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MAGX-000912-650L0x

GaN on SiC HEMT Pulsed Power Transistor
650 W Peak, 960-1215 MHz, 128 µs 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 µs 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.

Electrical Specifications: Freq. = 960 - 1215 MHz, T_A = 25°C

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
RF Functional Tests						
Peak Input Power	V_{DD} = 50 V, I_{DQ} = 500 mA, Pulse Width = 128 µs, Duty Cycle = 10%, P_{OUT} = 650 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°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}	-	1.7	-	mA
Gate Threshold Voltage	V_{DS} = 5 V, I_D = 90 mA	$V_{GS\ (TH)}$	-	-3.1	-	V
Forward Transconductance	V_{DS} = 5 V, I_D = 21 mA	G_M	-	22	-	S
Dynamic Characteristics						
Input Capacitance	Not applicable - Input matched	C_{ISS}	-	N/A	-	pF
Output Capacitance	V_{DS} = 50 V, V_{GS} = -8 V, Freq. = 1 MHz	C_{OSS}	-	55	-	pF
Reverse Transfer Capacitance		C_{RSS}	-	5.5	-	pF

Absolute Maximum Ratings[2,3,4]

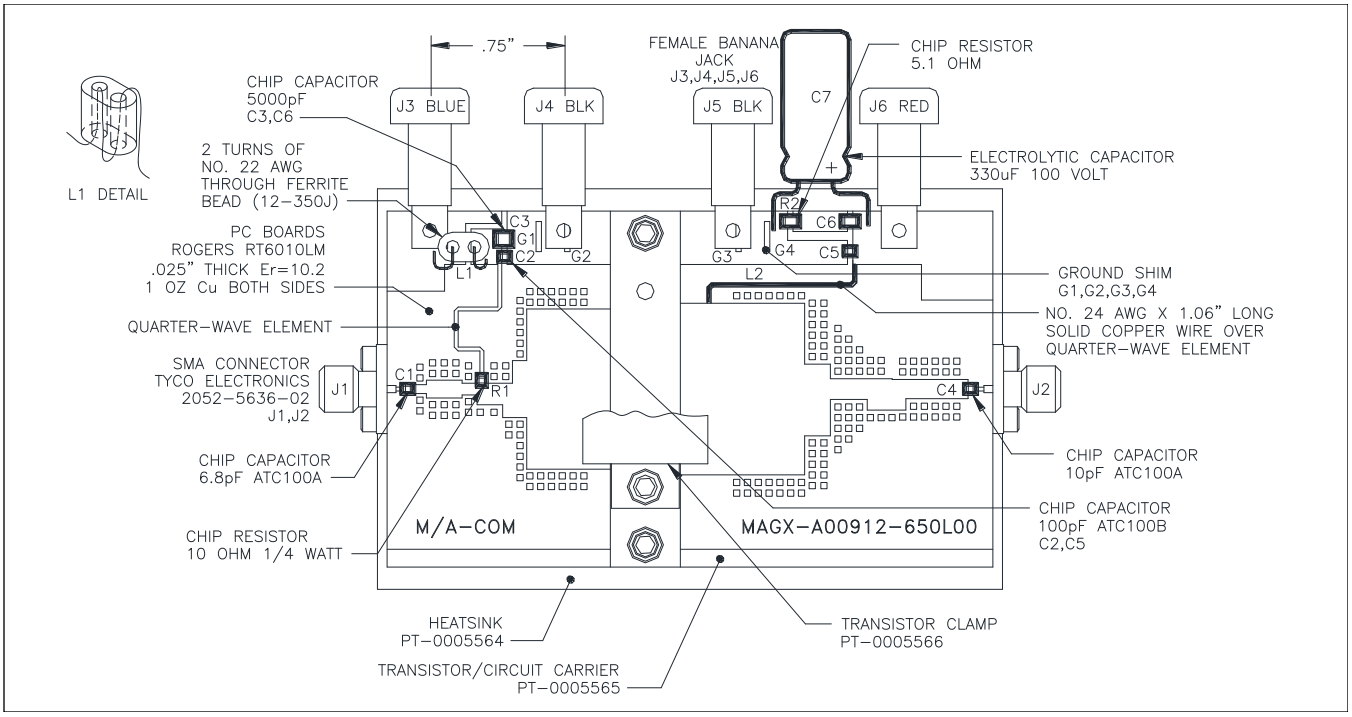
Parameter	Rating
Drain Voltage (V_{DD})	+65 V
Gate Voltage (V_{GG})	-8 to -2 V
Drain Current (I_{DD})	33 A
Input Power[5] (P_{IN})	P_{IN} (nominal) +3 dB
Operating Junction Temperature[6]	250 °C
Peak Pulsed Power Dissipation at 85 ºC	1 kW
Operating Temperature Range	-40 to +95 °C
Storage Temperature 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 x 10^6 hours (T_J < 200 °C)
   - MTTF = 6.8 x 10^4 hours (T_J < 250 °C)

Thermal Characteristics

Parameter	Test Conditions	Symbol	Typical	Units
Thermal Resistance	T_C = 70 ºC, 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

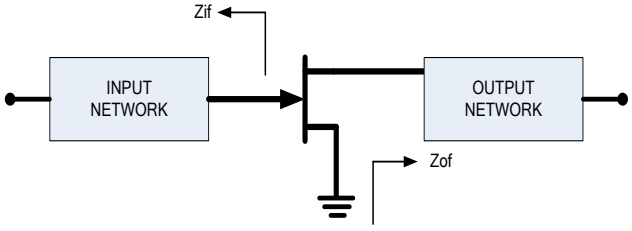
Test Fixture Assembly



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

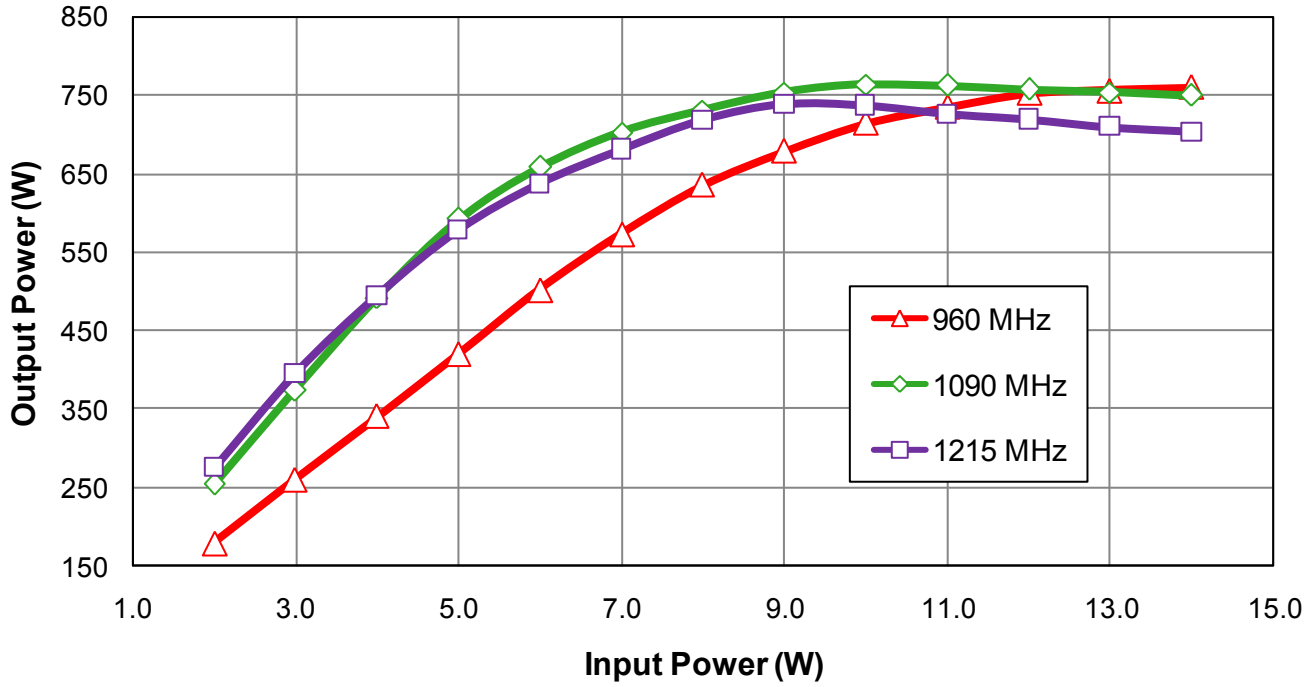
Turning the device ON

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.

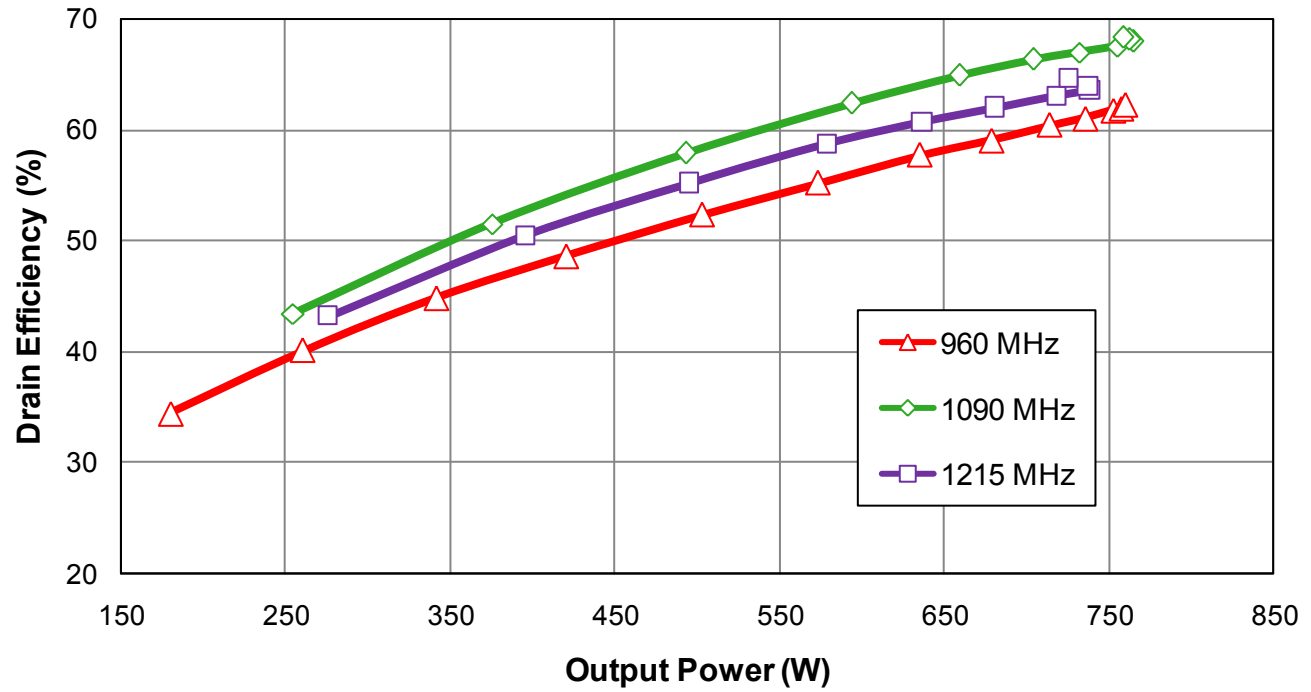
Turning the device OFF

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)



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

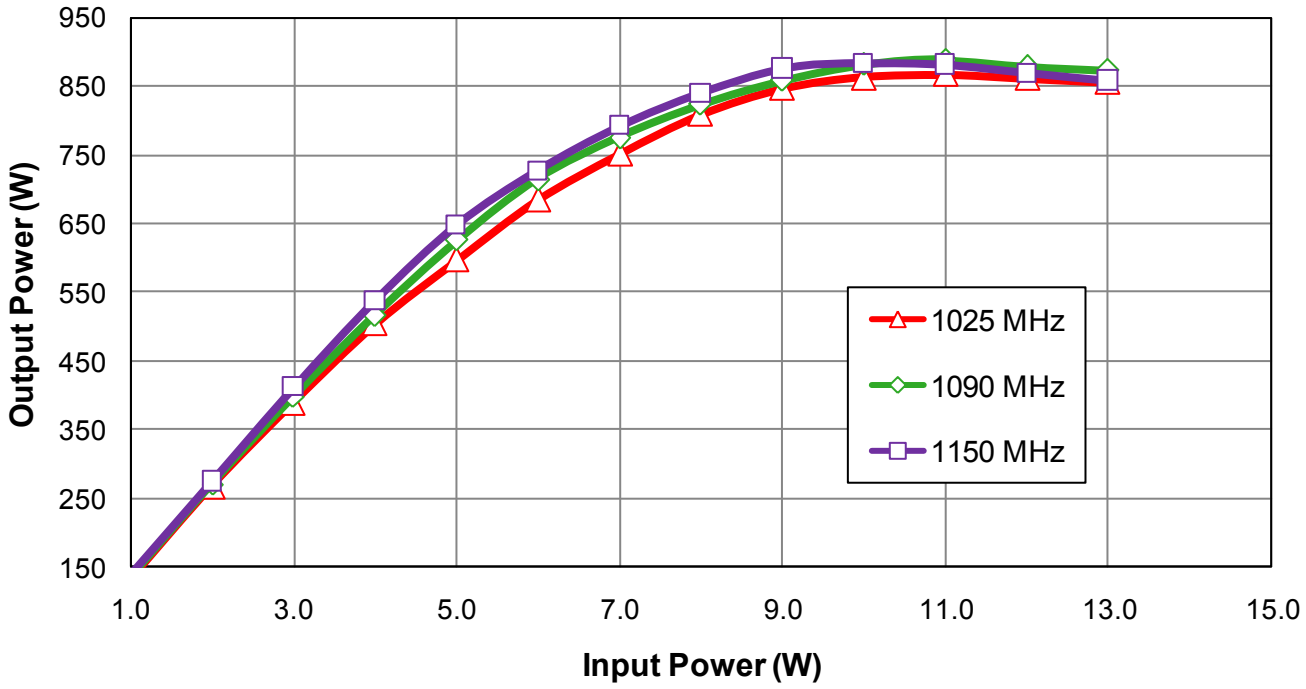
Freq (MHz)	P_{IN} (W)	Gain (dB)	I_D (A)	Eff. (%)	RL (dB)	Droop (dB)	+1dB OD (W)	VSWR-S (3:1)	VSWR-T (3:1)
1025	7.5	20.3	22.3	65.4	-11	0.1	875	S	P
1090	7.3	20.4	22.5	64.4	-11	0.1	872	S	P
1150	6.9	20.7	23.4	61.9	-14	0.1	875	S	P

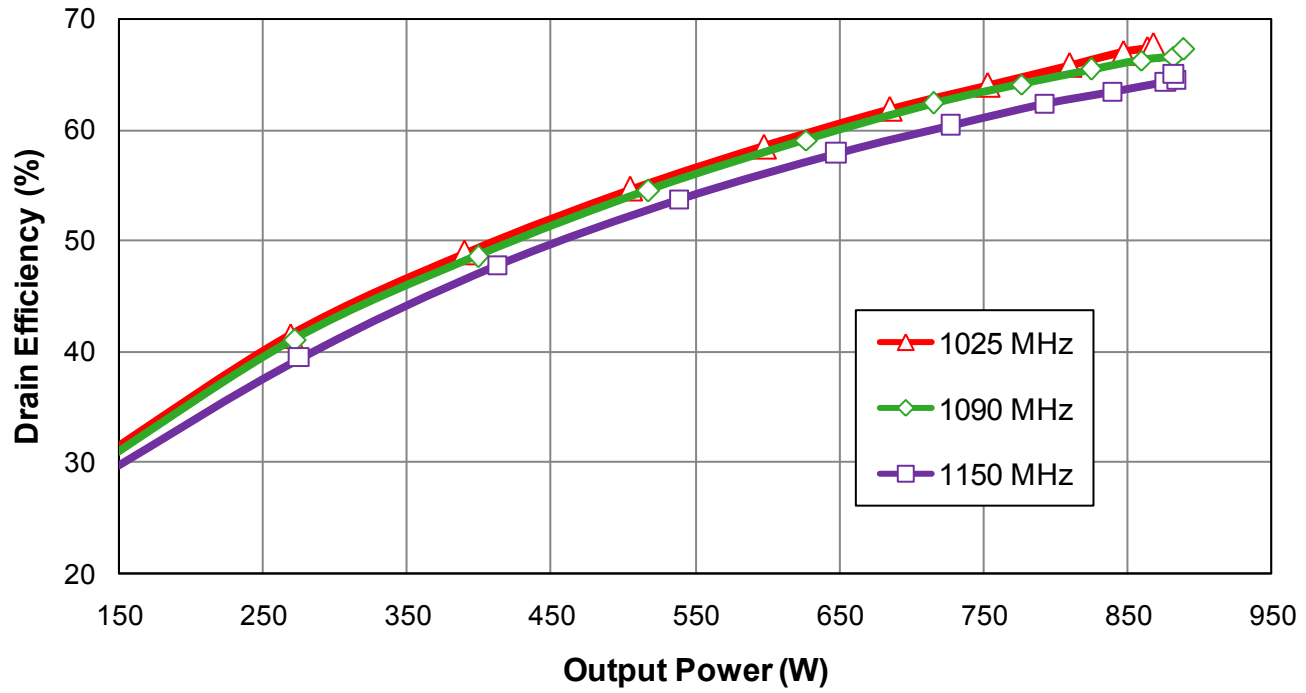
RF Performance under Alternate Operating Conditions[7,8]: Freq. = 1025 - 1150 MHz, T_A =

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	-	-

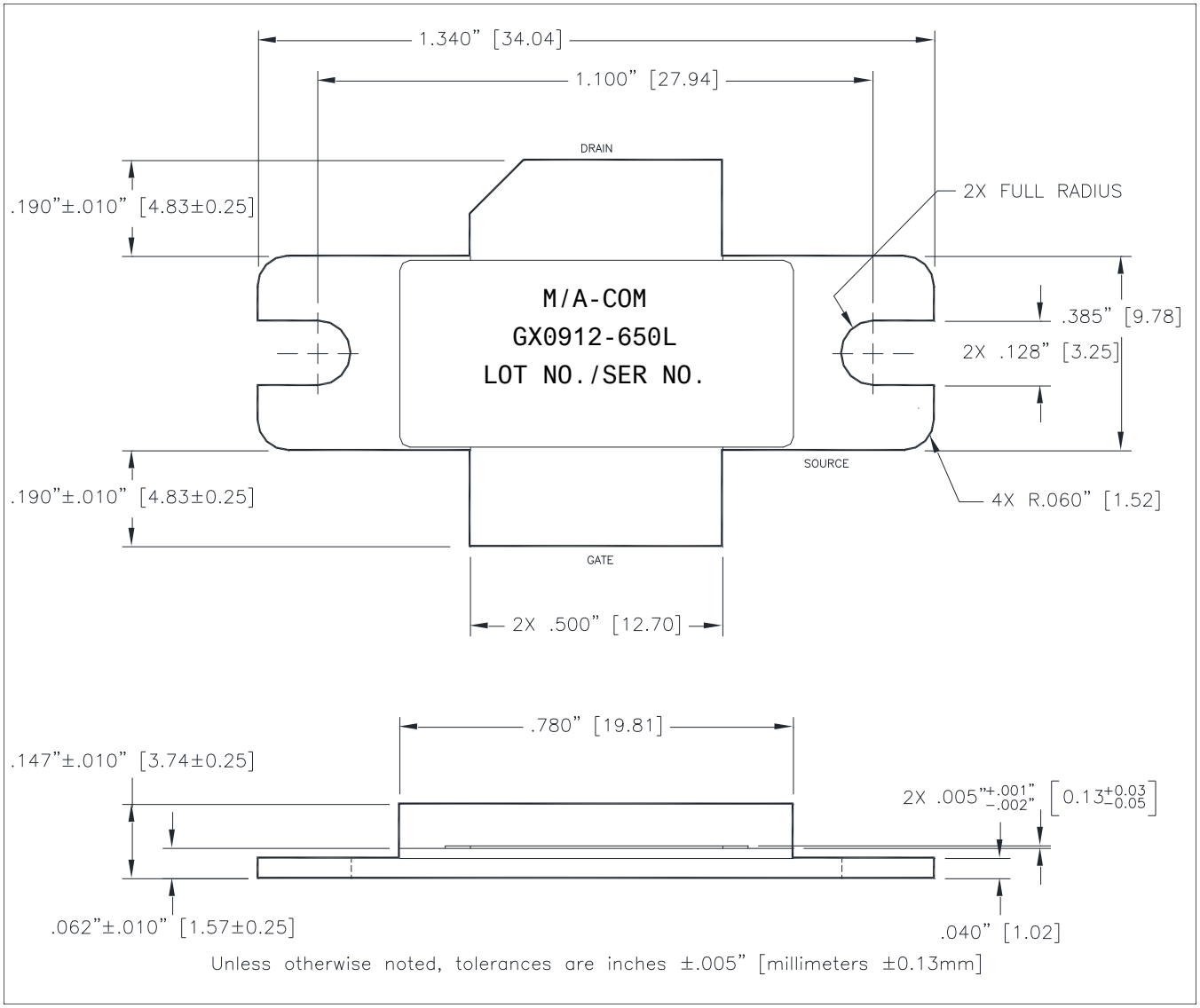
7. Operation of this device above V_{DD} = 50V may decrease operational lifetime.
8. Data measured in standard RF test fixture, reference page 4.

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



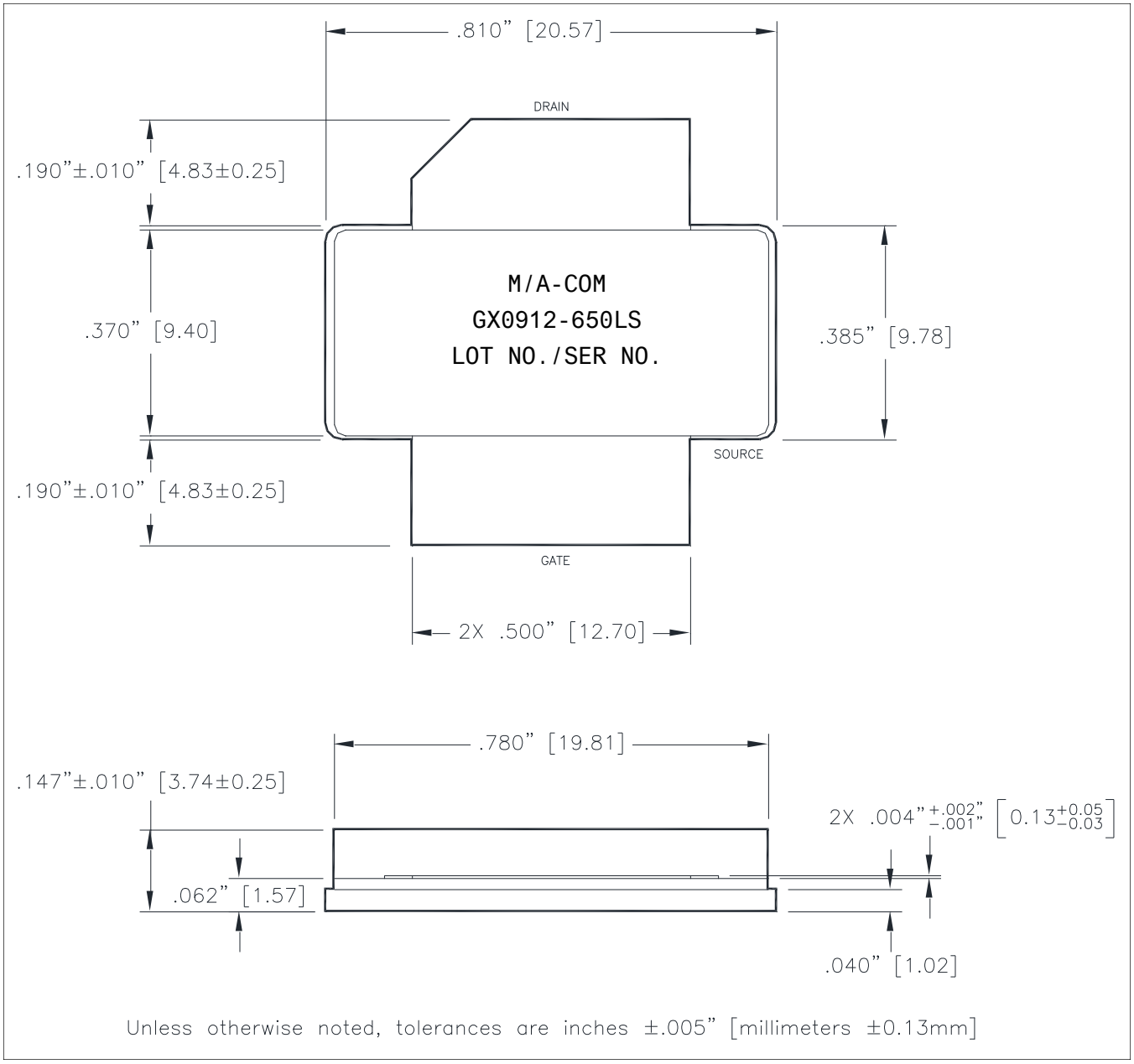


Outline Drawing MAGX-000912-650L00†



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

Outline Drawing MAGX-000912-650L0S†



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