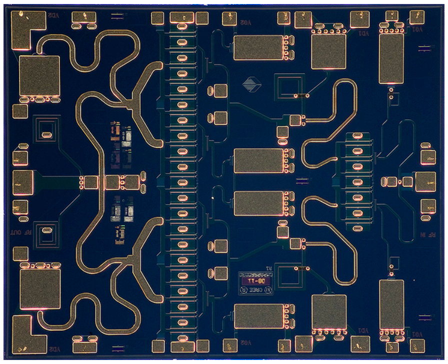
# CMPA2560025D

## 25 W, 2.5 - 6.0 GHz, GaN MMIC, Power Amplifier

### Description

Cree's CMP2560025D is a gallium nitride (GaN) High Electron Mobility Transistor (HEMT) based monolithic microwave integrated circuit (MMIC). GaN has superior properties compared to silicon or gallium arsenide, including higher breakdown voltage, higher saturated electron drift velocity and higher thermal conductivity. GaN HEMTs also offer greater power density and wider bandwidths compared to Si and GaAs transistors. This MMIC contains a two-stage reactively matched amplifier design approach enabling very wide bandwidths to be achieved.



PN: CMPA2560025D

### Typical Performance Over 2.5-6.0 GHz ($T_C = 25^\circ C$)

| Parameter | 2.5 GHz | 4.0 GHz | 6.0 GHz | Units |
|---|---|---|---|---|
| Gain | 27.5 | 24.3 | 23.1 | dB |
| Saturated Output Power, $P_{SAT}$[1] | 35.8 | 37.5 | 25.6 | W |
| Power Gain @ $P_{OUT}$ = 43 dBm | 23.1 | 20.9 | 16.3 | dB |
| PAE @ $P_{OUT}$ 43 dBm | 31.5 | 32.8 | 30.7 | % |

Note[1]: $P_{SAT}$ is defined as the RF output power where the device starts to draw positive gate current in the range of 7-13 mA

### Features

- 24 dB Small Signal Gain
- 25 W Typical $P_{SAT}$
- Operation up to 28 V
- High Breakdown Voltage
- High Temperature Operation
- Size 0.180 x 0.145 x 0.004 inches

### Applications

- Ultra Broadband Amplifiers
- Fiber Drivers
- Test Instrumentation
- EMC Amplifier Drivers

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

| Parameter | Symbol | Rating | Units |
|---|---|---|---|
| Drain-source Voltage | $V_{DSS}$ | 84 | VDC |
| Gate-source Voltage | $V_{GS}$ | -10, +2 | VDC |
| Storage Temperature | $T_{STG}$ | -65, +150 | ˚C |
| Operating Junction Temperature | $T_J$ | 225 | ˚C |
| Thermal Resistance, Junction to Case (packaged)[1] | $R_{\theta JC}$ | 2.5 | ˚C/W |
| Mounting Temperature (30 seconds) | $T_S$ | 320 | ˚C |

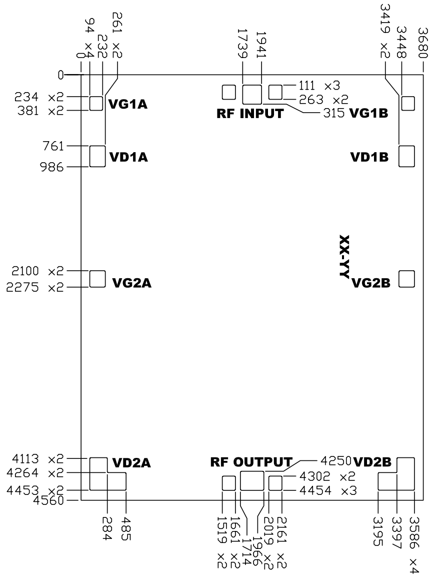
[1] Eutectic die attach using 80/20 AuSn solder mounted to a 40 mil thick CuW carrier.

## Electrical Characteristics (Frequency = 2.5 GHz to 6.0 GHz unless otherwise stated; $T_C$ = 25˚C)

| Characteristics | Symbol | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| **DC Characteristics** | | | | | | |
| Gate Threshold Voltage | $V_{(GS)TH}$ | -3.8 | -3.0 | -2.3 | V | $V_{DS}$ = 10 V, $I_D$ = 20 mA |
| Gate Quiescent Voltage | $V_{(GS)Q}$ | – | -2.7 | – | VDC | $V_{DD}$ = 26 V, $I_{DQ}$ = 1200 mA |
| Saturated Drain Current[1] | $I_{DS}$ | 8.0 | 9.7 | – | A | $V_{DS}$ = 6.0 V, $V_{GS}$ = 2.0 V |
| Drain-Source Breakdown Voltage | $V_{BD}$ | 84 | 100 | – | V | $V_{GS}$ = -8 V, $I_D$ = 20 mA |
| On Resistance | $R_{ON}$ | – | 0.35 | – | Ω | $V_{DS}$ = 0.1 V |
| Gate Forward Voltage | $V_{G\text{-}ON}$ | – | 1.9 | – | V | $I_{GS}$ = 3.6 mA |
| **RF Characteristics[2,3]** | | | | | | |
| Small Signal Gain | S21 | 21 | 25 | – | dB | $V_{DD}$ = 26 V, $I_{DQ}$ = 1200 mA |
| Power Output at 2.5 GHz | $P_{OUT1}$ | 30 | – | – | W | $V_{DD}$ = 26 V, $I_{DQ}$ = 1200 mA, $P_{IN} \leq 26$ dBm |
| Power Output at 3.0 GHz | $P_{OUT2}$ | 20 | 25 | – | W | $V_{DD}$ = 26 V, $I_{DQ}$ = 1200 mA, $P_{IN} \leq 26$ dBm |
| Power Output at 4.0 GHz | $P_{OUT3}$ | 20 | 30 | – | W | $V_{DD}$ = 26 V, $I_{DQ}$ = 1200 mA, $P_{IN} \leq 26$ dBm |
| Power Added Efficiency | PAE | – | 35 | – | % | $V_{DD}$ = 26 V, $I_{DQ}$ = 1200 mA |
| Power Gain | $G_P$ | – | 20 | – | dB | $V_{DD}$ = 26 V, $I_{DQ}$ = 1200 mA |
| Input Return Loss | S11 | – | 6 | – | dB | $V_{DD}$ = 26 V, $I_{DQ}$ = 1200 mA |
| Output Return Loss | S22 | – | 5 | – | dB | $V_{DD}$ = 26 V, $I_{DQ}$ = 1200 mA |
| Output Mismatch Stress | VSWR | – | – | 5:1 | Ψ | No damage at all phase angles, $V_{DD}$ = 26 V, $I_{DQ}$ = 1200 mA, $P_{OUT}$ = 25W CW |

Notes:
[1] Scaled from PCM data
[2] All data pulse tested on-wafer with Pulse Width = 10 µs, Duty Cycle = 1%
[3] Data measured into an output load with a 15 dB maximum return loss

## DIE Dimensions (units in microns)



Overall die size 3680 x 4560 (+0/-50) microns, die thickness 100 (+/-10) microns.
All Gate and Drain pads must be wire bonded for electrical connection.

| Pad Number | Function | Description | Pad Size (microns) | Note |
|---|---|---|---|---|
| 1 | RF-IN | RF-Input pad. Matched to 50 ohm. Requires external blocking capacitor. | 202 X 204 | 3 |
| 2 | VG1_A | Gate control for stage 1. $V_G$ -1.5 - 2.5 V. | 138 x 147 | 1, 2 |
| 3 | VG1_B | Gate control for stage 1. $V_G$ -1.5 - 2.5 V. | 138 x 147 | 1, 2 |
| 4 | VD1_A | Drain supply for stage 1. $V_D$ = 26 V. | 167 x 225 | 1 |
| 5 | VD1_B | Drain supply for stage 1. $V_D$ = 26 V. | 167 x 225 | 1 |
| 6 | VG2_A | Gate control for stage 2A. $V_G$ -1.5 - 2.5 V. | 167 x 175 | 1 |
| 7 | VG2_B | Gate control for stage 2B. $V_G$ -1.5 - 2.5 V. | 167 x 175 | 1 |
| 8 | VD2_A | Drain supply for stage 2A. $V_D$ = 26 V. | A | 1 |
| 9 | VD2_B | Drain supply for stage 2B. $V_D$ = 26 V. | A | 1 |
| 10 | RF-Out | This pad is DC blocked internally. The DC impedance ~ 0 ohm due output matching circuit. Requires external matching circuit for optimal performance for f >4.0 GHz. | 252 x 204 | 3 |

Notes:

[1] Attach bypass capacitor to port 2-9 per application circuit

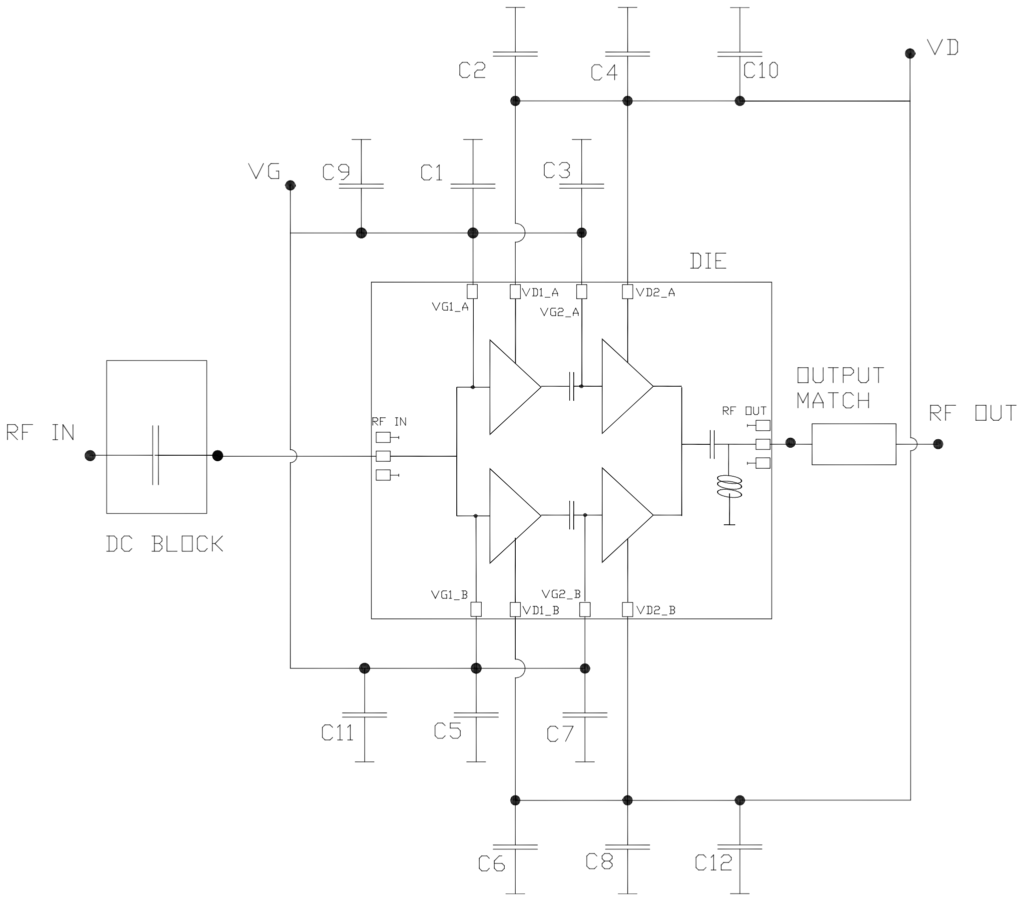
[2] VG1_A and VG1_B is connected internally so it would be enough to connect either one for proper operation

[3] The RF Input and Output pad have a ground-signal-ground with a pitch of 10 mil (250 um)

## Assembly Notes:

- Recommended solder is AuSn (80/20) solder. Refer to Cree’s website for the Eutectic Die Bond Procedure application note at www.cree.com/rf/document-library
- Vacuum collet is the preferred method of pick-up
- The backside of the die is the Source (ground) contact
- Die back side gold plating is 5 microns thick minimum
- Thermosonic ball or wedge bonding are the preferred connection methods
- Gold wire must be used for connections
- Use the die label (XX-YY) for correct orientation

## Block Diagram Showing Additional Capacitors for Operation Over 2.5 to 6.0 GHz



| Designator | Description | Quantity |
|---|---|---|
| C1,C2,C3,C4,C5,C6,C7,C8 | CAP, 120pF, +/-10%, SINGLE LAYER, 0.030”, Er 3300, 100V, Ni/Au TERMINATION | 8 |
| C9,C10,C11,C12 | CAP, 680pF, +/-10%, SINGLE LAYER, 0.070”, Er 3300, 100V, Ni/Au TERMINATION | 4 |

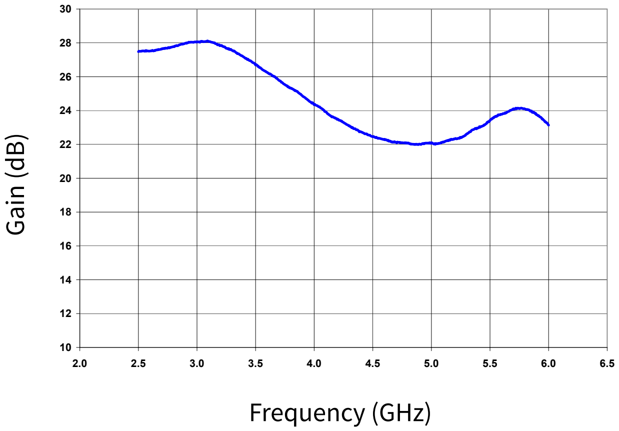
Notes:

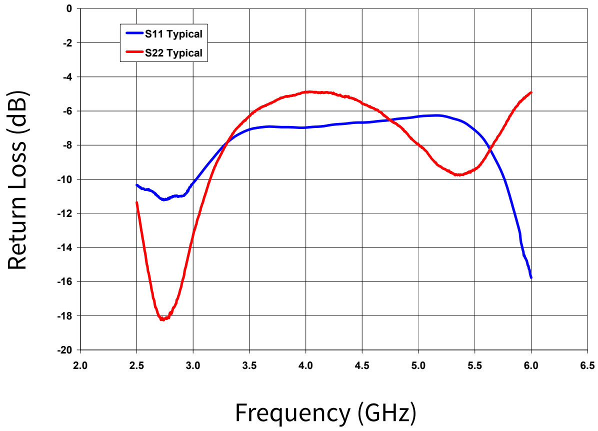
[1] An additional microstripline of 31 ohm impedance and electrical length of 72° at 6.0 GHz at the output of the MMIC is required to optimize overall performance in the 2.5 to 6.0 GHz frequency band

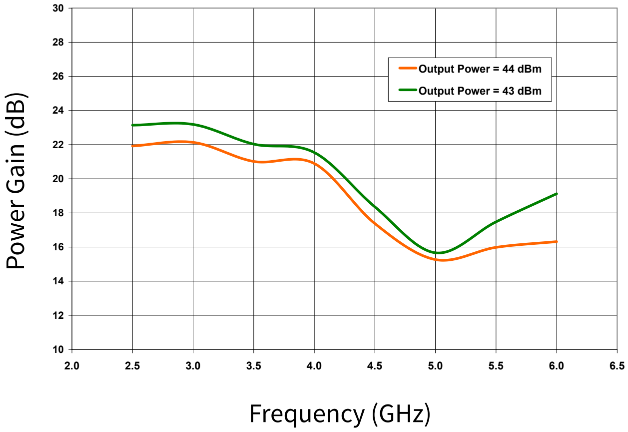
[2] The input, output and decoupling capacitors should be attached as close as possible to the die- typical distance is 5 to 10 mils with a maximum of 15 mils

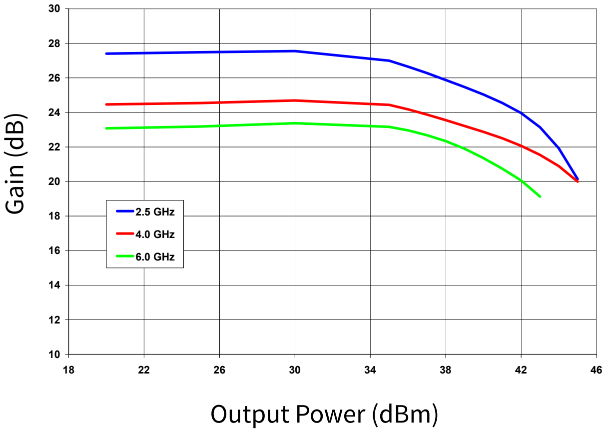
[3] The MMIC die and capacitors should be connected with 2 mil gold bond wires

## Typical Performance of the CMPA2560025D as Measured in CMPA2560025F-AMP


Small Signal Gain vs Frequency

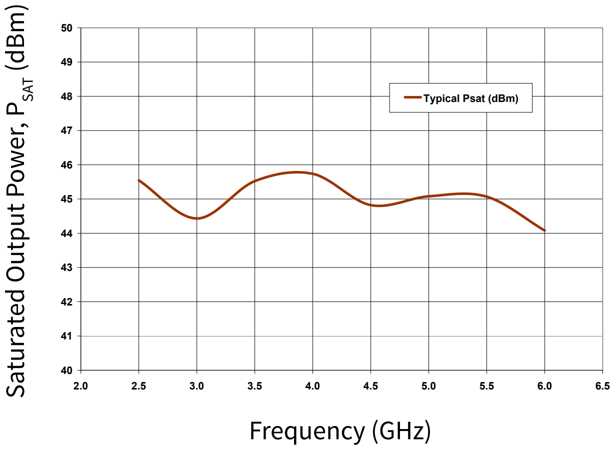

Input & Output Return Losses vs Frequency


Power Gain vs Frequency


Gain vs Output Power as a Function of Frequency

## Typical Performance of the CMPA2560025D as Measured in CMPA2560025F-AMP

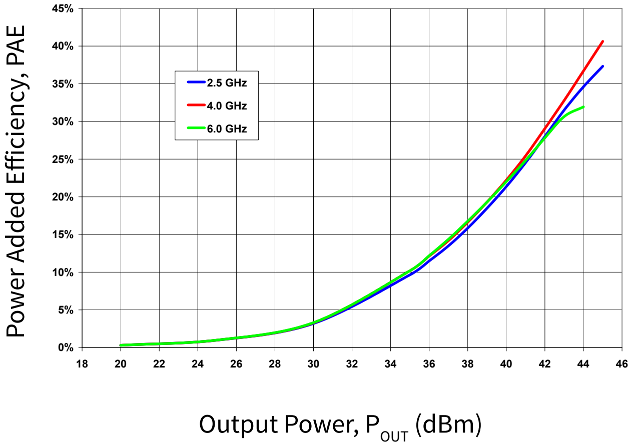
### Saturated Output Power Performance ($P_{SAT}$) vs Frequency



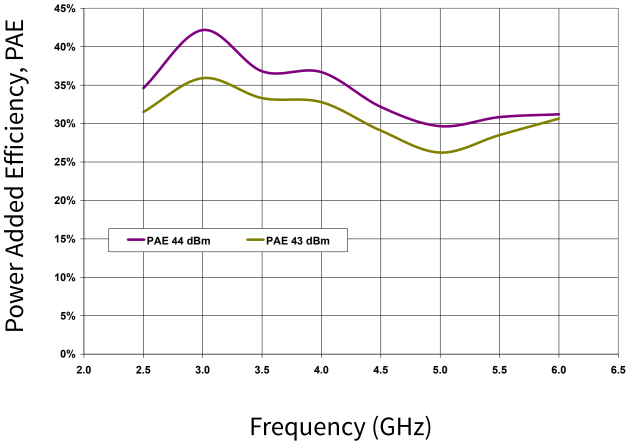
| Frequency (GHz) | $P_{SAT}$ (dBm) | $P_{SAT}$ (W) |
|---|---|---|
| 2.5 | 45.54 | 35.8 |
| 3.0 | 44.43 | 27.7 |
| 3.5 | 45.52 | 35.7 |
| 4.0 | 45.74 | 37.5 |
| 4.5 | 44.82 | 30.4 |
| 5.0 | 45.08 | 32.2 |
| 5.5 | 45.07 | 32.1 |
| 6.0 | 44.08 | 25.6 |

Notes: $P_{SAT}$ is defined as the RF output power where the device starts to draw positive gate current in the range of 7-13 mA

### Power Added Efficiency vs Output Power as a Function of Frequency

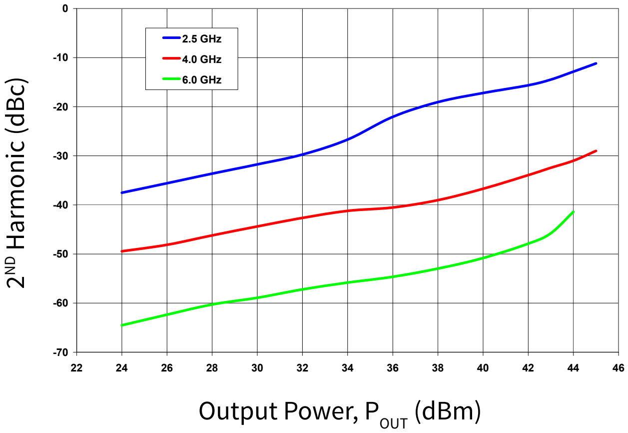


### PAE at 43 dBm and 44 dBm Output Power vs Frequency

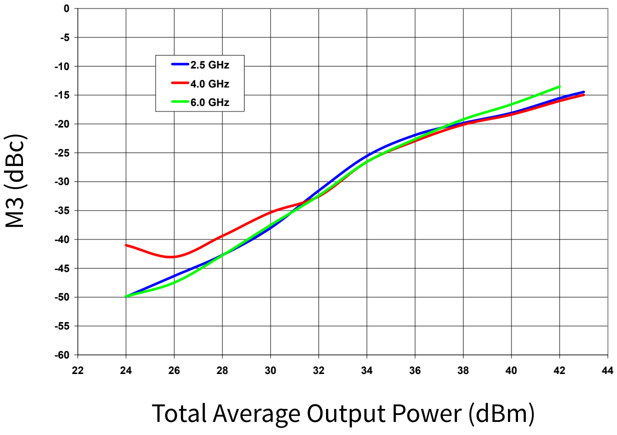


## Typical Performance of the CMPA2560025D as Measured in CMPA2560025F-AMP

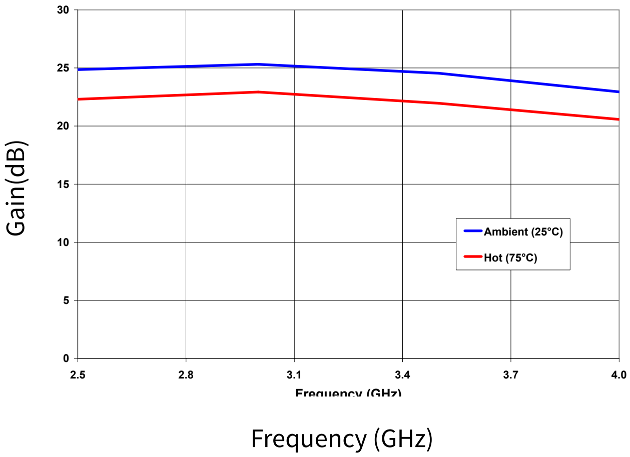
**$2^{ND}$ Harmonic vs Output Power as a Function of Frequency**



**IM3 vs Total Average Power as a Function of Frequency**

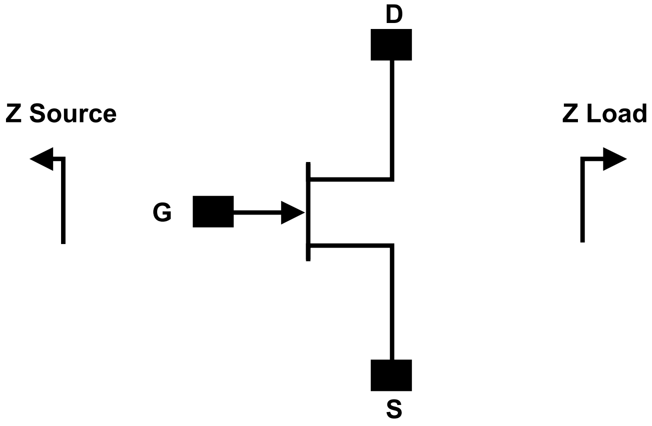


**Gain at $P_{OUT}$ of 40 dBm at 25°C & 75°C vs Frequency**



Notes: The temperature coefficient is -0.05 dB/°C

## Source and Load Impedances



| Frequency (MHz) | Z Source | Z Load |
|---|---|---|
| 2500 | 50 + j0 | 36.2 - j15.4 |
| 3000 | 50 + j0 | 32.7 – j15.4 |
| 3500 | 50 + j0 | 29.6 - j14.7 |
| 4000 | 50 + j0 | 27.0 - j13.8 |
| 4500 | 50 + j0 | 24.8 - j12.1 |
| 5000 | 50 + j0 | 23.0 - j10.4 |
| 5500 | 50 + j0 | 21.6 - j8.6 |
| 6000 | 50 + j0 | 20.6 - j6.7 |

Note 1. $V_{DD}$ = 26V, $I_{DQ}$ = 1200mA in the 780019 package
Note 2. Optimized for $P_{SAT}$
Note 3. The quoted impedances are those presented to the die by the CMPA2560025F-AMP demonstration amplifier, fully de-embedded to the die bond pad reference plane

## Electrostatic Discharge (ESD) Classifications

| Parameter | Symbol | Class | Test Methodology |
|---|---|---|---|
| Human Body Model | HBM | 1A (> 250 V) | JEDEC JESD22 A114-D |
| Charge Device Model | CDM | II (200 < 500V) | JEDEC JESD22 C101-C |

## Part Number System

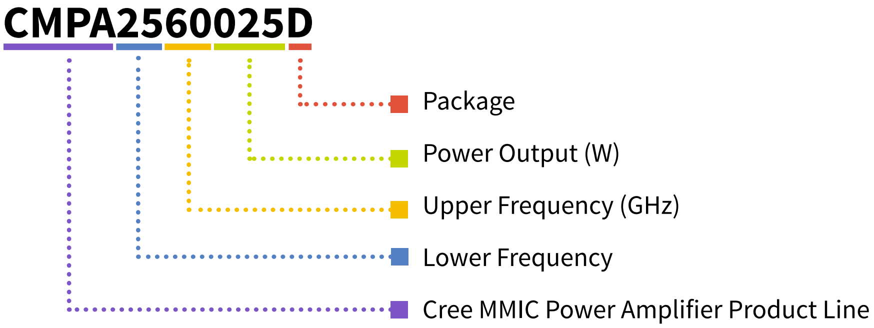


**Table 1.**

| Parameter | Value | Units |
|---|---|---|
| Lower Frequency | 5.5 | GHz |
| Upper Frequency[1] | 8.5 | GHz |
| Power Output | 30 | W |
| Package | Bare Die | - |

**Note[1]:** Alpha characters used in frequency code indicate a value greater than 9.9 GHz. See Table 2 for value.

**Table 2.**

| Character Code | Code Value |
|---|---|
| A | 0 |
| B | 1 |
| C | 2 |
| D | 3 |
| E | 4 |
| F | 5 |
| G | 6 |
| H | 7 |
| J | 8 |
| K | 9 |
| Examples: | 1A = 10.0 GHz<br>2H = 27.0 GHz |

## Product Ordering Information

| Order Number | Description | Unit of Measure |
|---|---|---|
| CMPA2560025D | GaN HEMT | Each |

For more information, please contact:

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## Notes

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