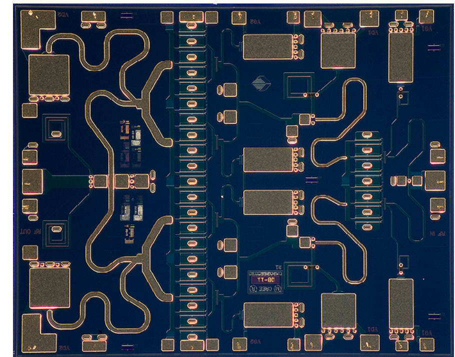
CMPA2560025D

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



PN: CMPA2560025D

Description

Wolfspeed's CMPA2560025D 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.

Typical Performance Over 2.5-6.0 GHz (T_C = 25°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: 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	V_{DC}
Gate-source Voltage	V_{GS}	-10, +2	
Storage Temperature	T_{STG}	-65, +150	°C
Operating Junction Temperature	T_J	225	
Thermal Resistance, Junction to Case (packaged)[1]	$R_{\theta JC}$	2.5	°C/W
Mounting Temperature (30 seconds)	T_S	320	°C

Note:
[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	–	V_{DC}	V_{DD} = 26 V, I_{DQ} = 1200 mA
Saturated Drain Current	I_{DS}	8.0	9.7	–	A	V_{DS} = 6.0 V, V_{GS} = 2.0 V
Drain-Source Breakdown Voltage	V_{BR}	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						
Small Signal Gain	S21	21	25	–	dB	V_{DD} = 26 V, I_{DQ} = 1200 mA
Power Output at 2.5 GHz	P_{OUT}	30	–	–	W	V_{DD} = 26 V, I_{DQ} = 1200 mA, $P_{IN} \leq$ 26 dBm,
Power Output at 3.0 GHz		20	25	–		
Power Output at 4.0 GHz			30	–		
Power Added Efficiency	PAE	–	35	–	%	V_{DD} = 26 V, I_{DQ} = 1200 mA
Power Gain	G_P	–	20	–	dB	
Input Return Loss	S11	–	6	–		
Output Return Loss	S22	–	5	–		
Output Mismatch Stress	VSWR	–	–	5:1	Ψ	No damage at all phase angles, V_{DD} = 26 V, I_{DQ} = 1200 mA, P_{OUT} = 25 W CW

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

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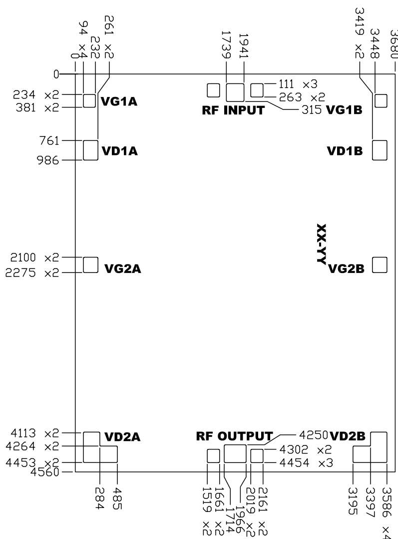
DIE Dimensions (units in microns)



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			
4	VD1_A	Drain supply for stage 1. V_D = 26 V.	167 x 225	1
5	VD1_B			
6	VG2_A	Gate control for stage 2A. V_G -1.5 - 2.5 V.	167 x 175	
7	VG2_B	Gate control for stage 2B. V_G -1.5 - 2.5 V.		
8	VD2_A	Drain supply for stage 2A. V_D = 26 V.	A	
9	VD2_B	Drain supply for stage 2B. V_D = 26 V.		
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 Wolfspeed's website for the Eutectic Die Bond Procedure application note at www.wolfspeed.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

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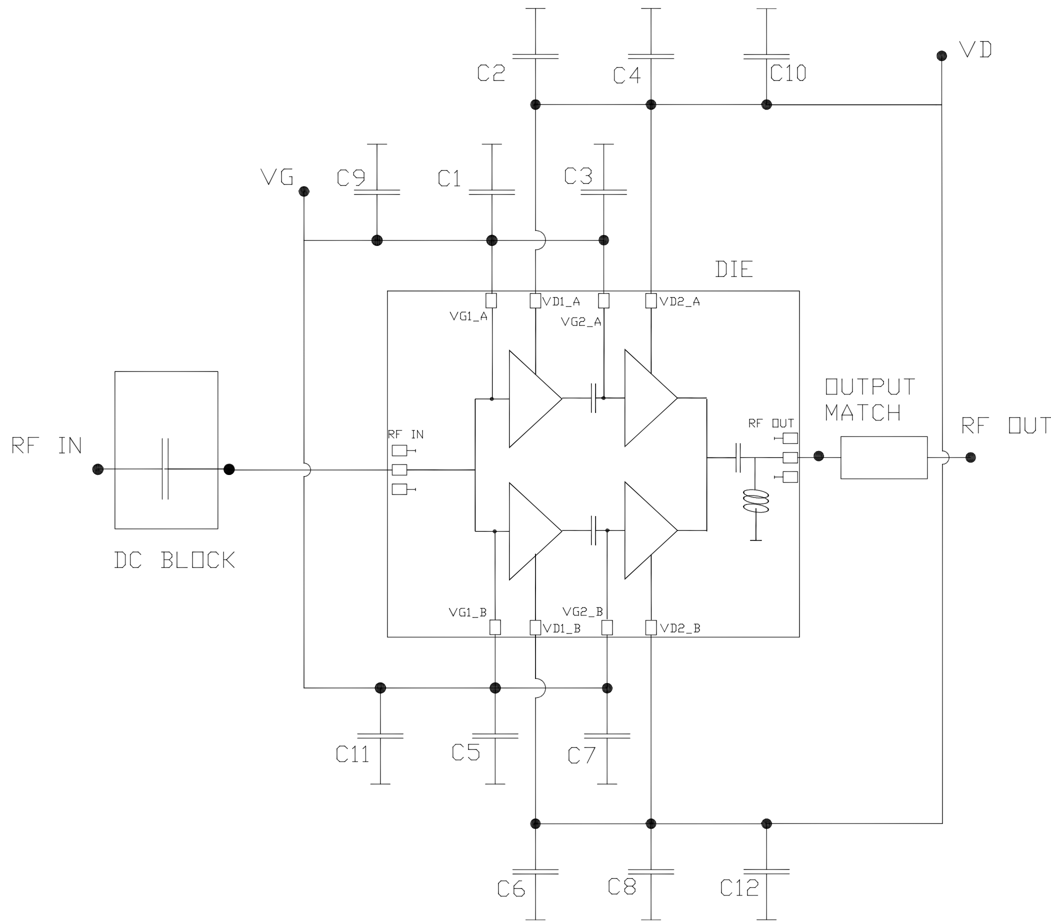
Block Diagram Showing Additional Capacitors for Operation Over 2.5 to 6.0 GHz



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

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Typical Performance of the CMPA2560025D as Measured in CMPA2560025F-AMP

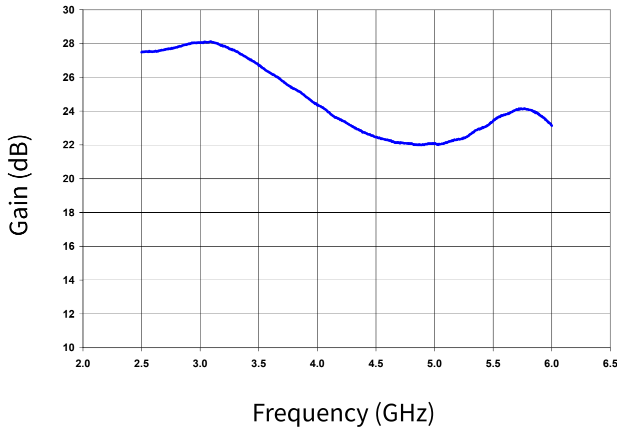

Figure 1. Small Signal Gain vs Frequency

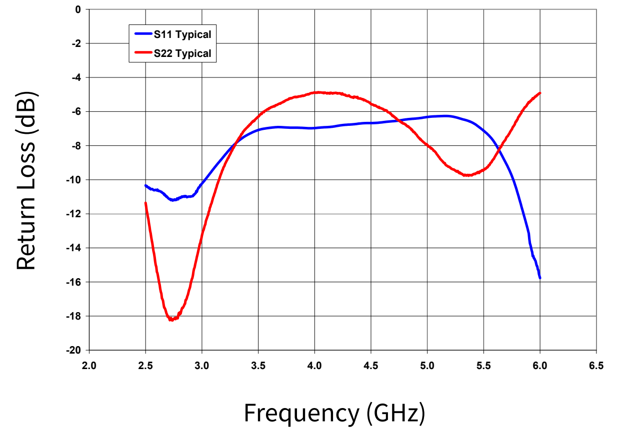

Figure 2. Input & Output Return Losses vs Frequency

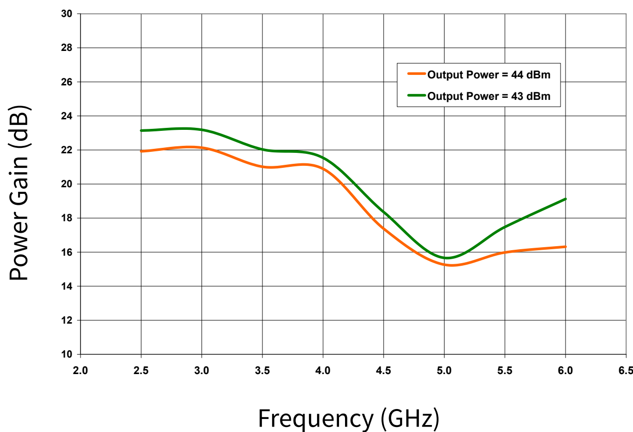

Figure 3. Power Gain vs Frequency

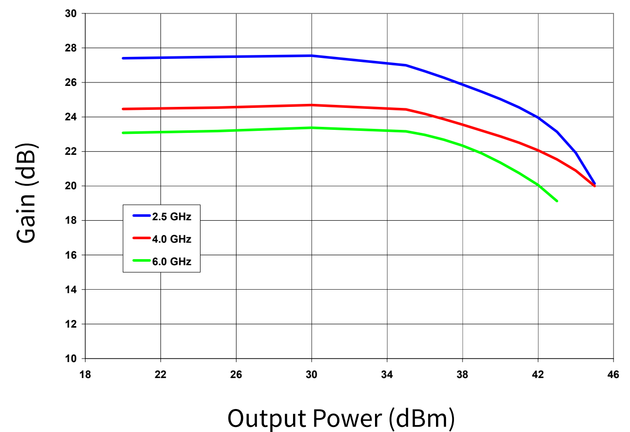

Figure 4. Gain vs Output Power as a Function of Frequency

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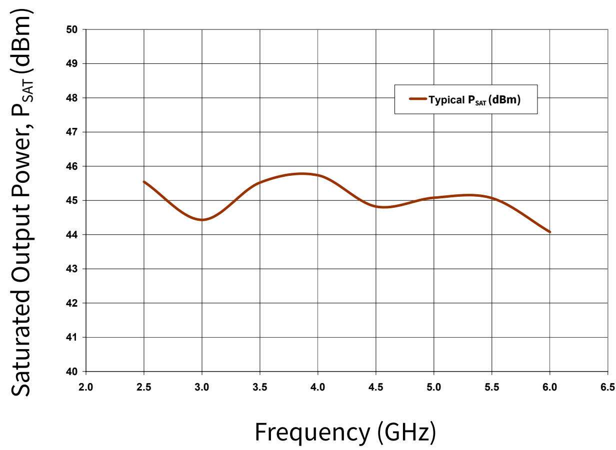
Typical Performance of the CMPA2560025D as Measured in CMPA2560025F-AMP



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

Figure 5. Saturated Output Power Performance (P_{SAT}) vs Frequency

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

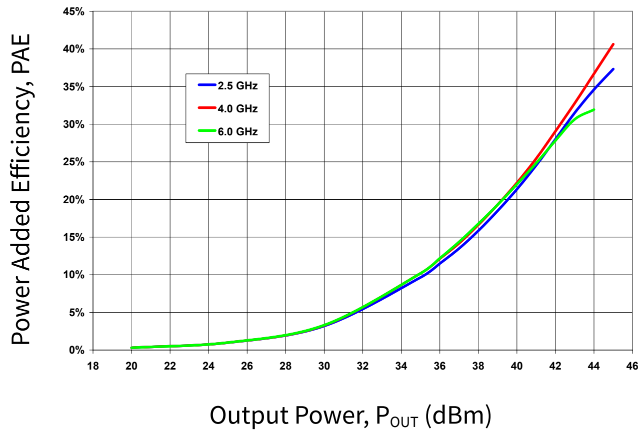


Figure 6. Power Added Efficiency vs Output Power as a Function of Frequency

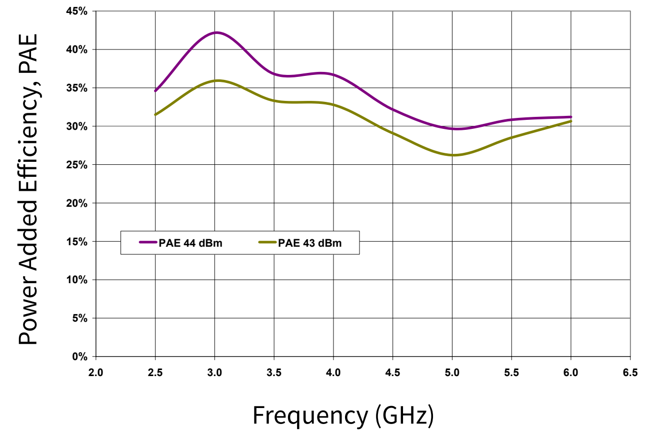


Figure 7. PAE at 43 dBm and 44 dBm Output Power vs Frequency

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Typical Performance of the CMPA2560025D as Measured in CMPA2560025F-AMP

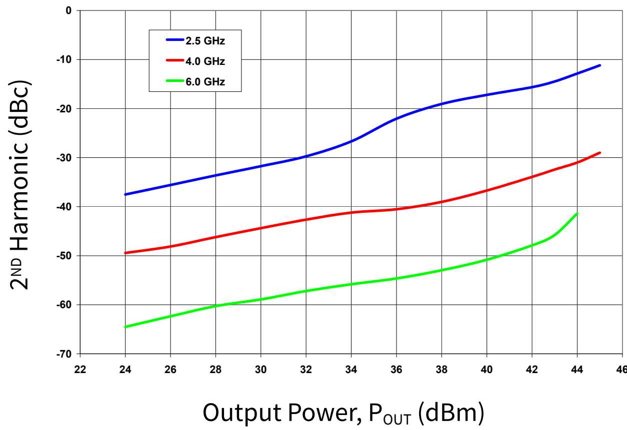

Figure 8. 2ND Harmonic vs Output Power as a Function of Frequency

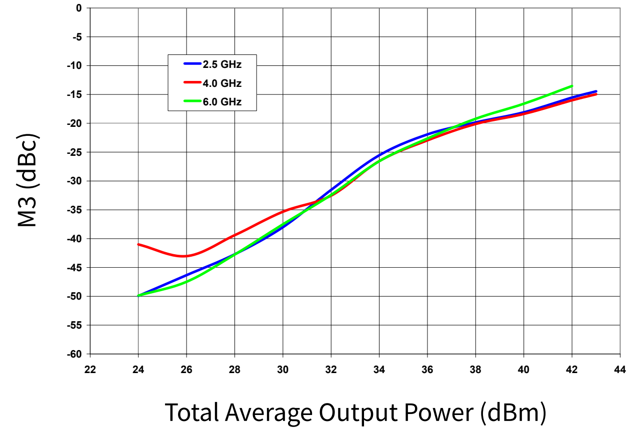

Figure 9. IM3 vs Total Average Power as a Function of Frequency

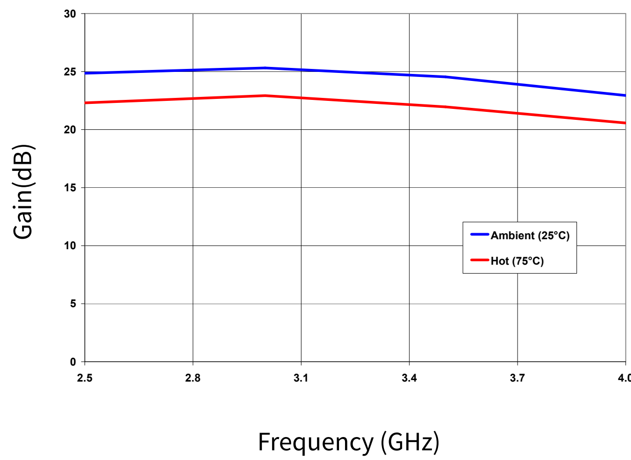

Figure 10. Gain at P_{OUT} of 40 dBm at 25°C & 75°C vs Frequency

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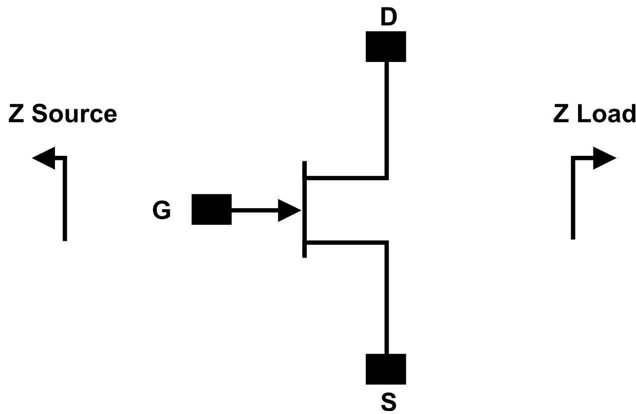
Source and Load Impedances



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

Notes
[1] V_{DD} = 26V, I_{DQ} = 1200mA in the 780019 package
[2] Optimized for P_{SAT}
[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	Classification Level	Test Methodology
Human Body Model	HBM	TBD	ANSI/ESDA/JEDEC JS-001 Table 3	JEDEC JESD22 A114-D

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Part Number System

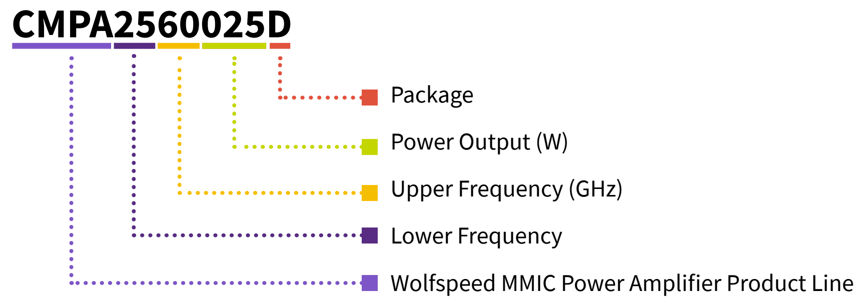

Table 1.

Parameter	Value	Units
Lower Frequency	5.5	GHz
Upper Frequency[1]	8.5	
Power Output	25	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 2H = 27.0 GHz

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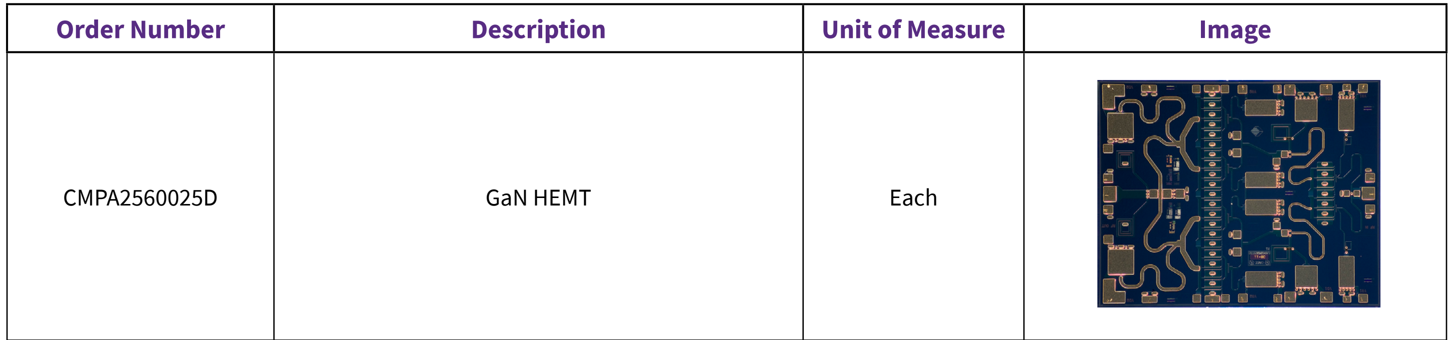
Product Ordering Information

Order Number	Description	Unit of Measure	Image
CMPA2560025D	GaN HEMT	Each	

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