
C4	1 pF, 600L, ATC
C5	10 nF, 0402, Murata
C6	0.8 pF, 600L, ATC
C7	1.5 pF, 600L, ATC
C8	2.4 pF, 600L, ATC
C9	1 nF, 0603, Murata
C10	10 nF, 0603, Murata
C11	1.1 pF, 600L, ATC
C12	1.5 pF, 600L, ATC
C13	1.6 pF, 600L, ATC
C14	1.3 pF, 600L, ATC
C15	0.6 pF, 600L, ATC
C16	0.2 pF, 600L, ATC
C17	0.6 pF, 600L, ATC
C18	0.3 pF, 600L, ATC
L1	56 nH, 0402HP, Coilcraft
L2	12 nH, 0402HP, Coilcraft
R1	100 Ω, 0402, Panasonic
R2	1.2 kΩ, 0402, Panasonic
R3	100 Ω, 0402, Panasonic

10. Parallel combination of two capacitors.

Bias Sequencing

Turning the device ON

1. Set V_G to the pinch-off value (V_P), typically -5 V.
2. Turn on V_D to nominal voltage (50 V).
3. Increase V_{GS} to desired quiescent current.
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. Turn off V_D.
4. Turn off V_G.

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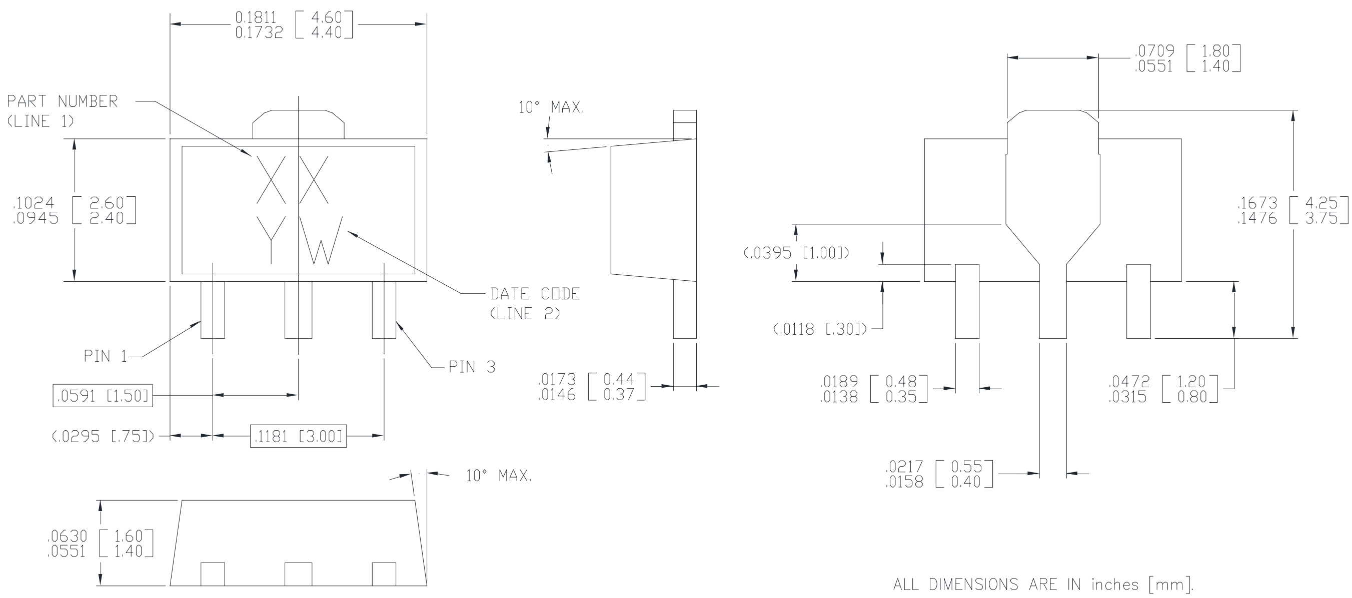
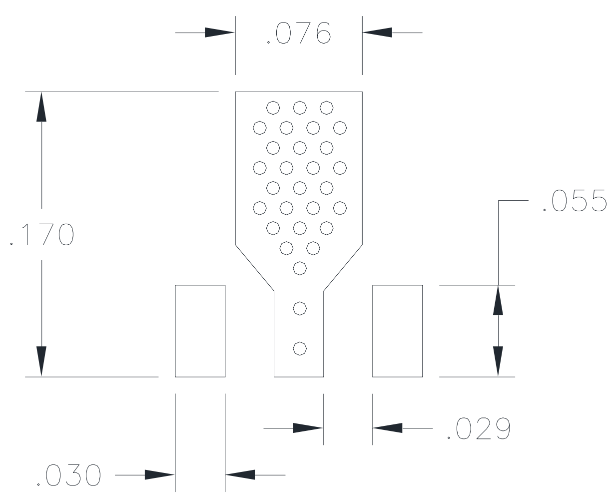
SOT-89 Package Outline and Landing Pattern[11,12]





11. Reference Application Note M538 for lead-free solder reflow recommendations. Meets JEDEC moisture sensitivity level 1 requirements. Lead plating is 100% Sn matte.
12. Landing pattern indicates dimensions of solder mask opening. Cu-filled via holes under the ground are typically used for optimal thermal performance. Recommended pattern: 8 mil diameter , 8 mil spacing.

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 1A devices.

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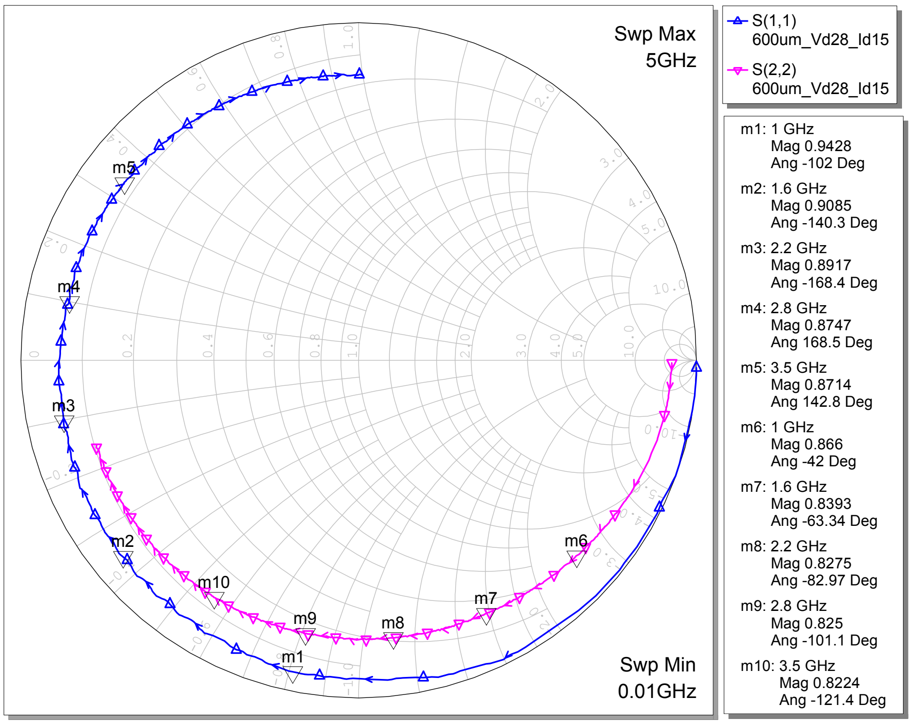
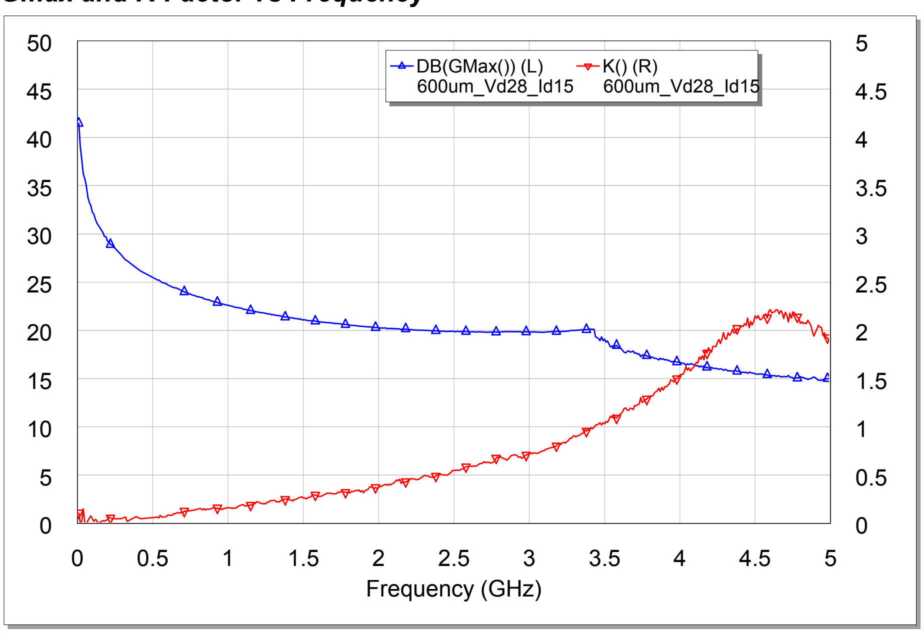
Applications Section

S-Parameter Data: T_A = 25°C, V_{DD} = 28 V, I_{DQ} = 15 mA

Device S11 and S22



Gmax and K-Factor vs Frequency



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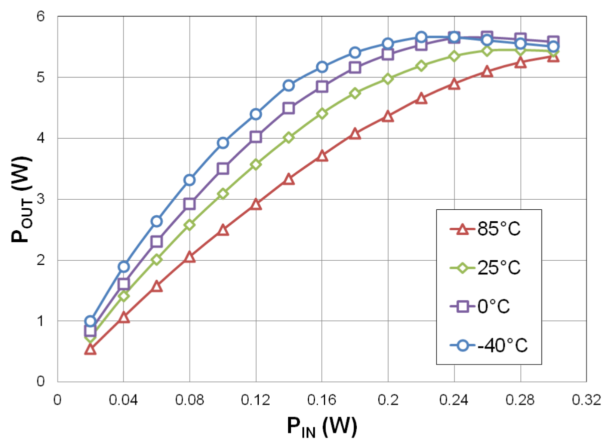
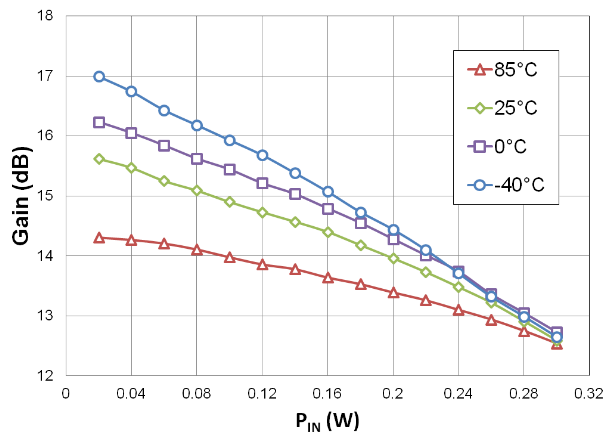
Applications Section

Typical Performance Curves (reference 1.4-1.6 GHz parts list):
1.6 GHz, 1 ms Pulse, 10% Duty Cycle, V_{DD} = 50 V, T_A = 25°C, Z_0 = 50 Ω

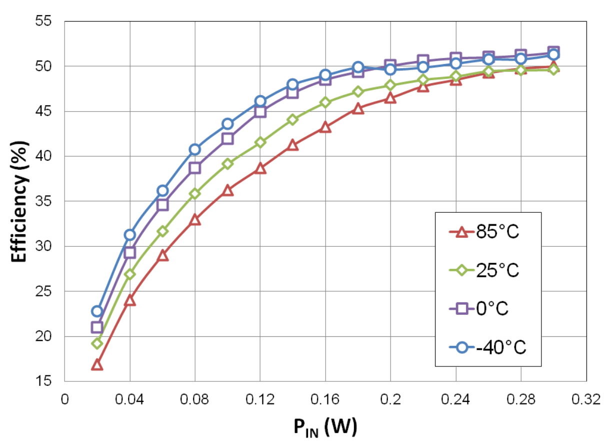
Output Power vs. Input Power



Gain vs. Input Power



Drain Efficiency vs. Input Power



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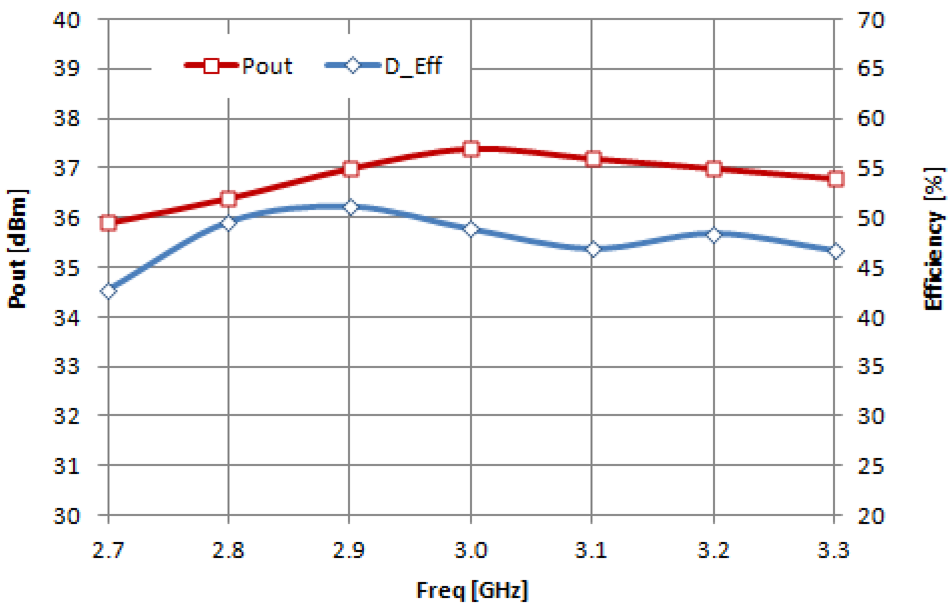
Applications Section

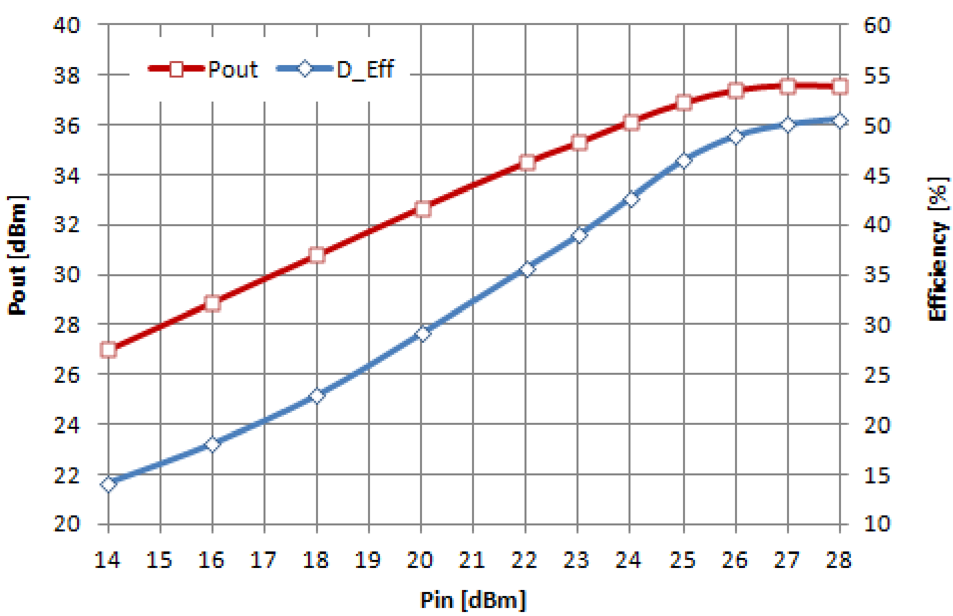
Typical Performance Curves (reference 2.9-3.3 GHz parts list):

300 μs Pulse, 10% Duty Cycle, V_{DD}= 50 V, T_A = 25°C, Z_0 = 50 Ω

Output Power and Efficiency vs. Frequency (P_{IN} = 26 dBm)



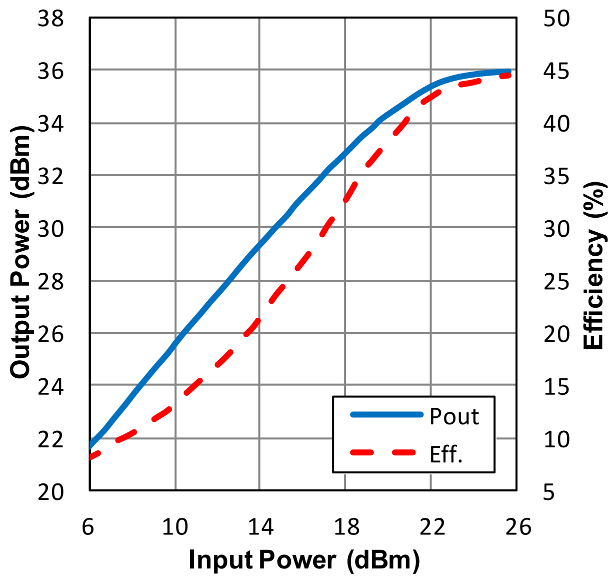
Output Power and Efficiency vs. Input Power (Frequency = 3.0 GHz)



Applications Section

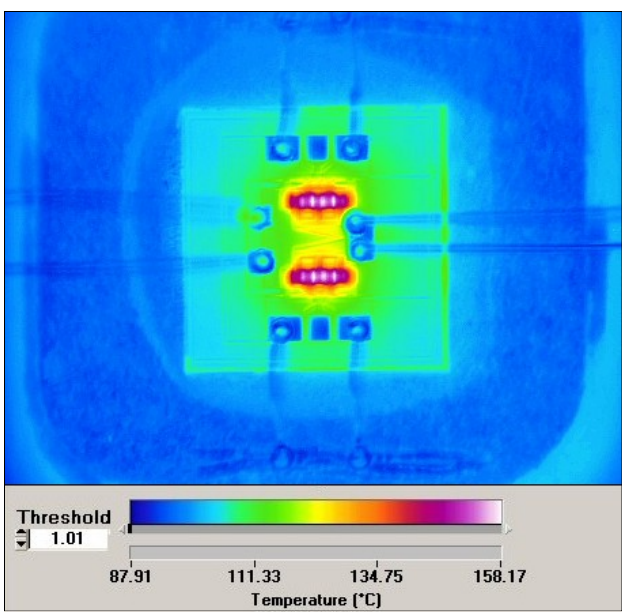
Typical CW Performance:
Freq. = 2.7 GHz, V_{DD} = 50 V, T_A = 25°C, I_{DQ} = 13 mA, Load-Pull Test Fixture

Output Power and Efficiency vs. Input Power



Typical CW Thermal Performance: V_{DD} = 50 V, T_A = 85°C, I_{DQ} = 13 mA

Thermal Image



P_{IN} (W)	P_{OUT} (W)	Eff. (%)	T_J (°C)	P_{DISS} (W)	R_{TH} (°C/W)
0.18	4.47	41.2	158	6.56	11.1

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