

# CMPA5259050S

50 W, 5.0 - 5.9 GHz, GaN MMIC, Power Amplifier

#### **Description**

The CMPA5259050S is a gallium nitride (GaN) High Electron Mobility Transistor (HEMT) based monolithic microwave integrated circuit (MMIC). This MMIC contains a two-stage reactively matched amplifier design approach enabling high power and power added efficiency to be achieved in a 5 mm x 5 mm surface mount (QFN package).



Package Type: 5 x 5 QFN PN: CMPA5259050S

### Typical Performance Over 5.0 - 5.9 GHz ( $T_c = 25^{\circ}$ C)

| Parameter                             | 5.2 GHz | 5.5 GHz | 5.9 GHz | Units |
|---------------------------------------|---------|---------|---------|-------|
| Small Signal Gain <sup>1,2</sup>      | 27.0    | 26.0    | 27.1    | dB    |
| Output Power <sup>1,3</sup>           | 48.2    | 48.1    | 48.6    | dBm   |
| Power Gain <sup>1,3</sup>             | 23.2    | 23.1    | 23.6    | dB    |
| Power Added Efficiency <sup>1,3</sup> | 56      | 51      | 49      | %     |

#### Note:

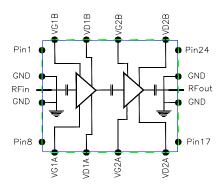
#### **Features**

- >50% Typical Power Added Efficiency
- 27 dB Small Signal Gain
- 65 W Typical P<sub>SAT</sub>
- Operation up to 28 V
- High Breakdown Voltage
- **High Temperature Operation**

Note: Features are typical performance across frequency under 25°C operation. Please reference performance charts for additional details.

#### **Applications**

Civil and Military Pulsed **Radar Amplifiers** 





 $<sup>^{1}</sup>$  V<sub>DD</sub> = 28 V, I<sub>DQ</sub> = 500 mA

 $<sup>^{2}</sup>$  Measured at P<sub>IN</sub> = -20 dBm

 $<sup>^3</sup>$  Measured at  $P_{\text{IN}}$  = 25 dBm and 150  $\mu s;$  Duty Cycle = 20%



### Absolute Maximum Ratings (not simultaneous) at 25°C

| Parameter                    | Symbol            | Rating    | Units    | Conditions |
|------------------------------|-------------------|-----------|----------|------------|
| Drain-source Voltage         | $V_{	extsf{DSS}}$ | 84        | V        | ar°c       |
| Gate-source Voltage          | V <sub>GS</sub>   | -10, +2   | $V_{DC}$ | 25°C       |
| Storage Temperature          | T <sub>STG</sub>  | -55, +150 | °C       |            |
| Maximum Forward Gate Current | I <sub>GMAX</sub> | 18.96     | mA       | 25°C       |
| Maximum Drain Current        | I <sub>DMAX</sub> | 4.5       | Α        |            |
| Soldering Temperature        | Ts                | 260       | °C       |            |

### Electrical Characteristics (Frequency = 5.0 GHz to 5.9 GHz unless otherwise stated; $T_c = 25^{\circ}\text{C}$ )

| Characteristics                      | Symbol            | Min.  | Тур.  | Max. | Units           | Conditions  |
|--------------------------------------|-------------------|-------|-------|------|-----------------|---|
| DC Characteristics                   |                   |       |       |      |                 |   |
| Gate Threshold Voltage               | $V_{GS(th)}$      | -2.6  | -2.0  | -1.6 | V               | $V_{DS} = 10 \text{ V}, I_{D} = 18.96 \text{ mA}$                         |
| Gate Quiescent Voltage               | $V_{GS(Q)}$       | _     | -1.8  | _    | V <sub>DC</sub> | $V_{DD} = 28 \text{ V}, I_{DQ} = 500 \text{ mA}$                          |
| Saturated Drain Current <sup>1</sup> | I <sub>DS</sub>   | 18.96 | 22.75 | _    | А               | $V_{DS} = 6.0 \text{ V}, V_{GS} = 2.0 \text{ V}$                          |
| Drain-Source Breakdown Voltage       | V <sub>BD</sub>   | 84    | _     | _    | V               | V <sub>GS</sub> = -8 V, I <sub>D</sub> = 18.96 mA                         |
| RF Characteristics <sup>2,3</sup>    |                   |       |       |      |                 |   |
| Small Signal Gain at 5.2 GHz         | S21 <sub>1</sub>  | _     | 27    | _    |                 |   |
| Small Signal Gain at 5.55 GHz        | S21 <sub>2</sub>  | _     | 26.6  | _    | dB              | $V_{DD} = 28 \text{ V}, I_{DQ} = 500 \text{ mA}, P_{IN} = 5 \text{ dBm}$  |
| Small Signal Gain at 5.9 GHz         | S21 <sub>3</sub>  | -     | 27.2  | _    | ]               |   |
| Output Power at 5.2 GHz              | P <sub>OUT1</sub> | _     | 47.0  | _    |                 |   |
| Output Power at 5.55 GHz             | P <sub>OUT2</sub> | _     | 47.8  | _    | dBm             |   |
| Output Power at 5.9 GHz              | P <sub>OUT3</sub> | -     | 48.1  | _    | ]               | V = 20 V I = 500 m/ D = 25 dDm  |
| Power Added Efficiency at 5.2 GHz    | PAE <sub>1</sub>  | -     | 54    | _    | %               | $V_{DD} = 28 \text{ V}, I_{DQ} = 500 \text{ mA}, P_{IN} = 25 \text{ dBm}$ |
| Power Added Efficiency at 5.55 GHz   | PAE <sub>2</sub>  | _     | 53    | _    |                 |   |
| Power Added Efficiency at 5.9 GHz    | PAE <sub>3</sub>  | _     | 50    | _    |                 |   |
| Output Mismatch Stress               | VSWR              | _     | _     | 3:1  | Ψ               | No damage at all phase angles   |

#### Notes:

#### **Thermal Characteristics**

| Parameter  | Symbol          | Rating | Units | Conditions                           |
|--|-----------------|--------|-------|--------------------------------------|
| Operating Junction Temperature                               | TJ              | 225    | °C    |                                      |
| Thermal Resistance, Junction to Case (packaged) <sup>1</sup> | $R_{\theta JC}$ | 1.13   | °C/W  | Pulse Width = 150µs, Duty Cycle =20% |

#### Notes:

<sup>&</sup>lt;sup>1</sup> Scaled from PCM data

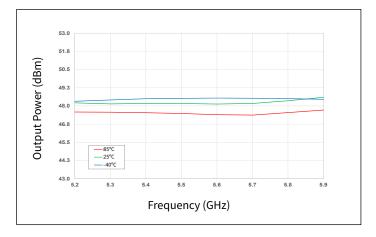
<sup>&</sup>lt;sup>2</sup> Measured in CMPA5259050S high volume test fixture at 5.2, 5.55 and 5.9 GHz and may not show the full capability of the device due to source inductance and thermal performance.

<sup>&</sup>lt;sup>3</sup> Unless otherwise noted: Pulse Width = 25μs, Duty Cycle = 1%

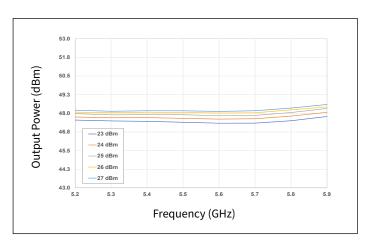
 $<sup>^{\</sup>rm 1}$  Measured for the CMPA5259050S at  $P_{\text{\tiny DISS}}$  = 64 W



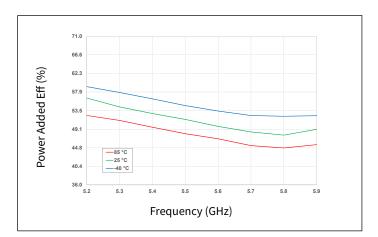
Test conditions unless otherwise noted: V<sub>D</sub> = 28 V, I<sub>DQ</sub> = 500 mA, Pulse Width = 150µs, Duty Cycle = 20%, P<sub>IN</sub> = 25 dBm, T<sub>BASE</sub> = +25°C



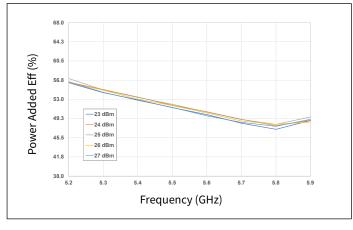
**Figure 1.** Output Power vs Frequency as a Function of Temperature



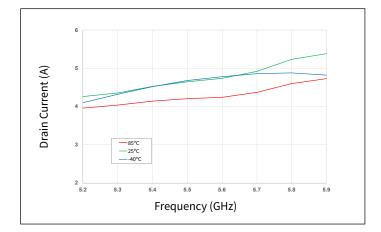
**Figure 2.** Output Power vs Frequency as a Function of Input Power



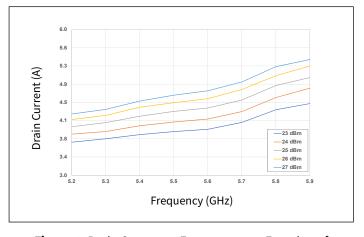
**Figure 3.** Power Added Eff. vs Frequency as a Function of Temperature



**Figure 4.** Power Added Eff. vs Frequency as a Function of Input Power



**Figure 5.** Drain Current vs Frequency as a Function of Temperature



**Figure 6.** Drain Current vs Frequency as a Function of Input Power



Test conditions unless otherwise noted: V<sub>D</sub> = 28 V, I<sub>DQ</sub> = 500 mA, Pulse Width = 150µs, Duty Cycle = 20%, P<sub>IN</sub> = 25 dBm, T<sub>BASE</sub> = +25°C

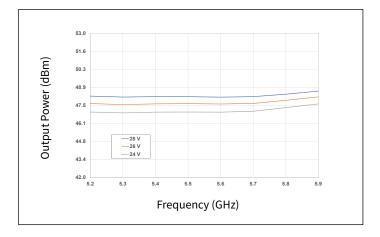


Figure 7. Output Power vs Frequency as a Function of V<sub>D</sub>

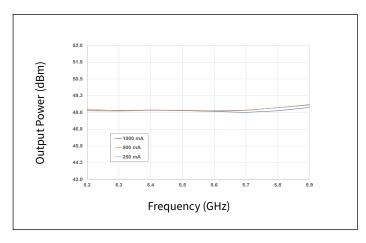


Figure 8. Output Power vs Frequency as a Function of IDQ

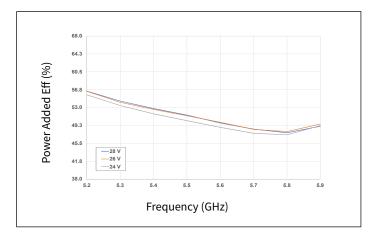


Figure 9. Power Added Eff. vs Frequency as a Function of V<sub>D</sub>

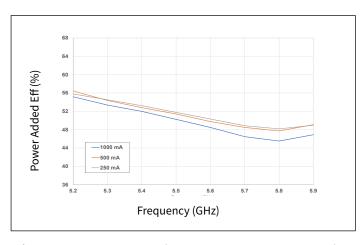


Figure 10. Power Added Eff. vs Frequency as a Function of I<sub>DO</sub>

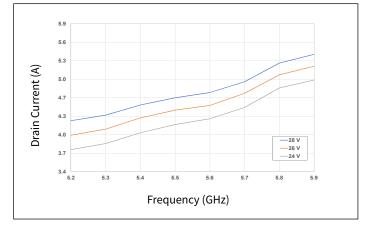


Figure 11. Drain Current vs Frequency as a Function of V<sub>D</sub>

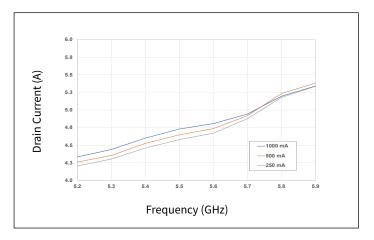


Figure 12. Drain Current vs Frequency as a Function of IDO

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Rev. 1.0, 2022-10-7



-5.2 GHz -5.55 GHz

-5.9 GHz

#### **Typical Performance of the CMPA5259050S**

Test conditions unless otherwise noted: V<sub>D</sub> = 28 V, I<sub>DQ</sub> = 500 mA, Pulse Width = 150µs, Duty Cycle = 20%, P<sub>IN</sub> = 25 dBm, T<sub>BASE</sub> = +25°C

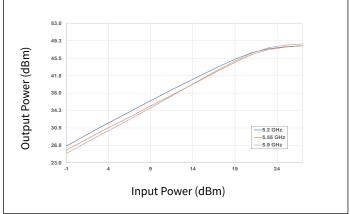
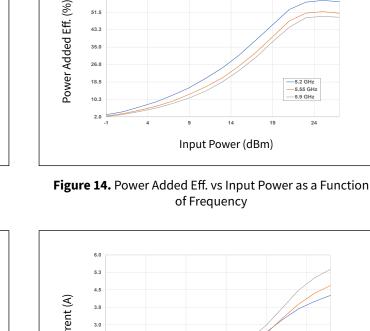


Figure 13. Output Power vs Input Power as a Function of Frequency



35.0

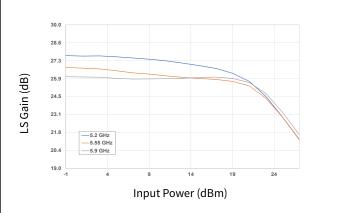
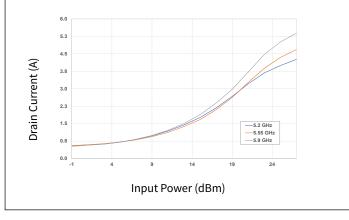


Figure 15. Large Signal Gain vs Input Power as a Function of Frequency



Input Power (dBm)

of Frequency

Figure 16. Drain Current vs Input Power as a Function of Frequency

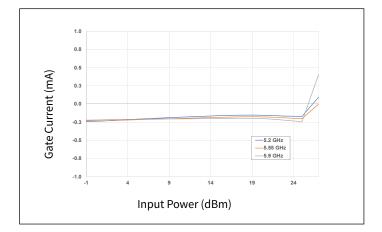


Figure 17. Gate Current vs Input Power as a Function of Frequency



Test conditions unless otherwise noted: V<sub>D</sub> = 28 V, I<sub>DQ</sub> = 500 mA, Pulse Width = 150µs, Duty Cycle = 20%, P<sub>IN</sub> = 25 dBm, T<sub>BASE</sub> = +25°C

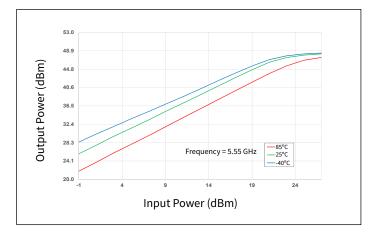


Figure 18. Output Power vs Input Power as a Function of Temperature

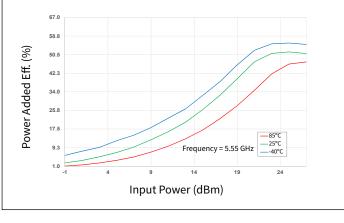


Figure 19. Power Added Eff. vs Input Power as a Function of Temperature

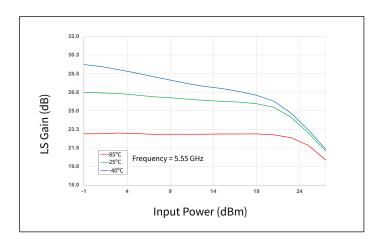


Figure 20. Large Signal Gain vs Input Power as a Function of Temperature

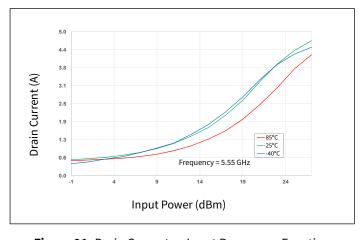


Figure 21. Drain Current vs Input Power as a Function of Temperature

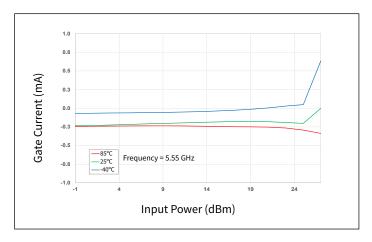


Figure 22. Gate Current vs Input Power as a Function of Temperature



Test conditions unless otherwise noted: V<sub>D</sub> = 28 V, I<sub>DQ</sub> = 500 mA, Pulse Width = 150µs, Duty Cycle = 20%, P<sub>IN</sub> = 25 dBm, T<sub>BASE</sub> = +25°C

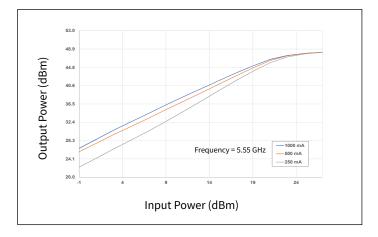


Figure 23. Output Power vs Input Power as a Function of  $I_{DQ}$ 

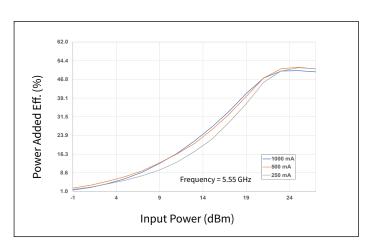


Figure 24. Power Added Eff. vs Input Power as a Function of IDQ

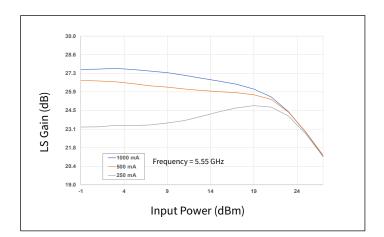


Figure 25. Large Signal Gain vs Input Power as a Function of IDO

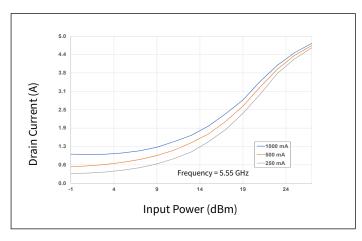


Figure 26. Drain Current vs Input Power as a Function of IDO

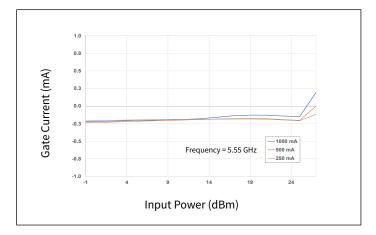
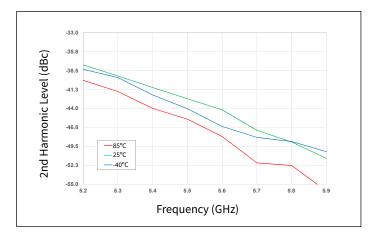


Figure 27. Gate Current vs Input Power as a Function of IDQ

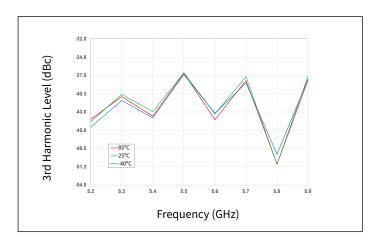
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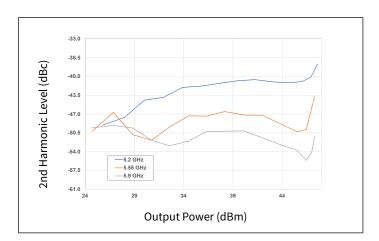
Test conditions unless otherwise noted: V<sub>D</sub> = 28 V, I<sub>DQ</sub> = 500 mA, Pulse Width = 150µs, Duty Cycle = 20%, P<sub>IN</sub> = 25 dBm, T<sub>BASE</sub> = +25°C



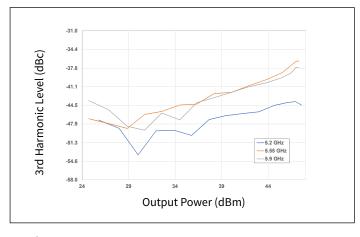
**Figure 28.** 2nd Harmonic vs Frequency as a Function of Temperature



**Figure 29.** 3rd Harmonic vs Frequency as a Function of Temperature



**Figure 30.** 2nd Harmonic vs Output Power as a Function of Frequency



**Figure 31.** 3rd Harmonic vs Output Power as a Function of Frequency

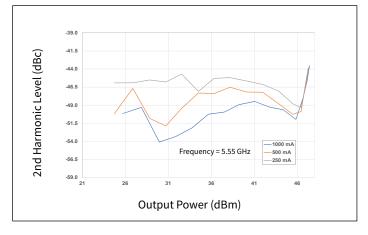


Figure 32. 2nd Harmonic vs Output Power as a Function of I<sub>DO</sub>

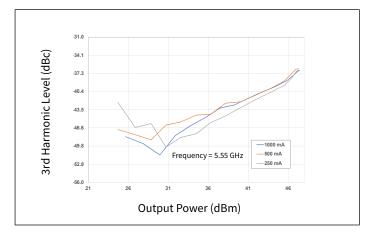


Figure 33. 3rd Harmonic vs Output Power as a Function of IDO



Test conditions unless otherwise noted:  $V_D = 28 \text{ V}$ ,  $I_{DQ} = 500 \text{ mA}$ ,  $P_{IN} = -20 \text{ dBm}$ ,  $T_{BASE} = +25 ^{\circ}\text{C}$ 

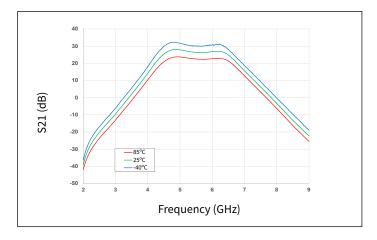


Figure 34. Gain vs Frequency as a Function of Temperature

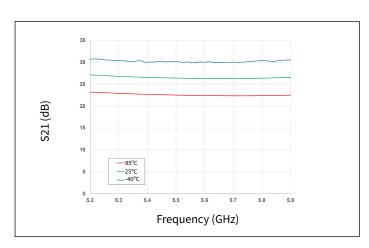


Figure 35. Gain vs Frequency as a Function of Temperature

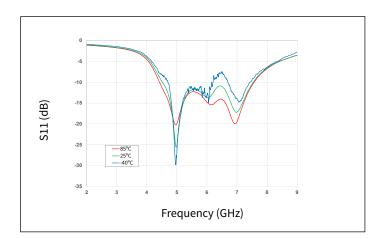


Figure 36. Input RL vs Frequency as a Function of Temperature

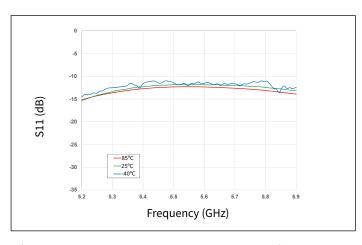


Figure 37. Input RL vs Frequency as a Function of Temperature

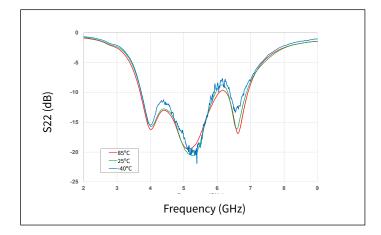


Figure 38. Output RL vs Frequency as a Function of Temperature

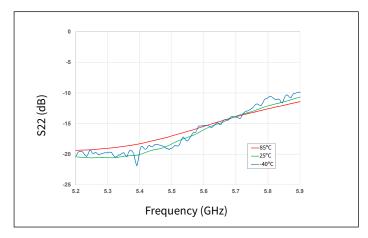


Figure 39. Output RL vs Frequency as a Function of Temperature



Test conditions unless otherwise noted:  $V_D = 28 \text{ V}$ ,  $I_{DQ} = 500 \text{ mA}$ ,  $P_{IN} = -20 \text{ dBm}$ ,  $T_{BASE} = +25 ^{\circ}\text{C}$ 

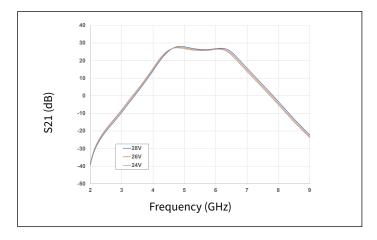


Figure 40. Gain vs Frequency as a Function of Voltage

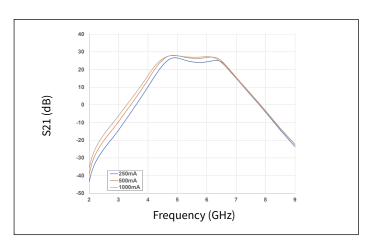


Figure 41. Gain vs Frequency as a Function of IDQ

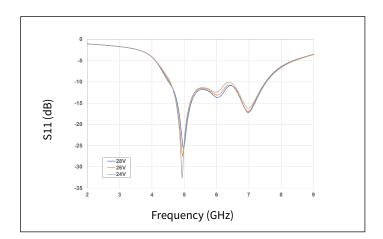


Figure 42. Input RL vs Frequency as a Function Voltage

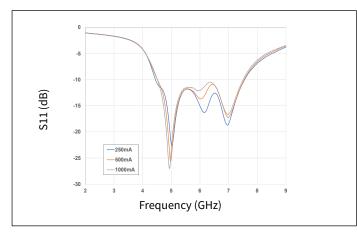


Figure 43. Input RL vs Frequency as a Function of IDO

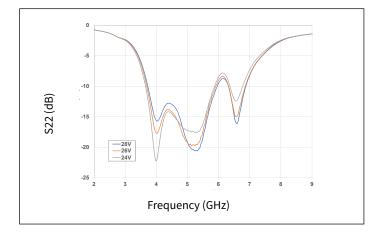


Figure 44. Output RL vs Frequency as a Function of Voltage

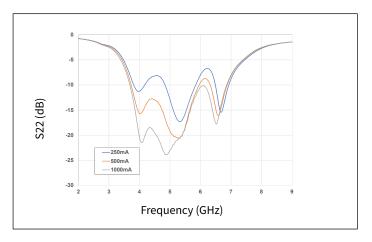
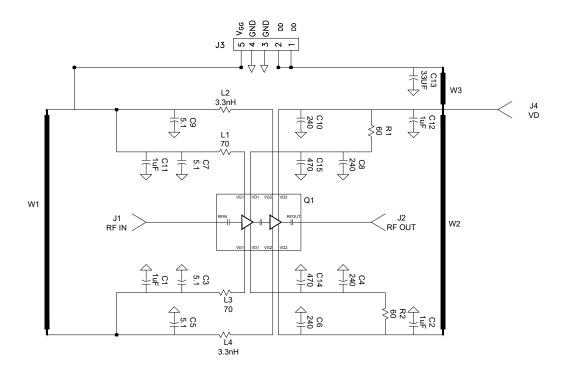


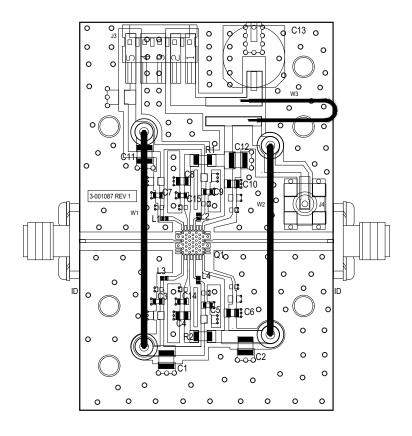
Figure 45. Output RL vs Frequency as a Function of IDQ



#### CMPA5259050S-AMP1 Demonstration Amplifier Schematic



### CMPA5259050S-AMP1 Demonstration Amplifier Circuit Outline





### CMPA5259050S-AMP1 Demonstration Amplifier Circuit Bill of Materials

| Designator       | Description  | Qty |
|------------------|--|-----|
| C13              | CAP, 33μF, 20%, G CASE   | 1   |
| C1, C2, C11, C12 | CAP, 1.0μF, 100V, 10%, X7R, 1210                               | 4   |
| C3, C5, C7, C9   | CAP, 5.1pF, +/-0.05pF, 0603, ATC, 600S                         | 4   |
| C4, C6, C8, C10  | CAP, 240pF +/-5%, 0805, ATC, 600F                              | 4   |
| C14, C15         | 470pF, NPO/COG 0603  | 2   |
| L2, L4           | INDUCTOR, SMT, 0402, 3.3nH, 5%                                 | 2   |
| L1, L3           | Ferrite bead, 70 ohm, 780mA, 0402                              | 2   |
| R1, R2           | Ferrite bead, 60 ohm, 3.7A, 18806                              | 2   |
| J1, J2           | CONN, SMA, PANEL MOUNT JACK, FLANGE, 4-HOLE, BLUNT POST, 20MIL | 2   |
| J3               | HEADER RT>PLZ .1CEN LK 5POS                                    | 1   |
| J4               | CONN, SMB, STRAIGHT JACK RECEPTACLE, SMT, 50 OHM, Au PLATED    | 1   |
| W1               | WIRE, BLACK, 20 AWG ~ 1.5"                                     | 1   |
| W2               | WIRE, BLACK, 20 AWG ~ 1.3"                                     | 3   |
| W3               | WIRE, BLACK, 20 AWG ~ 1.5"                                     | 3   |
|                  | PCB, TEST FIXTURE, RF35, 0.010", 5X5 2-STAGE, QFN              | 1   |
|                  | HEATSINK, 6X6 QFN, 3-STAGE 2.600 X 1.700 X 0.250               | 1   |
|                  | 2-56 SOC HD SCREW 3/16 SS                                      | 4   |
|                  | #2 SPLIT LOCKWASHER SS   | 4   |
| Q1               | CMPA5259050S   | 1   |

### **Electrostatic Discharge (ESD) Classifications**

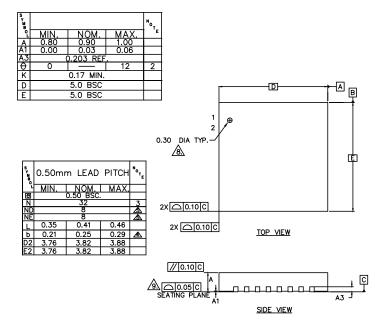
| Parameter           | Symbol | Class | Classification Level           | Test Methodology    |
|---------------------|--------|-------|--------------------------------|---------------------|
| Human Body Model    | НВМ    | 1B    | ANSI/ESDA/JEDEC JS-001 Table 3 | JEDEC JESD22 A114-D |
| Charge Device Model | CDM    | С3    | ANSI/ESDA/JEDEC JS-002 Table 3 | JEDEC JESD22 C101-C |

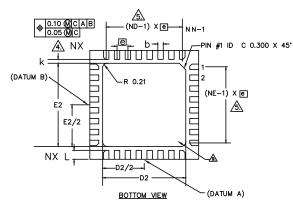
### Moisture Sensitivity Level (MSL) Classification

| Parameter                  | Symbol | Level         | Test Methodology   |
|----------------------------|--------|---------------|--------------------|
| Moisture Sensitivity Level | MSL    | 3 (168 hours) | IPC/JEDEC J-STD-20 |



#### Product Dimensions CMPA5259050S (Package 5 x 5 QFN)





#### NOTES:

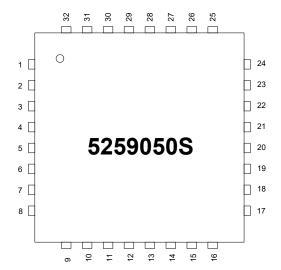
- 1. DIMENSIONING AND TOLERANCING CONFORM TO ASME Y14.5M. 1994.
  2. ALL DIMENSIONS ARE IN MILLIMETERS, 0 IS IN DEGREES.
  3. N IS THE TOTAL NUMBER OF TERMINALS.

  DIMENSION 5 APPLIES TO METALLIZED TERMINAL AND IS MEASURED BETWEEN 0.15 AND
- QUINCHISTORY OF APPLIES TO METALLEED TERMINAL AND IS MEASURED BETHELD O.TO AND
  0.30mm FROM TERMINAL TIP.
  ND AND NE REFER TO THE NUMBER OF TERMINALS ON EACH D AND E SIDE RESPECTIVELY.
  MAX. PACKAGE WARPAGE IS 0.056 mm. IN ALL DIRECTIONS.

- A PIN #1 ID ON TOP WILL BE LASER MARKED.
- 9. BILATERAL COPLANARITY ZONE APPLIES TO THE EXPOSED HEAT SINK SLUG AS WELL AS THE
- TERMINALS.

  10. THIS DRAWING CONFORMS TO JEDEC REGISTERED OUTLINE MO-220

  11. ALL PLATED SURFACES ARE 100% TIN MATTE 0.010 mm +/- 0.005 mm.



| PIN | DESC. | PIN | DESC. | PIN | DESC. |
|-----|-------|-----|-------|-----|-------|
| 1   | NC    | 15  | NC    | 29  | NC    |
| 2   | NC    | 16  | VD2A  | 30  | VD1B  |
| 3   | RFGND | 17  | NC    | 31  | NC    |
| 4   | RFIN  | 18  | NC    | 32  | VG1B  |
| 5   | RFGND | 19  | NC    |     |       |
| 6   | NC    | 20  | RFGND |     |       |
| 7   | NC    | 21  | RFOUT |     |       |
| 8   | NC    | 22  | RFGND |     |       |
| 9   | VG1A  | 23  | NC    |     |       |
| 10  | NC    | 24  | NC    |     |       |
| 11  | VD1A  | 25  | VD2B  |     |       |
| 12  | NC    | 26  | NC    |     |       |
| 13  | VG2A  | 27  | NC    |     |       |
| 14  | NC    | 28  | VG2B  |     |       |



#### **Part Number System**

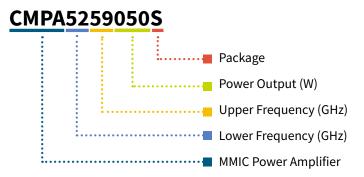


Table 1.

| Parameter       | Value         | Units |
|-----------------|---------------|-------|
| Lower Frequency | 5.0           | GHz   |
| Upper Frequency | 5.9           | GHZ   |
| Power Output    | 50            | W     |
| Package         | Surface Mount | -     |

#### Note:

Table 2.

| Character Code | Code Value                     |
|----------------|--------------------------------|
| А              | 0                              |
| В              | 1                              |
| С              | 2                              |
| D              | 3                              |
| E              | 4                              |
| F              | 5                              |
| G              | 6                              |
| Н              | 7                              |
| J              | 8                              |
| К              | 9                              |
| Examples       | 1A = 10.0 GHz<br>2H = 27.0 GHz |

<sup>&</sup>lt;sup>1</sup> Alpha characters used in frequency code indicate a value greater than 9.9 GHz. See Table 2 for value.



## **Product Ordering Information**

| Order Number      | Description                        | Unit of Measure | Image |
|-------------------|------------------------------------|-----------------|-------|
| CMPA5259050S      | GaN HEMT                           | Each            |       |
| CMPA5259050S-AMP1 | Test board with GaN MMIC installed | Each            |       |



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