

MAGX-000912-650L0x



GaN on SiC HEMT Pulsed Power Transistor
650 W Peak, 960-1215 MHz, 128 μ s Pulse, 10% Duty

Rev. V3

Features

- GaN on SiC Depletion-Mode Transistor Technology
- Internally Matched
- Common-Source Configuration
- Broadband Class AB Operation
- 50 V Operation
- 800 W Performance at 20 μ s and 6% Duty Factor
- RoHS* Compliant and 260 °C Reflow Compatible
- MTTF = 600 years ($T_J < 200$ °C)

Applications

- L-Band pulsed radar.

Description

The MAGX-000912-650L00 and MAGX-000912-650L0S are gold metalized matched gallium nitride (GaN) on silicon carbide RF power transistor optimized for civilian and military pulsed avionics amplifier applications for the 960 MHz to 1215 MHz range such as Mode-S, TCAS, JTIDS, DME and TACAN. 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. High breakdown voltages allow for reliable and stable operation in extreme mismatched load conditions unparalleled with older semiconductor technologies.

MAGX-000912-650L00



MAGX-000912-650L0S



Ordering Information

Part Number	Description
MAGX-000912-650L00	Standard Flange
MAGX-000912-650L0S	Earless Flange
MAGX-A00912-650L00	960 - 1215 MHz Evaluation Board ¹

1. When ordering the evaluation board, please indicate on sales order notes if it will be used for:

- A. Standard Flange devices
- B. Earless Flange devices

Typical RF Performance under Standard Operating Conditions, $P_{OUT} = 650$ W (Peak)

Freq (MHz)	P_{IN} (W)	Gain (dB)	I_D (A)	Eff. (%)	RL (dB)	Droop (dB)	+1dB OD (W)	VSWR-S (3:1)	VSWR-T (3:1)
960	6.5	20	21	62	-8	0.3	740	S	P
1030	5.2	21	20.3	64	-13	0.2	723	S	P
1090	5.8	20.5	20.3	64	-11	0.3	719	S	P
1150	5.7	20.6	21	62	-15	0.3	720	S	P
1215	6.0	20.4	21.6	60	-11	0.2	718	S	P

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

MAGX-000912-650L0x



GaN on SiC HEMT Pulsed Power Transistor
650 W Peak, 960-1215 MHz, 128 μ s Pulse, 10% Duty

Rev. V3

Electrical Specifications: Freq. = 960 - 1215 MHz, $T_A = 25^\circ\text{C}$

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
RF Functional Tests						
Peak Input Power	$V_{DD} = 50\text{ V}$, $I_{DQ} = 500\text{ mA}$, Pulse Width = 128 μ s, Duty Cycle = 10%, $P_{OUT} = 650\text{ W Peak (65 W avg.)}$	P_{IN}	-	5.8	9.2	W
Power Gain		G_P	18.5	20.5	-	dB
Drain Efficiency		η_D	57	62	-	%
Pulse Droop		Droop	-	0.3	0.5	dB
Load Mismatch Stability		VSWR-S	-	3:1	-	-
Load Mismatch Tolerance		VSWR-T	-	3:1	-	-

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}	-	1.7	-	mA
Gate Threshold Voltage	$V_{DS} = 5\text{ V}$, $I_D = 90\text{ mA}$	$V_{GS(TH)}$	-	-3.1	-	V
Forward Transconductance	$V_{DS} = 5\text{ V}$, $I_D = 21\text{ mA}$	G_M	-	22	-	S
Dynamic Characteristics						
Input Capacitance	Not applicable - Input matched	C_{ISS}	-	N/A	-	pF
Output Capacitance	$V_{DS} = 50\text{ V}$, $V_{GS} = -8\text{ V}$, Freq. = 1 MHz	C_{OSS}	-	55	-	pF
Reverse Transfer Capacitance		C_{RSS}	-	5.5	-	pF

Absolute Maximum Ratings^{2,3,4}

Parameter	Rating
Drain Voltage (V_{DD})	+65 V
Gate Voltage (V_{GG})	-8 to -2 V
Drain Current (I_{DD})	33 A
Input Power ⁵ (P_{IN})	P_{IN} (nominal) +3 dB
Operating Junction Temperature ⁶	250 °C
Peak Pulsed Power Dissipation at 85 °C	1 kW
Operating Temperature Range	-40 to +95 °C
Storage Temperature Range	-65 to +150 °C
ESD Maximum - Charged Device Model (CDM)	1300 V
ESD Maximum - Human Body Model (HBM)	4000 V

2. Exceeding any one or combination of these limits may cause permanent damage to this device.

3. MACOM does not recommend sustained operation near these survivability limits.

4. For saturated performance it is recommended that the sum of $(3 * V_{DD} + |V_{GG}|) < 175$ V.

5. Input Power Limit is +3 dB over nominal drive required to achieve $P_{OUT} = 650$ W.

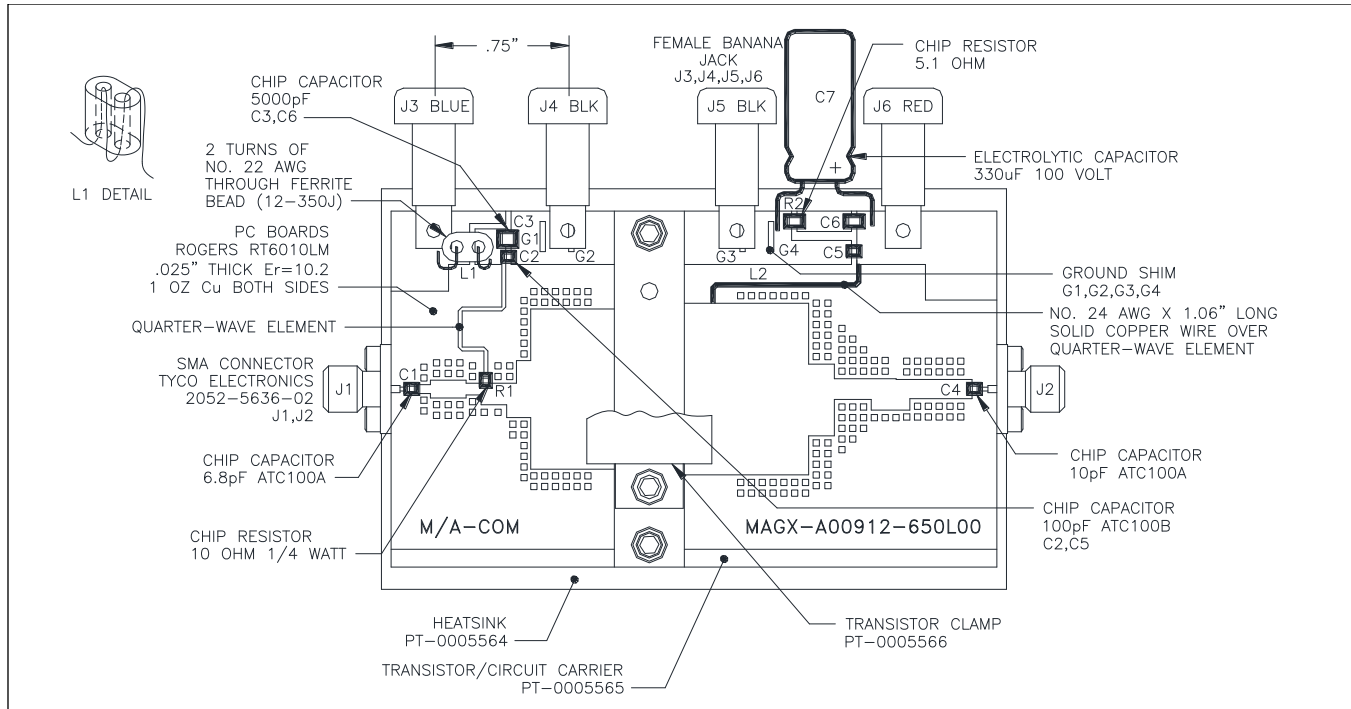
6. Operating junction temperature is measured with infrared (IR) microscope. Junction temperature directly affects a device's MTTF and should be kept as low as possible to maximize lifetime.

- MTTF = 5.3×10^6 hours ($T_J < 200$ °C)
- MTTF = 6.8×10^4 hours ($T_J < 250$ °C)

Thermal Characteristics

Parameter	Test Conditions	Symbol	Typical	Units
Thermal Resistance	$T_C = 70$ °C, $V_{DD} = 50$ V, $I_{DQ} = 500$ mA, $P_{OUT} = 650$ W, Pulse Width = 128 μs, Duty Cycle = 10%	Θ_{JC}	0.17	°C/W

Test Fixture Assembly



Contact MACOM for additional circuit information.

Test Fixture Impedances

Freq. (MHz)	Z _{IF} (Ω)	Z _{OF} (Ω)
960	0.7 - j0.9	1.4 + j0.7
1030	0.7 - j0.5	1.7 + j0.6
1060	0.8 - j0.1	1.7 + j0.5
1150	0.9 + j0.1	1.6 + j0.3
1215	1.1 + j0.4	1.2 + j0.4

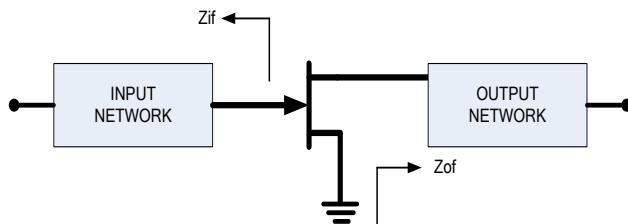
Correct Device Sequencing

Turning the device ON

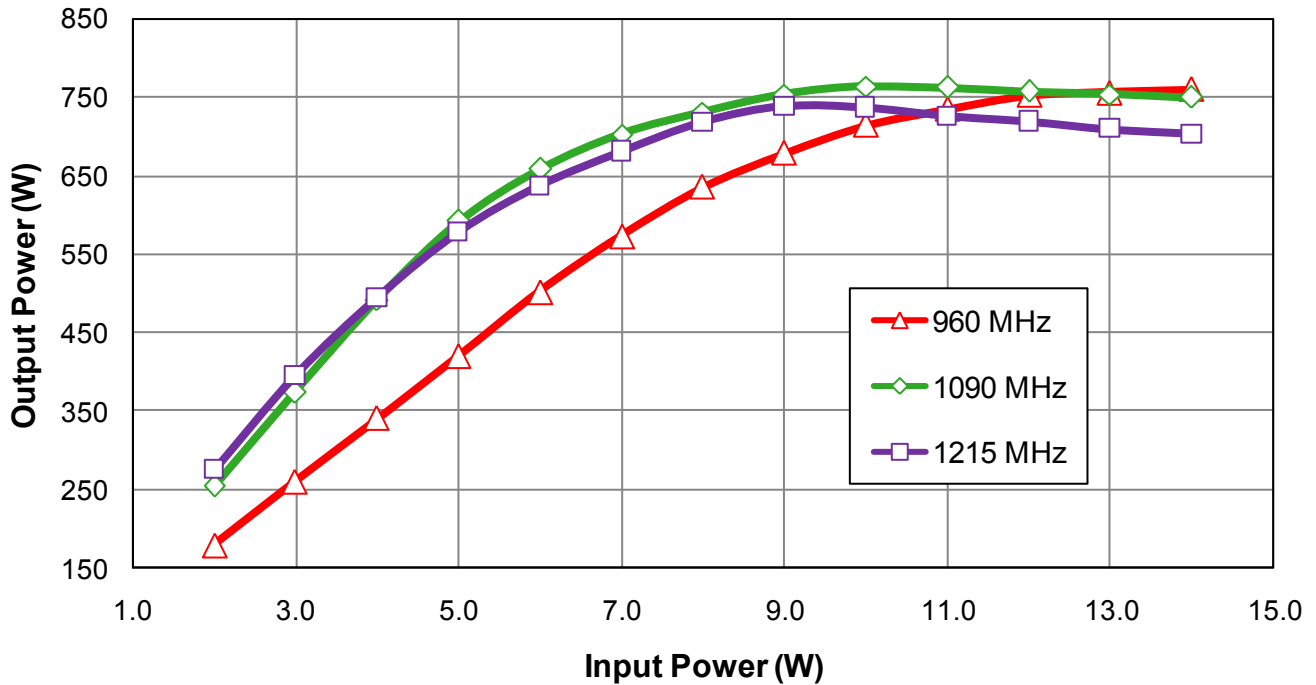
1. Set V_{GS} to the pinch-off (V_P), typically -5 V.
2. Turn on V_{DS} to nominal voltage (50 V).
3. Increase V_{GS} until the I_{DS} current is reached.
4. Apply RF power to desired level.

Turning the device OFF

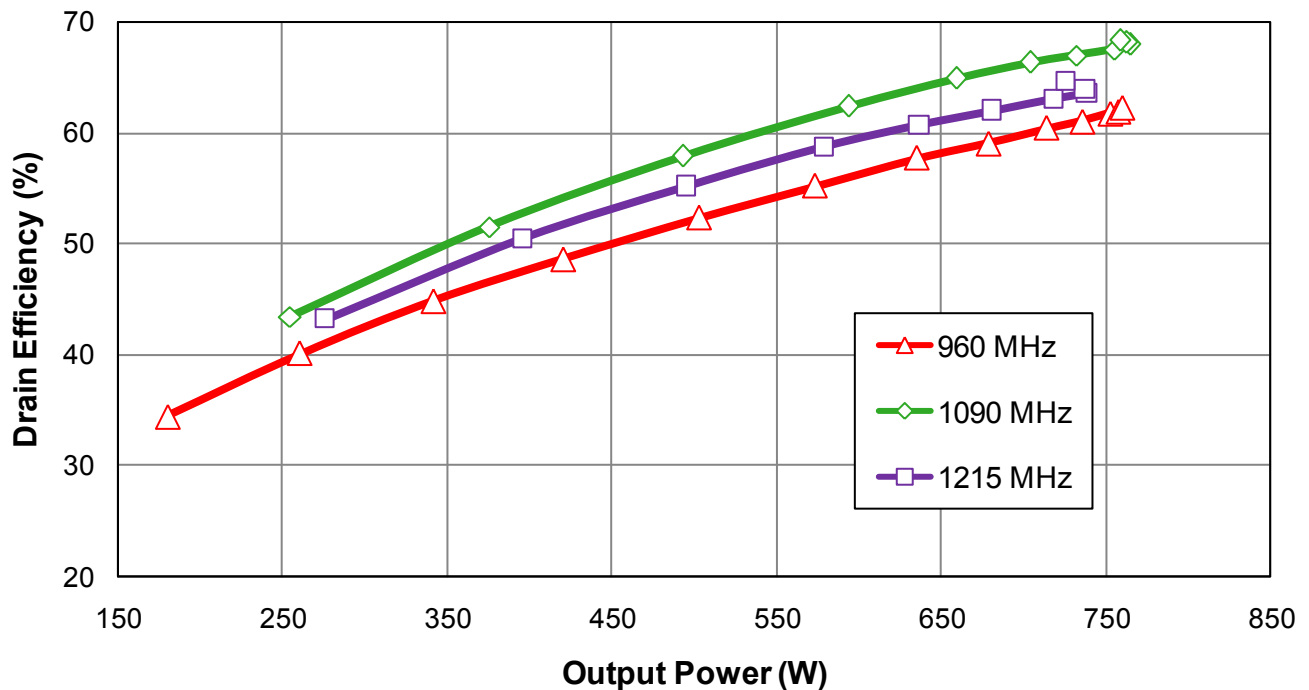
1. Turn the RF power off.
2. Decrease V_{GS} down to V_P .
3. Decrease V_{DS} down to 0 V.
4. Turn off V_{GS} .



RF Power Transfer Curve (Output Power vs. Input Power)



RF Power Transfer Curve (Drain Efficiency vs. Output Power)



MAGX-000912-650L0x



GaN on SiC HEMT Pulsed Power Transistor
650 W Peak, 960-1215 MHz, 128 μ s Pulse, 10% Duty

Rev. V3

Typical RF Performance under Alternate Operating Conditions^{7,8}
 $V_{DD} = 55$ V; $I_{DQ} = 500$ mA; Pulse = 20 μ s / 6%, $P_{OUT} = 800$ W (Peak)

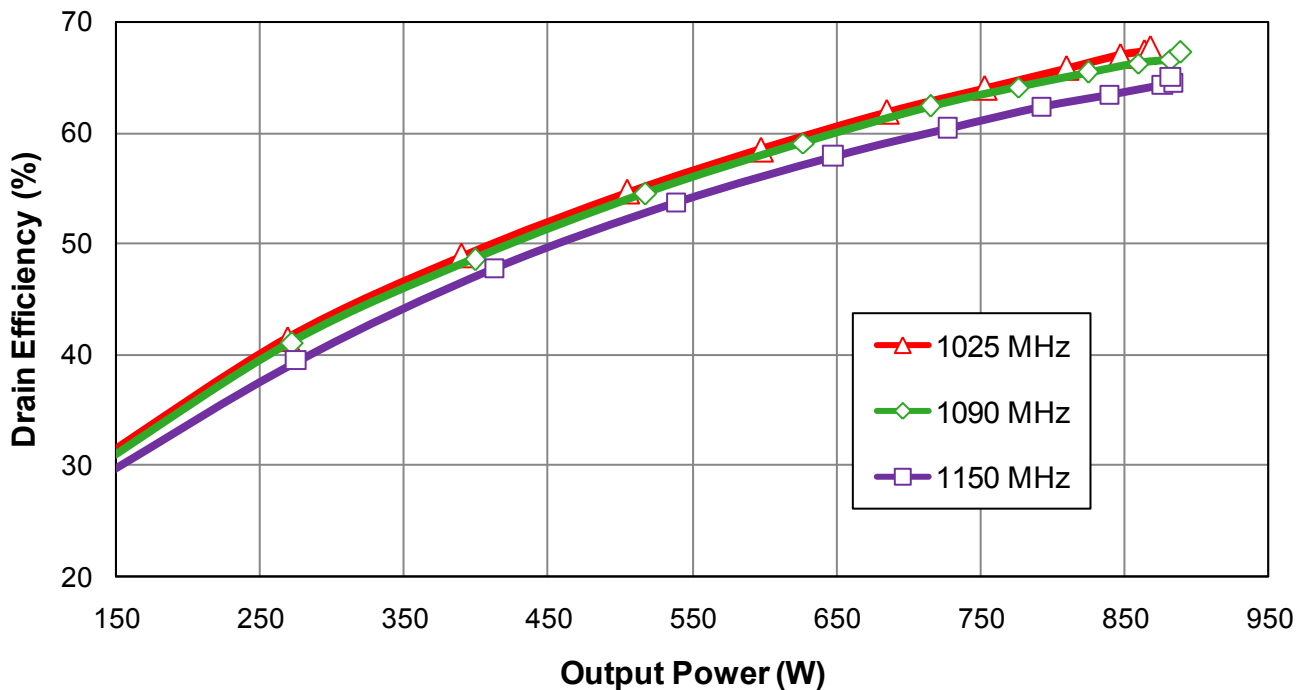
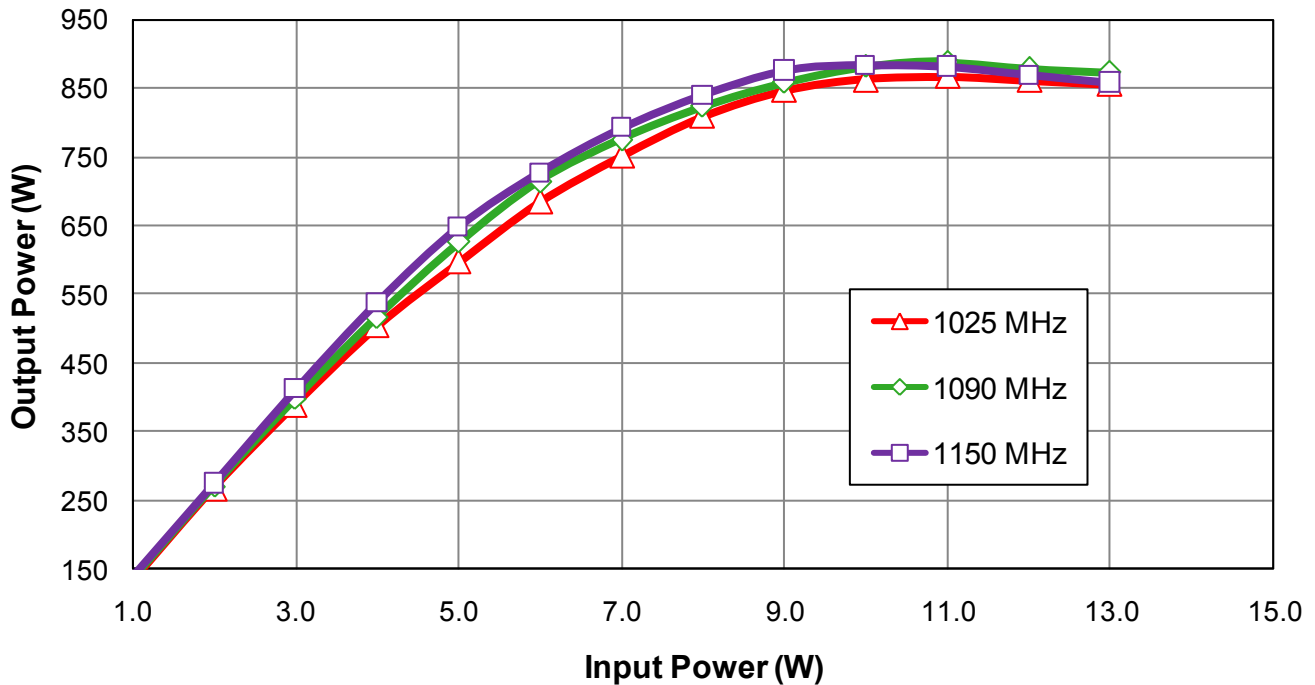
Freq (MHz)	P_{IN} (W)	Gain (dB)	I_D (A)	Eff. (%)	RL (dB)	Droop (dB)	+1dB OD (W)	VSWR-S (3:1)	VSWR-T (3:1)
1025	7.5	20.3	22.3	65.4	-11	0.1	875	S	P
1090	7.3	20.4	22.5	64.4	-11	0.1	872	S	P
1150	6.9	20.7	23.4	61.9	-14	0.1	875	S	P

RF Performance under Alternate Operating Conditions^{7,8}: Freq. = 1025 - 1150 MHz, $T_A =$

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
RF Functional Tests: $V_{DD} = 55$ V; $I_{DQ} = 500$ mA; Pulse = 20 μs / 6%						
Input Power	$P_{OUT} = 800$ W Peak (48 W avg.)	P_{IN}	-	7.2	-	Wpk
Power Gain	$P_{OUT} = 800$ W Peak (48 W avg.)	G_P	-	20.4	-	dB
Drain Efficiency	$P_{OUT} = 800$ W Peak (48 W avg.)	η_D	-	63	-	%
Pulse Droop	$P_{OUT} = 800$ W Peak (48 W avg.)	Droop	-	0.1	-	dB
Load Mismatch Stability	$P_{OUT} = 800$ W Peak (48 W avg.)	VSWR-S	-	3:1	-	-
Load Mismatch Tolerance	$P_{OUT} = 800$ W Peak (48 W avg.)	VSWR-T	-	3:1	-	-

7. Operation of this device above $V_{DD} = 50$ V may decrease operational lifetime.
8. Data measured in standard RF test fixture, reference page 4.

RF Power Transfer Curves under Alternate Operating Conditions
 ($V_{DD} = 55$ V; $I_{DQ} = 500$ mA; Pulse = 20 μ s / 6%)

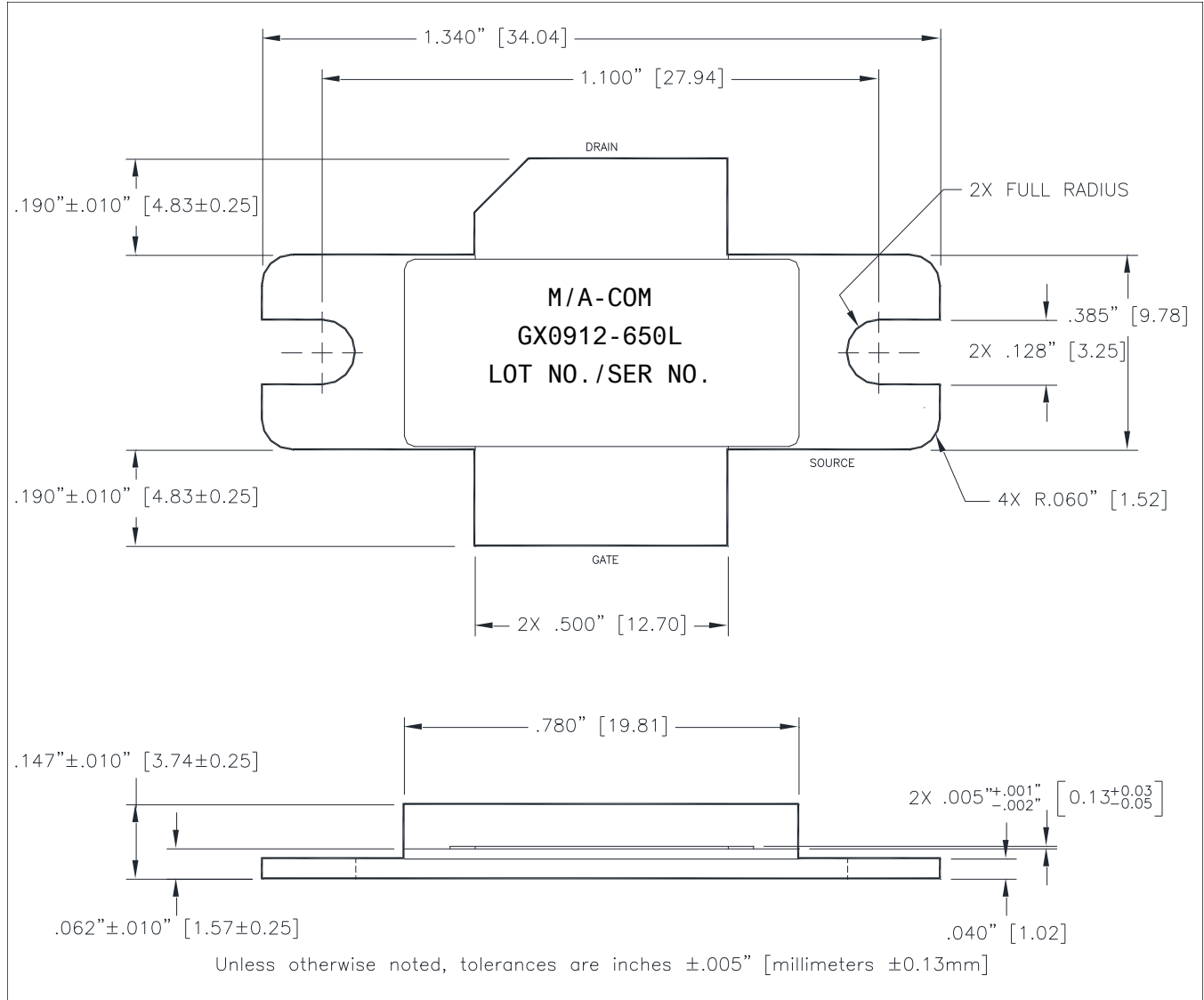


MAGX-000912-650L0x

GaN on SiC HEMT Pulsed Power Transistor
650 W Peak, 960-1215 MHz, 128 μ s Pulse, 10% Duty

Rev. V3

Outline Drawing MAGX-000912-650L0[†]



[†] Reference Application Note AN3025 for mounting/soldering recommendations.
Meets JEDEC moisture sensitivity level 1 requirements.
Plating is Ni/Au.

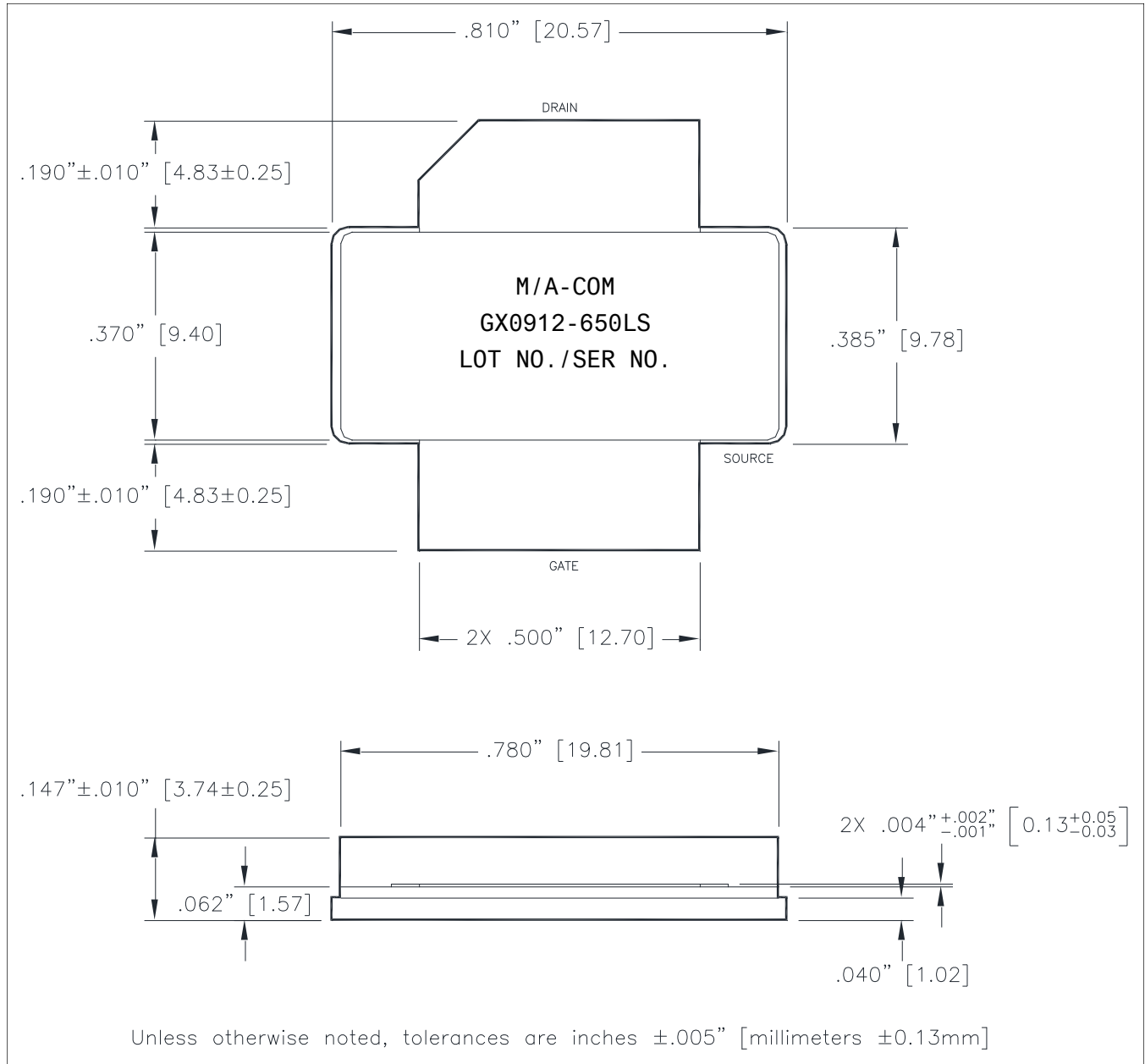
MAGX-000912-650L0x



GaN on SiC HEMT Pulsed Power Transistor
650 W Peak, 960-1215 MHz, 128 μ s Pulse, 10% Duty

Rev. V3

Outline Drawing MAGX-000912-650L0S[†]



[†] Reference Application Note AN3025 for mounting/soldering recommendations.
Meets JEDEC moisture sensitivity level 1 requirements.
Plating is Ni/Au.

M/A-COM Technology Solutions Inc. All rights reserved.

Information in this document is provided in connection with M/A-COM Technology Solutions Inc ("MACOM") products. These materials are provided by MACOM as a service to its customers and may be used for informational purposes only. Except as provided in MACOM's Terms and Conditions of Sale for such products or in any separate agreement related to this document, MACOM assumes no liability whatsoever. MACOM assumes no responsibility for errors or omissions in these materials. MACOM may make changes to specifications and product descriptions at any time, without notice. MACOM makes no commitment to update the information and shall have no responsibility whatsoever for conflicts or incompatibilities arising from future changes to its specifications and product descriptions. No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted by this document.

THESE MATERIALS ARE PROVIDED "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, RELATING TO SALE AND/OR USE OF MACOM PRODUCTS INCLUDING LIABILITY OR WARRANTIES RELATING TO FITNESS FOR A PARTICULAR PURPOSE, CONSEQUENTIAL OR INCIDENTAL DAMAGES, MERCHANTABILITY, OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT. MACOM FURTHER DOES NOT WARRANT THE ACCURACY OR COMPLETENESS OF THE INFORMATION, TEXT, GRAPHICS OR OTHER ITEMS CONTAINED WITHIN THESE MATERIALS. MACOM SHALL NOT BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, INCLUDING WITHOUT LIMITATION, LOST REVENUES OR LOST PROFITS, WHICH MAY RESULT FROM THE USE OF THESE MATERIALS.

MACOM products are not intended for use in medical, lifesaving or life sustaining applications. MACOM customers using or selling MACOM products for use in such applications do so at their own risk and agree to fully indemnify MACOM for any damages resulting from such improper use or sale.