

GaN on SiC HEMT Pulsed Power Transistor 120 W Peak, 3.1 to 3.5 GHz, 300 μ s Pulse, 10% Duty

Rev. V4

Features

- GaN on SiC Depletion-Mode HEMT Transistor
- Common-Source Configuration
- Broadband Class AB Operation
- Thermally Enhanced Cu/Mo/Cu Package
- RoHS* Compliant
- +50 V Typical Operation
- MTTF = 600 Years ($T_J < 200^\circ\text{C}$)
- 3A001.b.3.a.3 Export Classification
- MSL-1



Description

The MAGX-003135-120L00 is a gold metalized matched Gallium Nitride (GaN) on Silicon Carbide RF power transistor optimized for civilian and military radar pulsed applications between 3.1 - 3.5 GHz. Using state of the art wafer fabrication processes, these high performance transistors provide high gain, efficiency, bandwidth, ruggedness over a wide bandwidth for today's demanding application needs. The MAGX-003135-120L00 is constructed using a thermally enhanced Cu/Mo/Cu flanged ceramic package which provides excellent thermal performance. High breakdown voltages allow for reliable and stable operation in extreme mismatched load conditions unparalleled with older semiconductor technologies.

Ordering Information

Part Number	Description
MAGX-003135-120L00	120 W GaN Power Transistor
MAGX-003135-SB4PPR	3.1-3.5 GHz Evaluation Board

* Restrictions on Hazardous Substances, European Union Directive 2011/65/EU.

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Electrical Specifications: Freq. = 3.1 - 3.5 GHz, $T_A = 25^\circ\text{C}$

Parameter	Symbol	Min.	Typ.	Max.	Units
RF Functional Tests: $P_{IN} = 10\text{ W}$, $V_{DD} = 50\text{ V}$, $I_{DQ} = 300\text{ mA}$, Pulse Width = 300 μs, Duty = 10%					
Peak Output Power	P_{OUT}	120	135	-	W
Power Gain	G_P	10.8	11.8	-	dB
Drain Efficiency	η_D	45	52	-	%
Load Mismatch Stability	VSWR-S	-	5:1	-	-
Load Mismatch Tolerance	VSWR-T	-	10:1	-	-

Electrical Characteristics: $T_A = 25^\circ\text{C}$

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
DC Characteristics						
Drain-Source Leakage Current	$V_{GS} = -8\text{ V}$, $V_{DS} = 175\text{ V}$	I_{DS}	-	0.5	9	mA
Gate Threshold Voltage	$V_{DS} = 5\text{ V}$, $I_D = 23\text{ mA}$	$V_{GS(TH)}$	-5	-3	-2	V
Forward Transconductance	$V_{DS} = 5\text{ V}$, $I_D = 9\text{ A}$	G_M	3.3	-	-	S
Dynamic Characteristics						
Input Capacitance	Not Applicable (Input Matched)	C_{ISS}	N/A	N/A	N/A	pF
Output Capacitance	$V_{DS} = 50\text{ V}$, $V_{GS} = -8\text{ V}$, $F = 1\text{ MHz}$	C_{OSS}	-	13.4	16	pF
Reverse Transfer Capacitance	$V_{DS} = 50\text{ V}$, $V_{GS} = -8\text{ V}$, $F = 1\text{ MHz}$	C_{RSS}	-	1.4	2.2	pF

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Absolute Maximum Ratings^{1,2,3,4,5}

Parameter	Limit
Input Power (P_{IN})	42 dBm
Drain Supply Voltage (V_{DD})	+65 V
Gate Supply Voltage (V_{GG})	-8 to 0 V
Supply Current (I_{DD})	6.7 A
Absolute Maximum Junction/Channel Temperature	200°C
Pulsed Power Dissipation at 85°C	170 W (Pulse Width = 100 µs) 144 W (Pulse Width = 300 µs)
Operating Temperature	-40 to +95°C
Storage Temperature	-65 to +150°C
ESD Min. - Charged Device Model (CDM)	300 V
ESD Min. - Human Body Model (HBM)	700 V

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

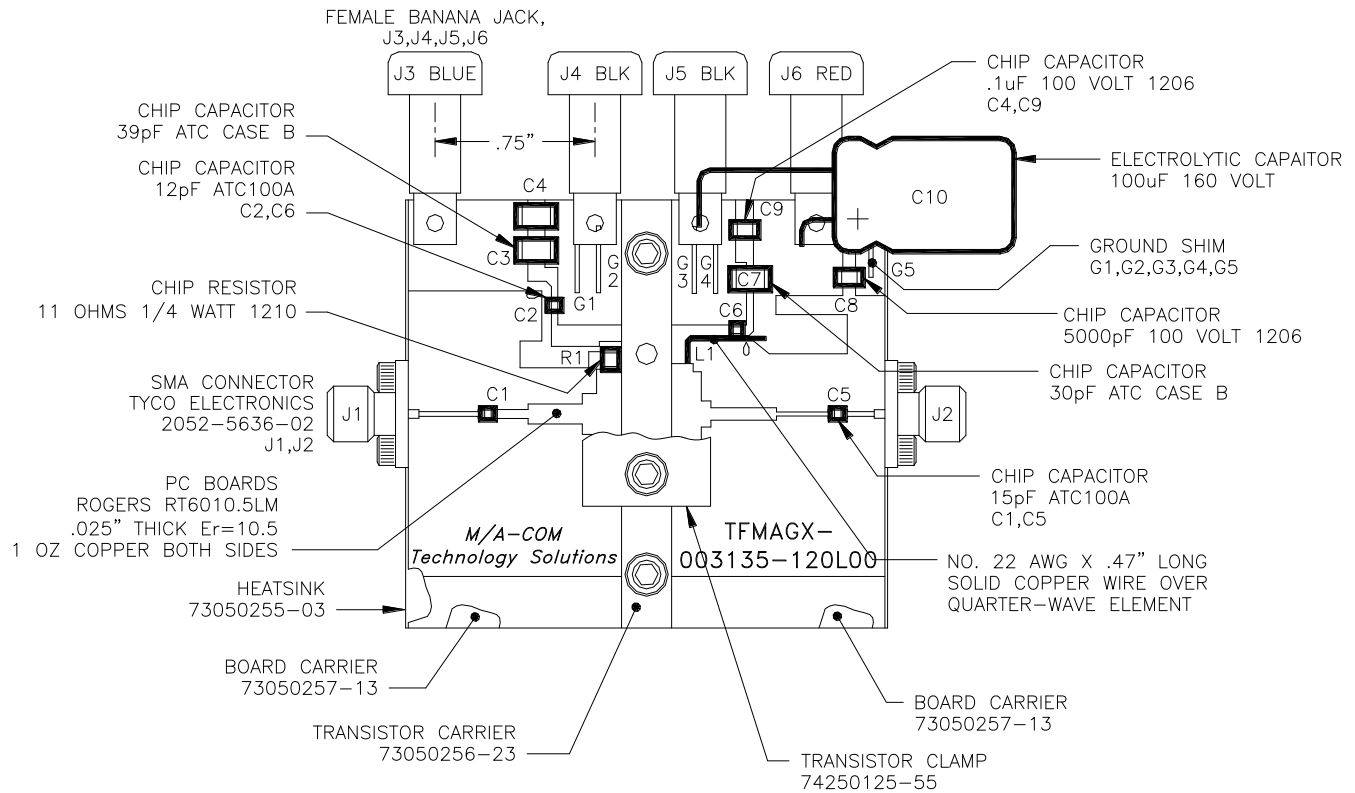
Typical Transient Thermal Resistances ($I_{DQ} = 300 \text{ mA}$, 300 µs pulse, 10% duty cycle):

- Freq. = 3.1 GHz, $\Theta_{JC} = 0.63^\circ\text{C/W}$
 $T_J = 178^\circ\text{C}$ ($T_C = 85^\circ\text{C}$, 50 V, 5.15 A, $P_{OUT} = 120 \text{ W}$, $P_{IN} = 9.5 \text{ W}$)
- Freq. = 3.3 GHz, $\Theta_{JC} = 0.69^\circ\text{C/W}$
 $T_J = 188^\circ\text{C}$ ($T_C = 85^\circ\text{C}$, 50 V, 5.24 A, $P_{OUT} = 120 \text{ W}$, $P_{IN} = 7.0 \text{ W}$)
- Freq. = 3.5 GHz, $\Theta_{JC} = 0.67^\circ\text{C/W}$
 $T_J = 180^\circ\text{C}$ ($T_C = 85^\circ\text{C}$, 50 V, 5.12 A, $P_{OUT} = 120 \text{ W}$, $P_{IN} = 6.8 \text{ W}$)

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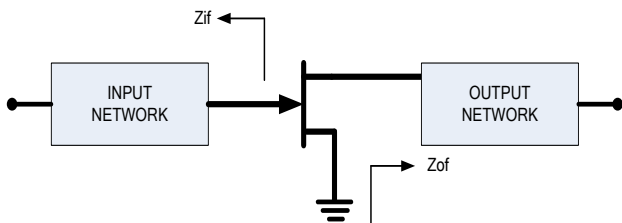
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Evaluation Board Assembly (3.1 - 3.5 GHz)



Evaluation Board Impedances

Freq. (MHz)	Z_{IF} (Ω)	Z_{OF} (Ω)
3100	5.9 - j4.2	4.1 - j2.4
3300	5.2 - j4.8	4.0 - j2.8
3500	3.9 - j5.0	2.6 - j2.6



Correct Device Sequencing

Turning the device ON

1. Set V_{GS} to the pinch-off (V_P), typically -5 V.
2. Turn on V_{DS} 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

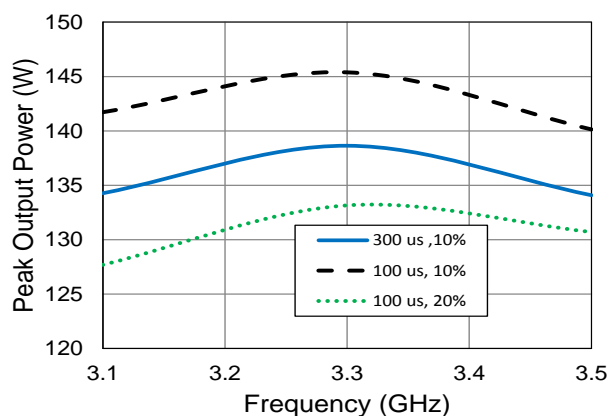
1. Turn the RF power off.
2. Decrease V_{GS} down to V_P .
3. Decrease V_{DS} down to 0 V.
4. Turn off V_{GS}

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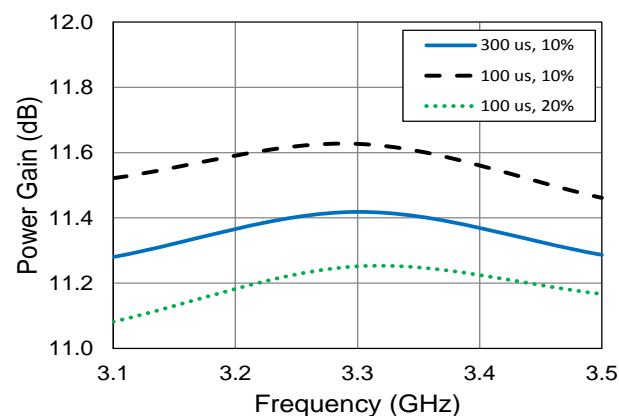
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Typical Performance Curves: $P_{IN} = 10$ W, $V_{DD} = 50$ V, $I_{DQ} = 300$ mA

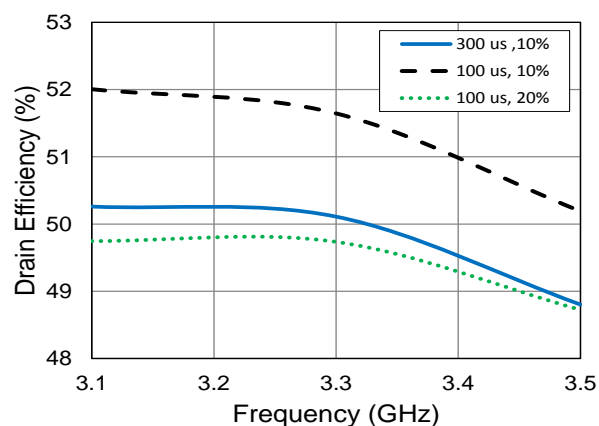
Peak Output Power vs. Frequency



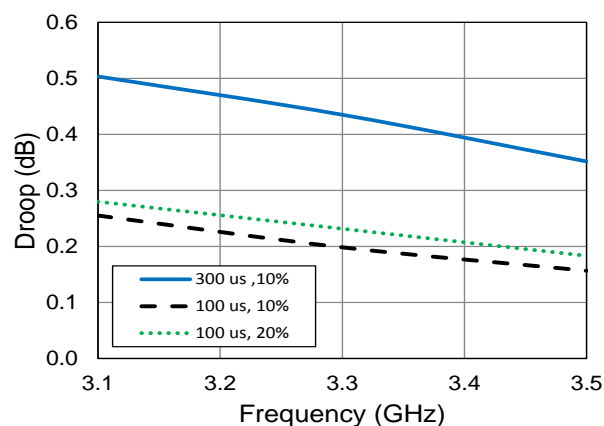
Power Gain vs. Frequency



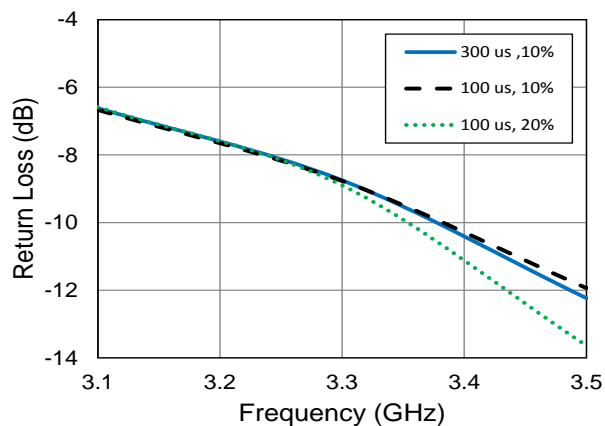
Drain Efficiency vs. Frequency



Return Loss vs. Frequency



Droop vs. Frequency

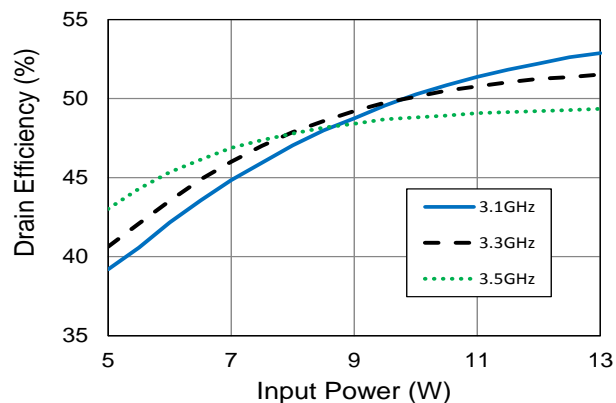
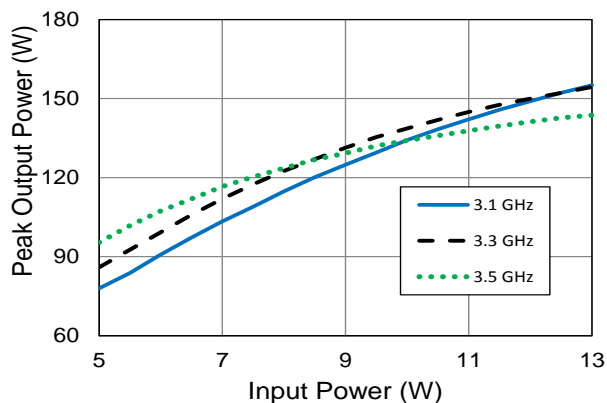


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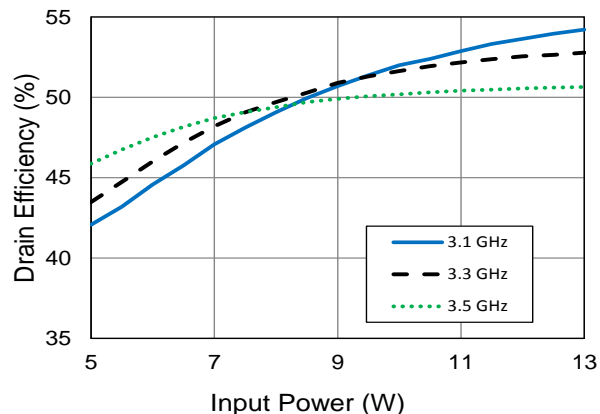
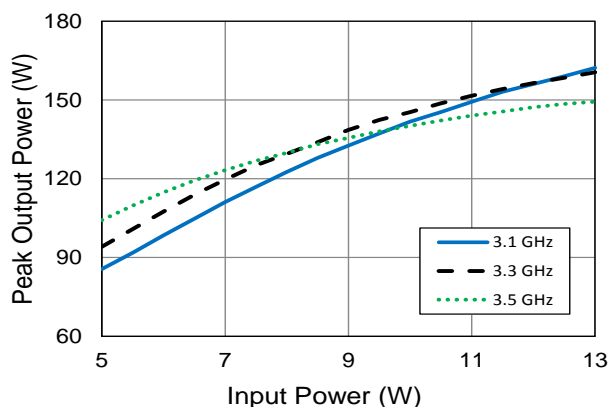
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Typical Performance Curves: $V_{DD} = 50$ V, $I_{DQ} = 300$ mA

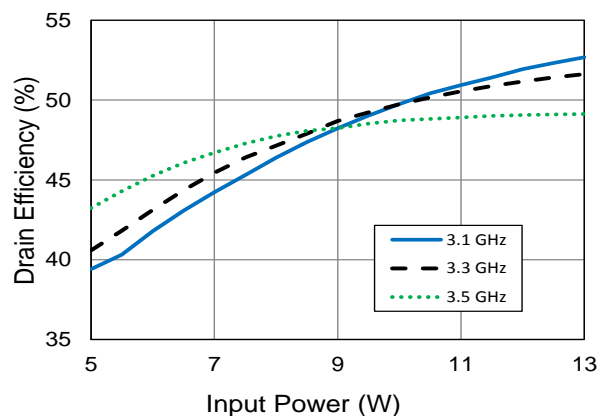
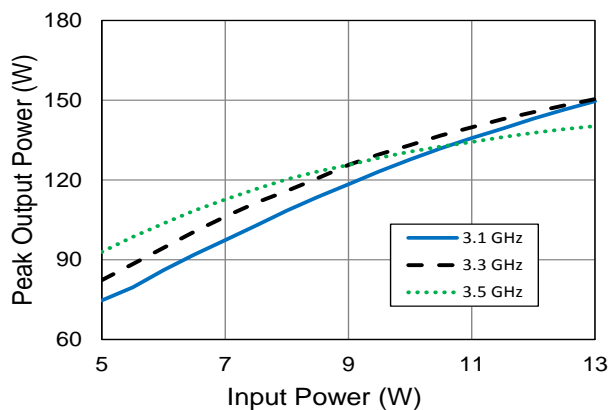
Output Power / Drain Efficiency vs. Input Power (Pulse Width = 300 μ s, Duty = 10%)



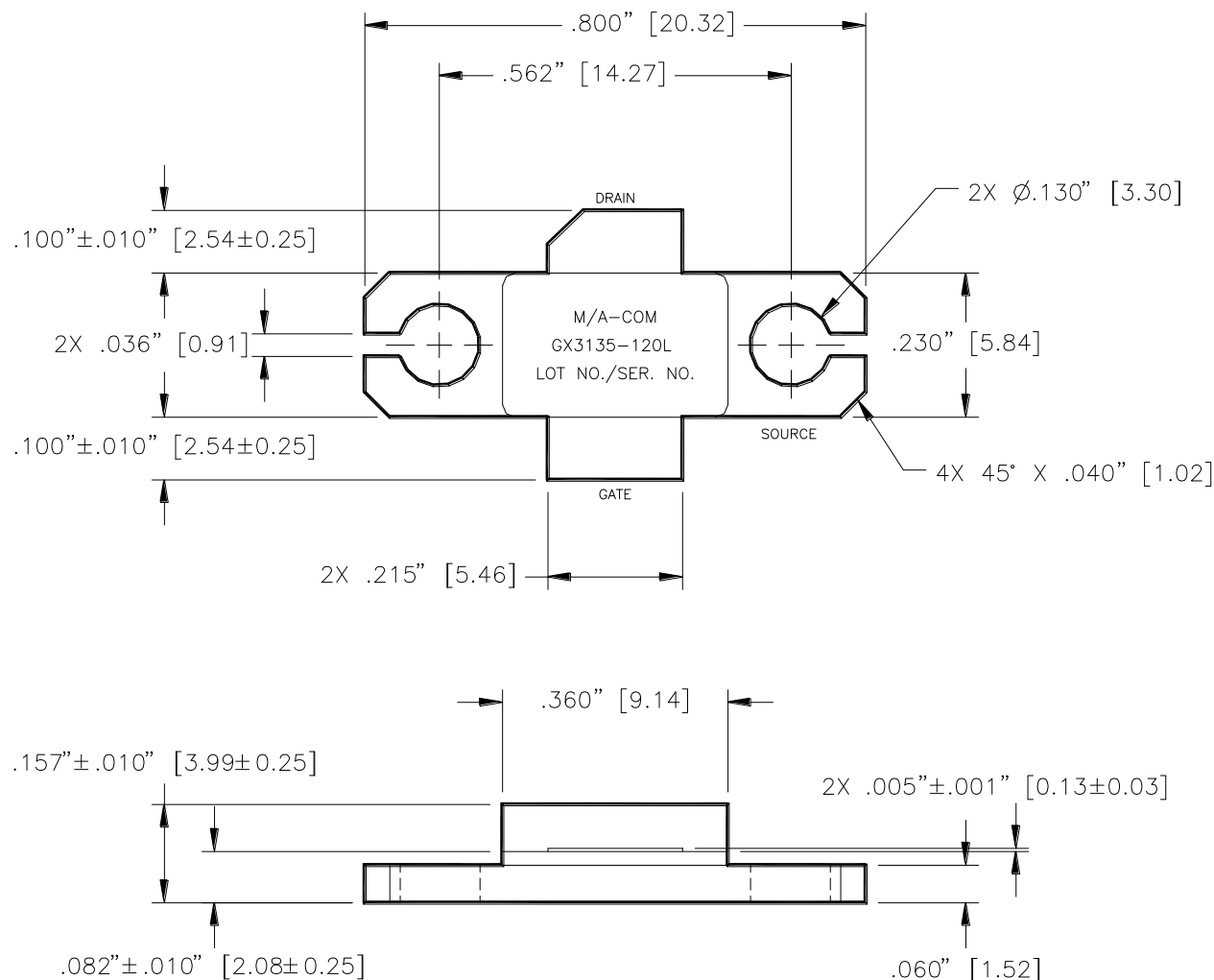
Output Power / Drain Efficiency vs. Input Power (Pulse Width = 100 μ s, Duty = 10%)



Output Power / Drain Efficiency vs. Input Power (Pulse Width = 100 μ s, Duty = 20%)



Package Outline



Unless otherwise noted, tolerances are inches ± 0.005 " [millimeters ± 0.13 mm]

Handling Procedures

Please observe the following precautions to avoid damage:

Static Sensitivity

Gallium Nitride 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.

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