

## Features

- GaN on SiC Depletion-Mode Transistor Technology
- Internally Matched
- Common-Source Configuration
- Broadband Class AB Operation
- RoHS\* Compliant and 260°C Reflow Compatible
- +50 V Typical Operation
- MTTF = 600 Years ( $T_J < 200^\circ\text{C}$ )

## Applications

- L-Band pulsed radar.

## Description

The MAGX-001214-650L0x is a gold-metalized matched Gallium Nitride (GaN) on Silicon Carbide (SiC) RF power transistor optimized for pulsed L-Band radar applications. Using state of the art wafer fabrication processes, these high performance transistors provide high gain, efficiency, bandwidth, and ruggedness over a wide bandwidth for today's demanding application needs. High breakdown voltages allow for reliable and stable operation under more extreme mismatch load conditions compared with older semiconductor technologies.

## MAGX-001214-650L00



## Ordering Information

| Part Number        | Description                    |
|--------------------|--------------------------------|
| MAGX-001214-650L00 | GaN Transistor                 |
| MAGX-L21214-650L00 | 1200-1400 MHz Evaluation Board |

## Typical RF Performance Under Standard Operating Conditions, $P_{OUT} = 650\text{ W}$ (Peak)

| Freq. (MHz) | $P_{IN}$ (W) | Gain (dB) | $I_D$ (A) | Eff. (%) | RL (dB) | Droop (dB) | +1dB OD (W) | VSWR-S (3:1) |
|-------------|--------------|-----------|-----------|----------|---------|------------|-------------|--------------|
| 1200        | 8.7          | 18.8      | 21.3      | 61.0     | -13.9   | 0.2        | 717         | S            |
| 1250        | 8.5          | 18.9      | 22.0      | 58.9     | -13.8   | 0.3        | 726         | S            |
| 1300        | 8.0          | 19.1      | 22.4      | 57.8     | -13.5   | 0.3        | 724         | S            |
| 1350        | 7.0          | 19.7      | 21.8      | 59.7     | -15.8   | 0.3        | 723         | S            |
| 1400        | 7.0          | 19.7      | 21.1      | 61.4     | -15.0   | 0.2        | 697         | S            |

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

## GaN on SiC HEMT Pulsed Power Transistor 650 W Peak, 1200-1400 MHz, 300 $\mu$ s Pulse, 10% Duty

Rev. V3

### Electrical Specifications: Freq. = 1200 - 1400 MHz, $T_A = 25^\circ\text{C}$

| Parameter                  | Test Conditions                                                                                                                                  | Symbol   | Min. | Typ. | Max. | Units |
|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|----------|------|------|------|-------|
| <b>RF Functional Tests</b> |                                                                                                                                                  |          |      |      |      |       |
| Peak Input Power           | $V_{DD} = 50\text{ V}$ , $I_{DQ} = 500\text{ mA}$<br>Pulse Width = 300 $\mu$ s,<br>Duty Cycle = 10%<br>$P_{OUT} = 650\text{ W Peak (65 W avg.)}$ | $P_{IN}$ | -    | 7.5  | 10.3 | W     |
| Power Gain                 |                                                                                                                                                  | $G_P$    | 18   | 19.5 | -    | dB    |
| Drain Efficiency           |                                                                                                                                                  | $\eta_D$ | 55   | 60   | -    | %     |
| Pulse Droop                |                                                                                                                                                  | Droop    | -    | 0.3  | 0.6  | dB    |
| Load Mismatch Stability    |                                                                                                                                                  | VSWR-S   | -    | 2:1  | -    | -     |
| Load Mismatch Tolerance    |                                                                                                                                                  | VSWR-T   | -    | 3:1  | -    | -     |

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

| Parameter                      | Test Conditions                                                    | Symbol       | Min. | Typ. | Max. | Units |
|--------------------------------|--------------------------------------------------------------------|--------------|------|------|------|-------|
| <b>DC Characteristics</b>      |                                                                    |              |      |      |      |       |
| Drain-Source Leakage Current   | $V_{GS} = -8\text{ V}$ , $V_{DS} = 175\text{ V}$                   | $I_{DS}$     | -    | 1.7  | 33   | mA    |
| Gate Threshold Voltage         | $V_{DS} = 5\text{ V}$ , $I_D = 90\text{ mA}$                       | $V_{GS(TH)}$ | -5   | -2.9 | -2   | V     |
| Forward Transconductance       | $V_{DS} = 5\text{ V}$ , $I_D = 21\text{ mA}$                       | $G_M$        | 16.2 | 21.7 | -    | S     |
| <b>Dynamic Characteristics</b> |                                                                    |              |      |      |      |       |
| Input Capacitance              | Not applicable - Input matched                                     | $C_{ISS}$    | N/A  | N/A  | N/A  | pF    |
| Output Capacitance             | $V_{DS} = 50\text{ V}$ , $V_{GS} = -8\text{ V}$ ,<br>Freq. = 1 MHz | $C_{OSS}$    | -    | 55   | -    | pF    |
| Reverse Transfer Capacitance   |                                                                    | $C_{RSS}$    | -    | 5.5  | -    | pF    |

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**Absolute Maximum Ratings**<sup>1,2,3</sup>

| Parameter                                   | Limit                     |
|---------------------------------------------|---------------------------|
| Drain Voltage ( $V_{DD}$ )                  | +65 V                     |
| Gate Voltage ( $V_{GG}$ )                   | -8 to 0 V                 |
| Drain Current ( $I_{DD}$ )                  | 27 A                      |
| Input Power <sup>4</sup> ( $P_{IN}$ )       | $P_{IN}$ (nominal) + 3 dB |
| Operating Junction Temperature <sup>5</sup> | 250°C                     |
| Peak Pulsed Power Dissipation at 85°C       | 700 W                     |
| Operating Temperature Range                 | -40 to +85°C              |
| Storage Temperature Range                   | -65 to +150°C             |
| ESD Min. - Charged Device Model (CDM)       | 1300 V                    |
| ESD Min. - Human Body Model (HBM)           | 4000 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 it is recommended that the sum of  $(3 * V_{DD} + |V_{GG}|) < 175$  V.
- Input Power Limit is +3 dB over nominal drive required to achieve  $P_{OUT} = 650$  W.
- 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 =  $5.3 \times 10^6$  hours ( $T_J < 200^\circ\text{C}$ )
  - MTTF =  $6.8 \times 10^4$  hours ( $T_J < 250^\circ\text{C}$ )

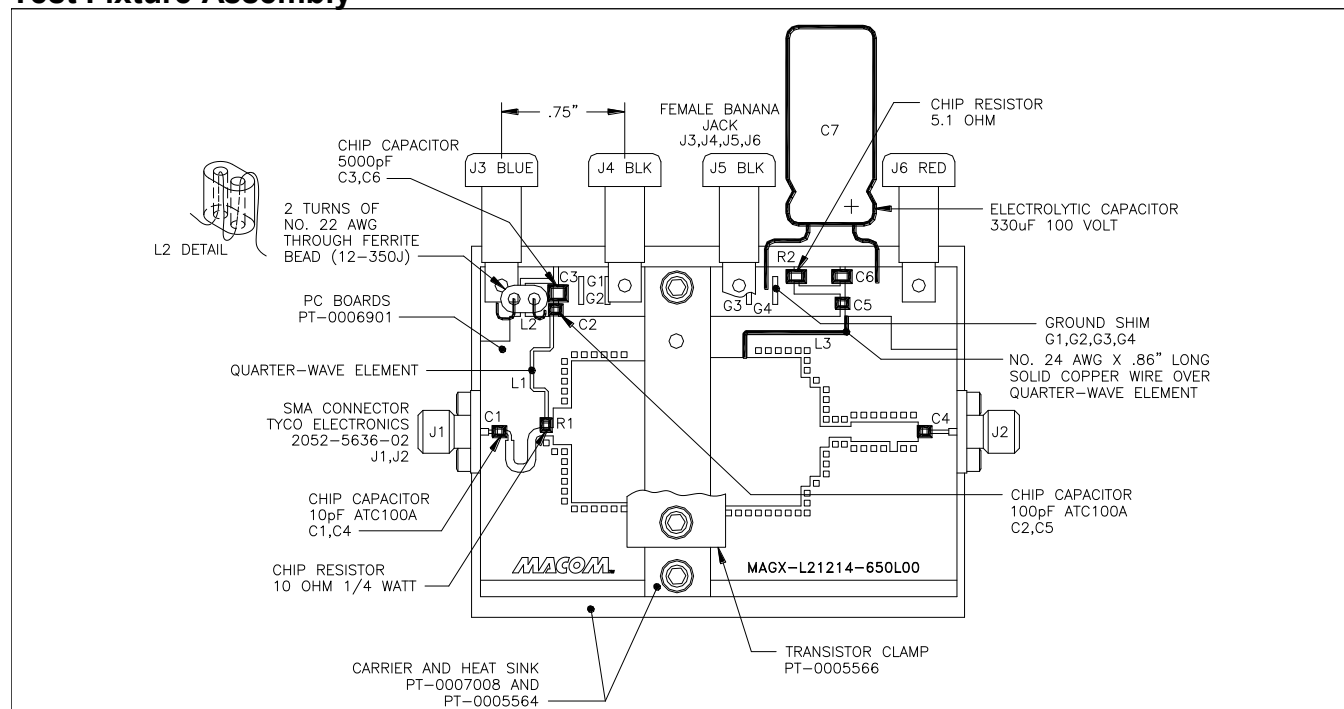
**Thermal Characteristics**

| Parameter          | Test Conditions                                                                                                                 | Symbol        | Typical | Units              |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------|---------------|---------|--------------------|
| Thermal Resistance | $T_C = 70^\circ\text{C}$ , $V_{DD} = 50$ V, $I_{DQ} = 500$ mA, $P_{OUT} = 650$ W<br>Pulse Width = 300 $\mu$ s, Duty Cycle = 10% | $\Theta_{JC}$ | 0.25    | $^\circ\text{C/W}$ |

## GaN on SiC HEMT Pulsed Power Transistor 650 W Peak, 1200-1400 MHz, 300 $\mu$ s Pulse, 10% Duty

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### Test Fixture Assembly



Contact factory for gerber file or additional circuit information.

### Test Fixture Impedances

| F (MHz) | $Z_{IF}$ ( $\Omega$ ) | $Z_{OF}$ ( $\Omega$ ) |
|---------|-----------------------|-----------------------|
| 1200    | $0.8 - j0.9$          | $1.4 + j0.2$          |
| 1250    | $0.8 - j0.7$          | $1.4 + j0.2$          |
| 1300    | $0.7 - j0.6$          | $1.4 + j0.1$          |
| 1350    | $0.7 - j0.4$          | $1.2 + j0.1$          |
| 1400    | $0.7 - j0.2$          | $1.1 + j0.2$          |

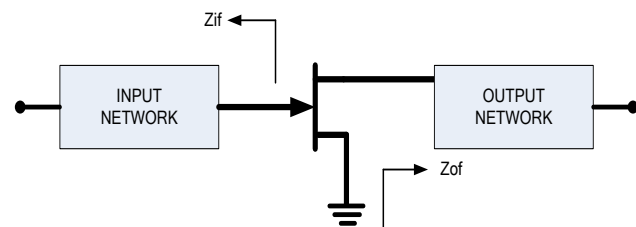
### Correct Device Sequencing

#### 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  $V_{GS}$ .

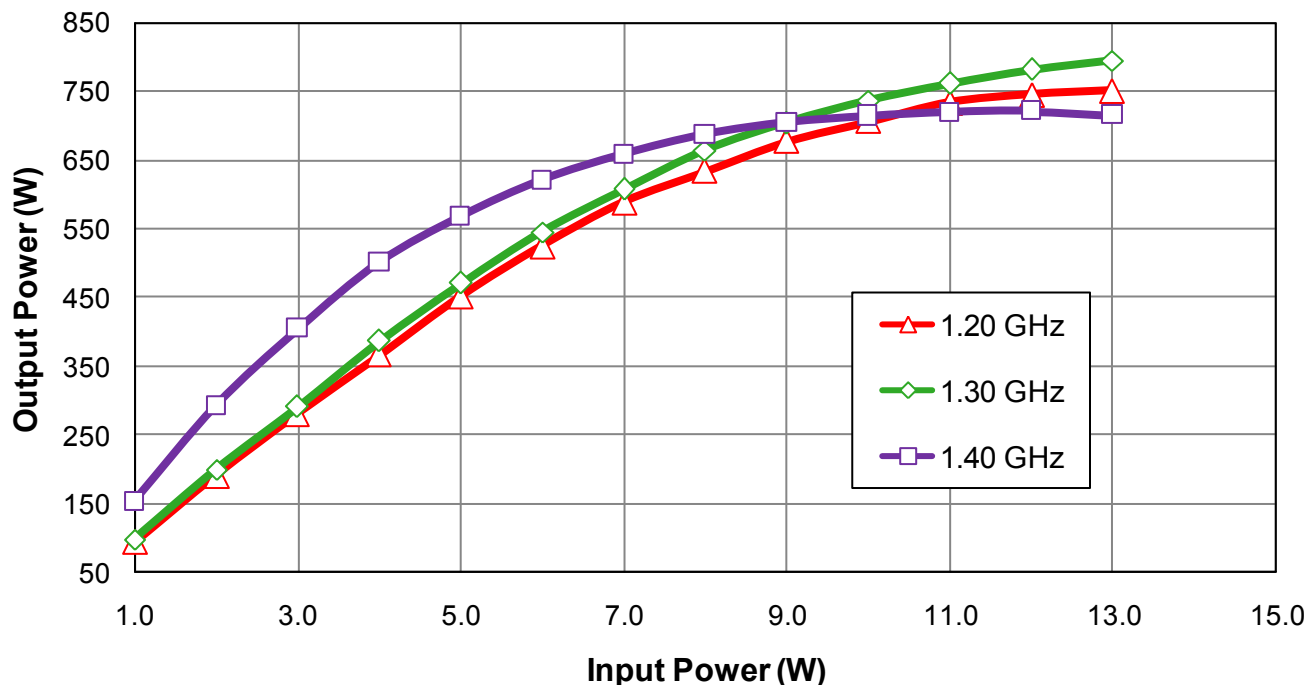


Contact factory for gerber file or additional circuit information.

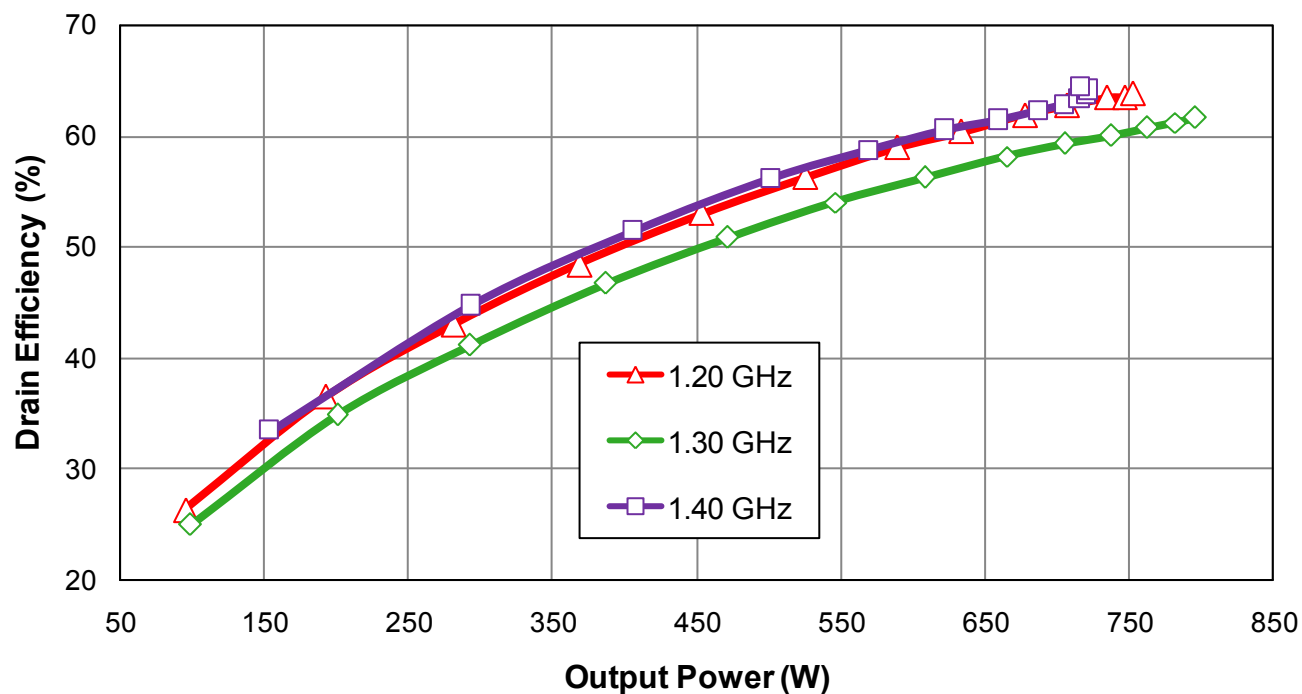
**GaN on SiC HEMT Pulsed Power Transistor**  
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**RF Power Transfer Curve (Output Power vs. Input Power)**



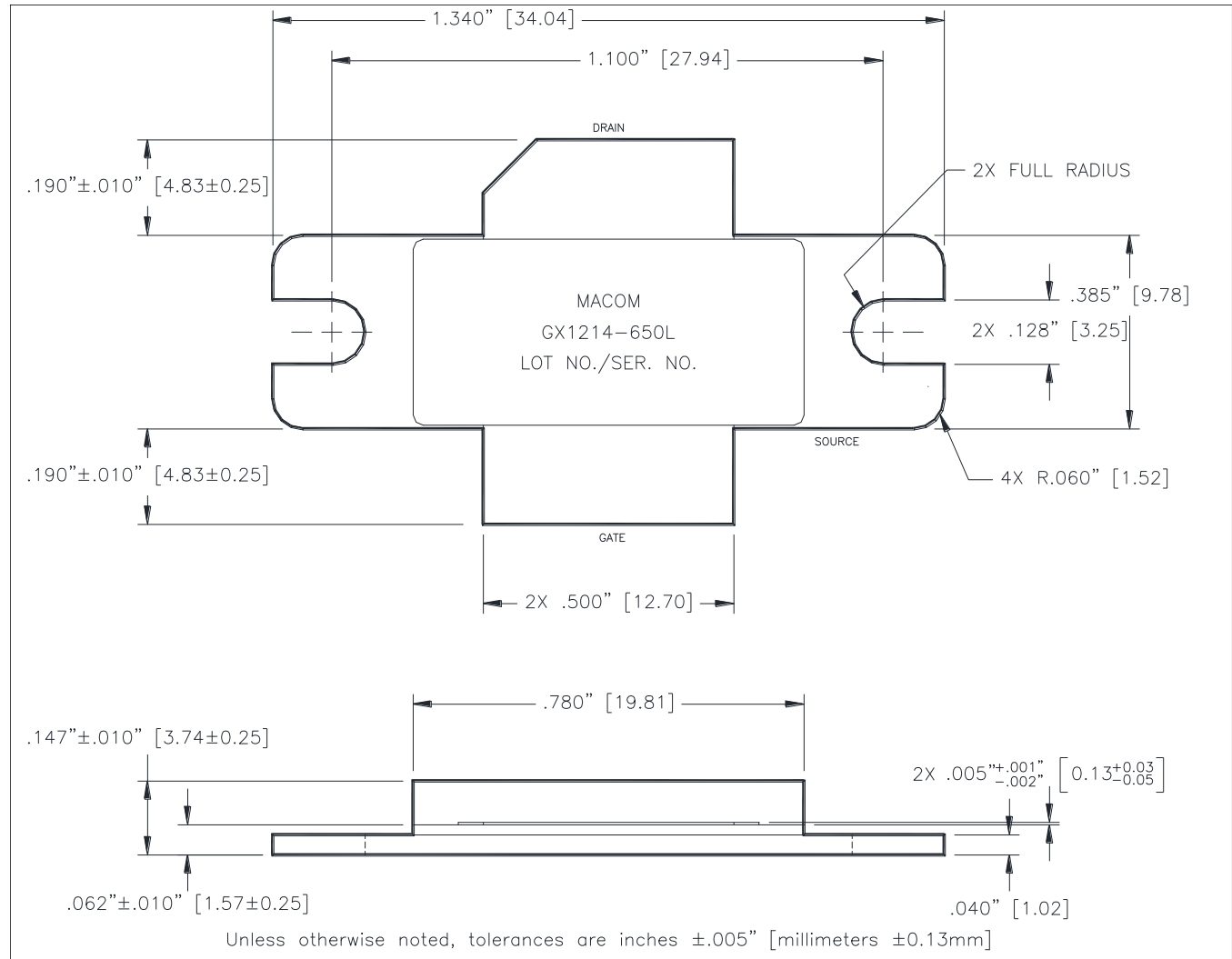
**RF Power Transfer Curve (Drain Efficiency vs. Output Power)**



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## Outline Drawing MAGX-001214-650L00



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