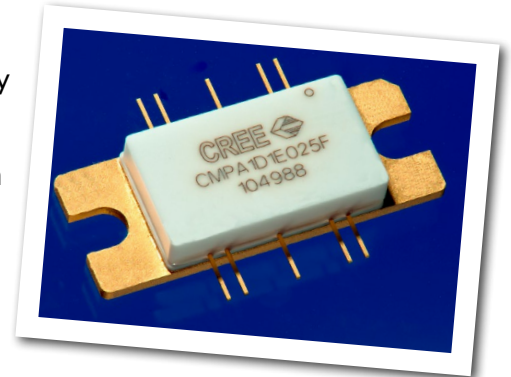


# CPA1D1E025F

## 25 W, 13.75 - 14.5 GHz, 40 V, Ku-Band GaN MMIC, Power Amplifier

Cree's CPA1D1E025F is a gallium nitride (GaN) High Electron Mobility Transistor (HEMT) based monolithic microwave integrated circuit (MMIC) on a silicon carbide substrate, using a 0.25  $\mu\text{m}$  gate length fabrication process. The Ku Band 25W MMIC is targeted for commercial Ku Band applications. It offers high gain and superior efficiency while meets OQPSK linearity required for Satcom applications at 3dB backed off Psat operations. This Ku Band MMIC is available in a 10 lead, 25 mm x 9.9 mm metal/ceramic flanged package.



### Typical Performance Over 13.75-14.5 GHz ( $T_c = 25^\circ\text{C}$ )

Parameter	13.75 GHz	14.0 GHz	14.25 GHz	14.5 GHz	Units
Small Signal Gain	26	27	27	26	dB
Linear Output Power	19	19	20	18	W
Power Gain	19.5	18.6	17.1	16.7	dB
Power Added Efficiency	18	18	17	16	%

Note<sup>1</sup>: Measured at -30 dBc, 1.6 MHz from carrier, in the CPA1D1E025F-TB under OQPSK modulation, 1.6 Msps, PN23, Alpha Filter = 0.2.

### Features

- 26 dB Small Signal Gain
- 40 W Typical Pulsed  $P_{SAT}$
- Operation up to 40 V
- $P_{AVE} = 42$  dBm, linear power under OQPSK
- Class A/B high gain, high efficiency 50 ohm MMIC Ku Band high power amplifier

### Applications

- Satellite Communications Uplink

## Absolute Maximum Ratings (not simultaneous)

Parameter	Symbol	Rating	Units	Conditions
Drain-source Voltage	$V_{DSS}$	84	$V_{DC}$	25°C
Gate-source Voltage	$V_{GS}$	-10, +2	$V_{DC}$	25°C
Power Dissipation	$P_{DISS}$	94	W	
Storage Temperature	$T_{STG}$	-55, +150	°C	
Operating Junction Temperature	$T_J$	225	°C	
Maximum Forward Gate Current	$I_{GMAX}$	10	mA	25°C
Soldering Temperature <sup>1</sup>	$T_S$	245	°C	
Screw Torque	$\tau$	40	in-oz	
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.5	°C/W	$P_{DISS} = 94 \text{ W}, 85^\circ\text{C}$
Case Operating Temperature	$T_C$	-40, +85	°C	CW, $P_{DISS} = 94 \text{ W}$

Note:

<sup>1</sup> Refer to the Application Note on soldering at [www.cree.com/products/wireless\\_appnotes.asp](http://www.cree.com/products/wireless_appnotes.asp)

## Electrical Characteristics (Frequency = 13.75 GHz to 14.5 GHz unless otherwise stated; $T_C = 25^\circ\text{C}$ )

Characteristics	Symbol	Min.	Typ.	Max.	Units	Conditions
<b>DC Characteristics<sup>1</sup></b>						
Gate Threshold	$V_{GS(TH)}$	-3.8	-3.0	-2.3	V	$V_{DS} = 10 \text{ V}, I_D = 18.2 \text{ mA}$
Gate Quiescent Voltage	$V_Q$	-	-2.7	-	V	$V_{DS} = 40 \text{ V}, I_D = 240 \text{ mA}$
Saturated Drain Current <sup>2</sup>	$I_{DS}$	14.6	16.4	-	A	$V_{DS} = 6.0 \text{ V}, V_{GS} = 2.0 \text{ V}$
Drain-Source Breakdown Voltage	$V_{BD}$	84	100	-	V	$V_{GS} = -8 \text{ V}, I_D = 18.2 \text{ mA}$
<b>RF Characteristics<sup>3</sup></b>						
Small Signal Gain	S21	-	26	-	dB	$V_{DD} = 40 \text{ V}, I_{DQ} = 240 \text{ mA}, P_{IN} = -20 \text{ dBm}$
Input Return Loss	S11	-	-8	-	dB	$V_{DD} = 40 \text{ V}, I_{DQ} = 240 \text{ mA}, P_{IN} = -20 \text{ dBm}$
Output Return Loss	S22	-	-10	-	dB	$V_{DD} = 40 \text{ V}, I_{DQ} = 240 \text{ mA}, P_{IN} = -20 \text{ dBm}$
Output Mismatch Stress	VSWR	-	-	5:1	$\Psi$	No damage at all phase angles, $V_{DD} = 40 \text{ V}, I_{DQ} = 240 \text{ mA}, P_{OUT} = 41 \text{ dBm OQPSK}$

Notes:

<sup>1</sup> Measured on-wafer prior to packaging.

<sup>2</sup> Scaled from PCM data.

<sup>3</sup> Measured in the CMPA1D1E025F-TB.

## Electrical Characteristics Continued... ( $T_c = 25^\circ\text{C}$ )

Characteristics	Symbol	Min.	Typ.	Max.	Units	Conditions
<b>RF Characteristics<sup>1,2,3,4</sup></b>						
Power Added Efficiency	PAE1	-	16.0	-	%	$V_{DD} = 40\text{ V}$ , $I_{DQ} = 240\text{ mA}$ , Frequency = 13.75 GHz
Power Added Efficiency	PAE2	-	14.0	-	%	$V_{DD} = 40\text{ V}$ , $I_{DQ} = 240\text{ mA}$ , Frequency = 14.5 GHz
Power Gain	$G_{p1}$	-	21.5	-	dB	$V_{DD} = 40\text{ V}$ , $I_{DQ} = 240\text{ mA}$ , Frequency = 13.75 GHz
Power Gain	$G_{p2}$	-	19.0	-	dB	$V_{DD} = 40\text{ V}$ , $I_{DQ} = 240\text{ mA}$ , Frequency = 14.5 GHz
OQPSK Linearity	ACLR1	-	-38	-	dBc	$V_{DD} = 40\text{ V}$ , $I_{DQ} = 240\text{ mA}$ , Frequency = 13.75 GHz
OQPSK Linearity	ACLR2	-	-37	-	dBc	$V_{DD} = 40\text{ V}$ , $I_{DQ} = 240\text{ mA}$ , Frequency = 14.5 GHz

### Notes:

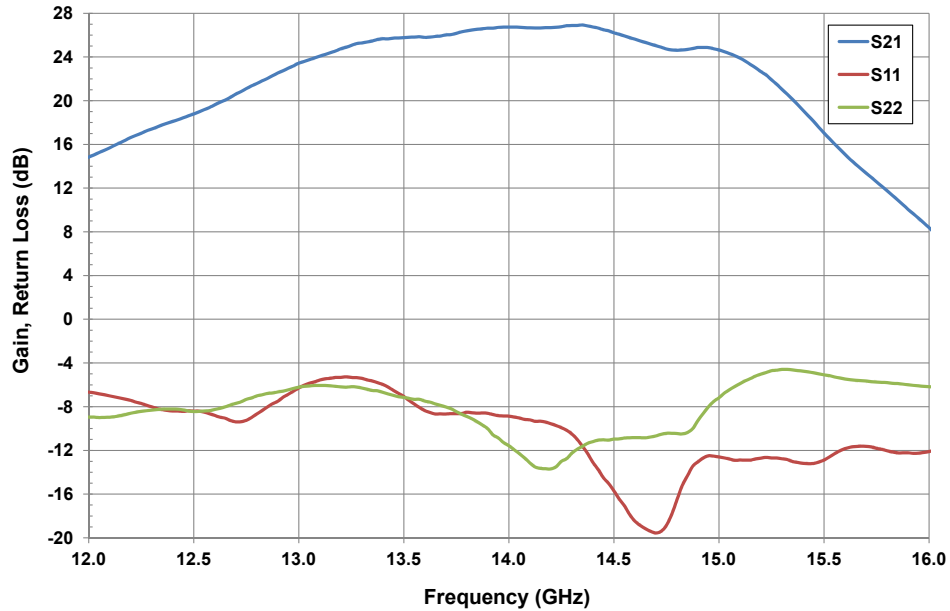
- <sup>1</sup> Measured in the CMPA1D1E025F-TB.
- <sup>2</sup> Under OQPSK modulated signal, 1.6 Msps, PN23, Alpha Filter = 0.2.
- <sup>3</sup> Measured at  $P_{AVE} = 41\text{ dBm}$ .
- <sup>4</sup> Fixture loss de-embedded.

## Electrostatic Discharge (ESD) Classifications

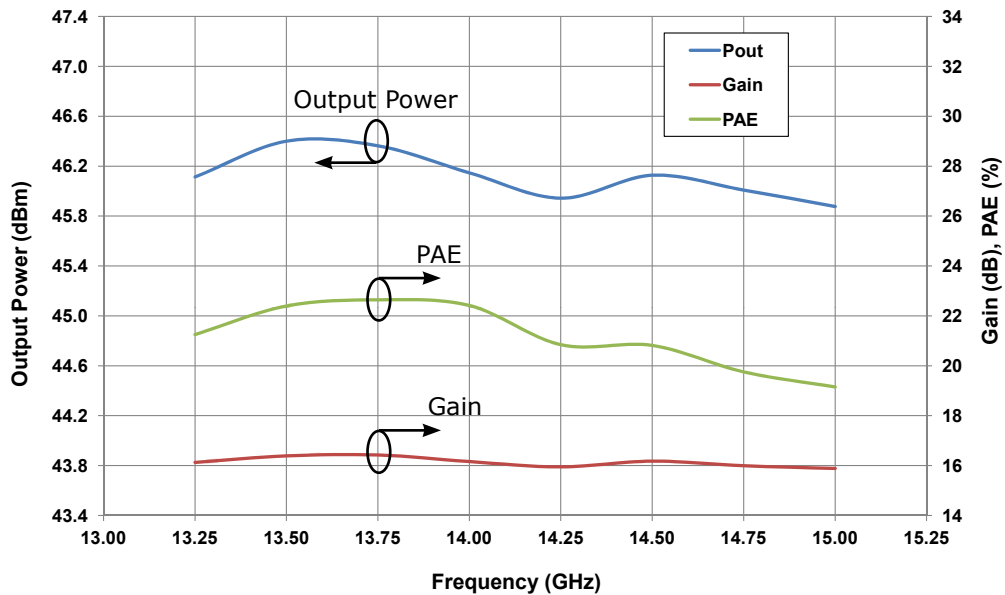
Parameter	Symbol	Class	Test Methodology
Human Body Model	HBM	1A (> 250 V)	JEDEC JESD22 A114-D
Charge Device Model	CDM	II (200 < 500 V)	JEDEC JESD22 C101-C

## Typical Performance

**Figure 1. - Small Signal S-parameters  
CMPA1D1E025F in Test Fixture**  
 $V_{DD} = 40V, I_{DQ} = 240\text{ mA}, T_{case} = 25^{\circ}C$

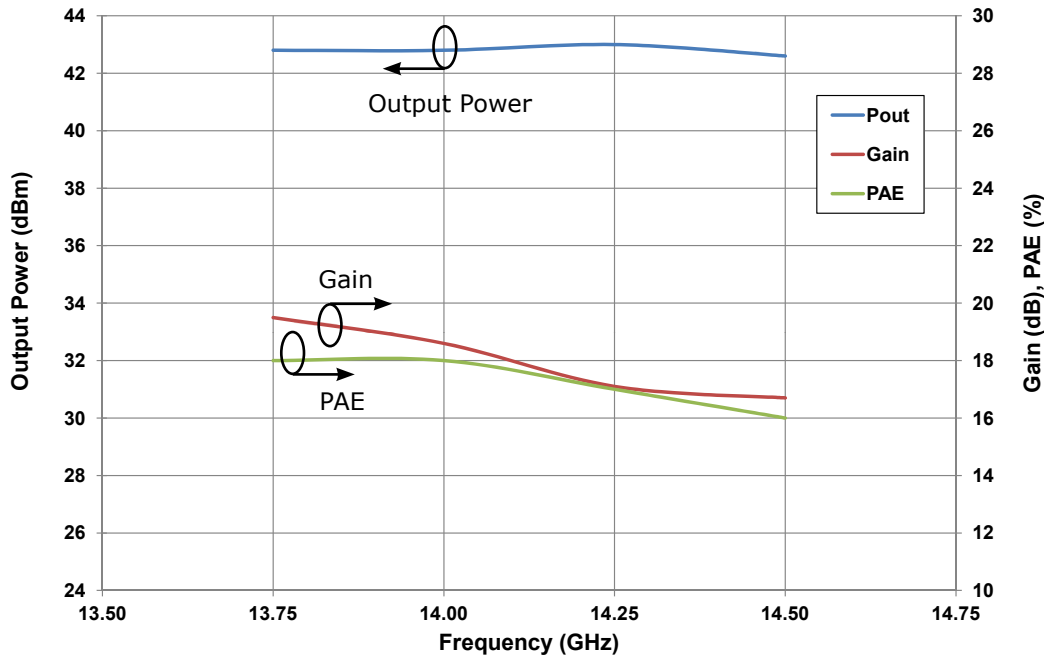


**Figure 2. - CMPA1D1E025F Pulsed @  $P_{IN} = 30\text{ dBm}$   
10% duty, 100  $\mu$ S pulse width**  
 $V_{DD} = 40\text{ V}, I_{DQ} = 240\text{ mA}, T_{case} = 25^{\circ}C$

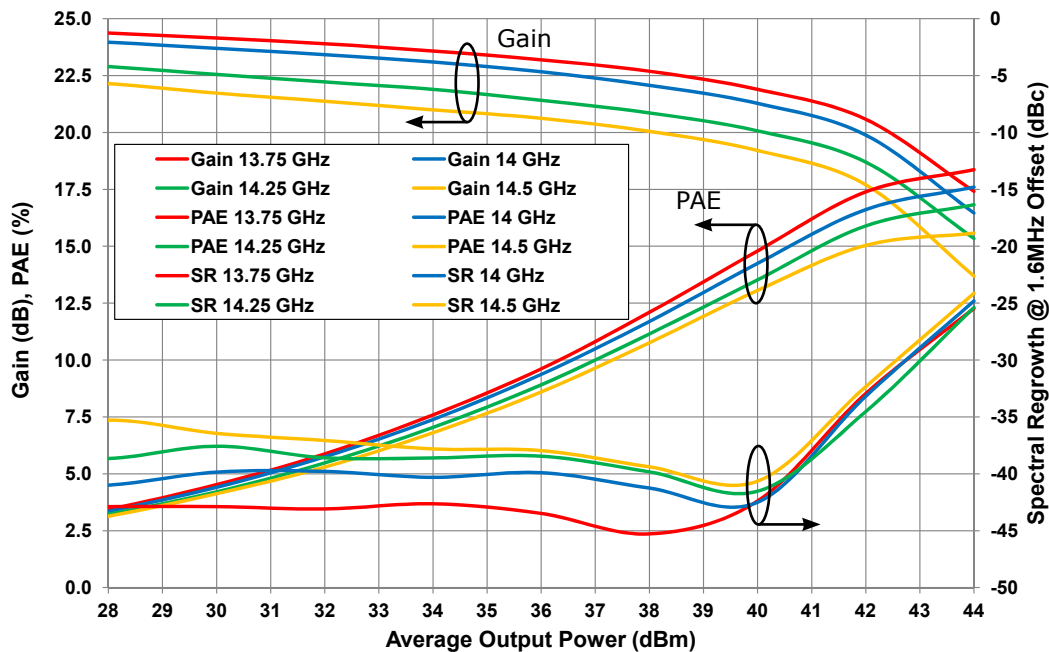


## Typical Performance

**Figure 3. - CMPA1D1E025F Modulated @ Spectral Regrowth = -30dBc, 1.6 MHz from Carrier  
1.6 Msps OQPSK Modulation  
 $V_{DD} = 40V, I_{DQ} = 240\text{ mA}, T_{case} = 25^{\circ}C$**

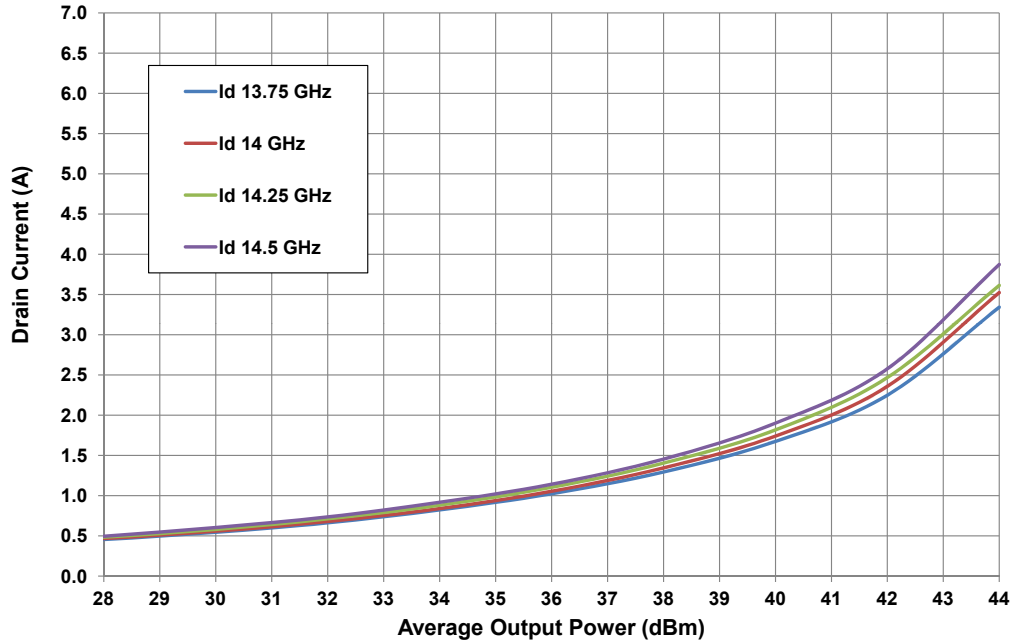


**Figure 4. - CMPA1D1E025F Modulated Power Sweep  
1.6 Msps OQPSK Modulation  
 $V_{DD} = 40\text{ V}, I_{DQ} = 240\text{ mA}, T_{case} = 25^{\circ}C$**

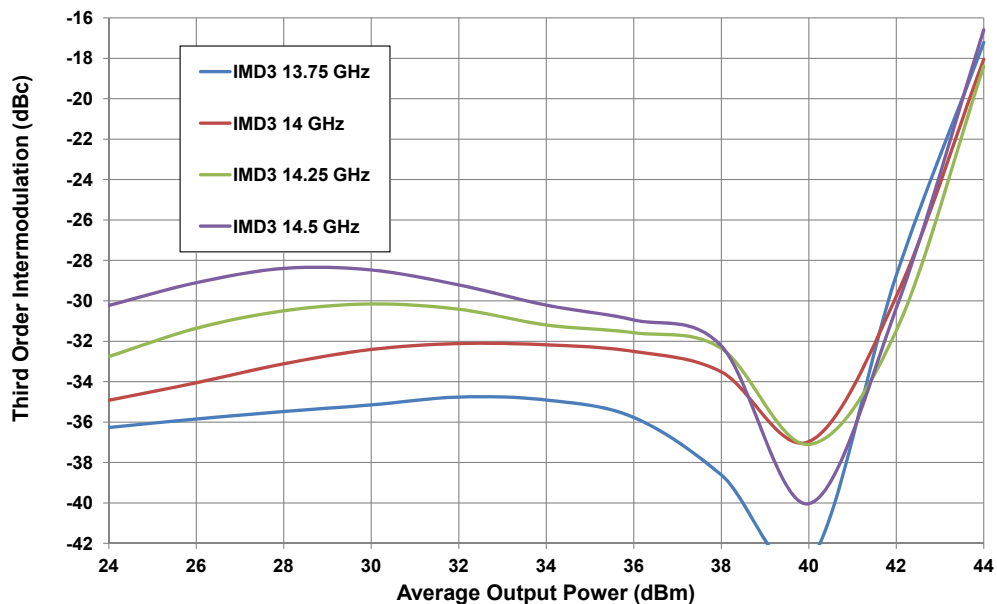


## Typical Performance

**Figure 5. - CMPA1D1E025F Modulated Power Sweep**  
**1.6 Msps OQPSK Modulation**  
 $V_{DD} = 40\text{ V}$ ,  $I_{DQ} = 240\text{ mA}$ ,  $T_{case} = 25^\circ\text{C}$

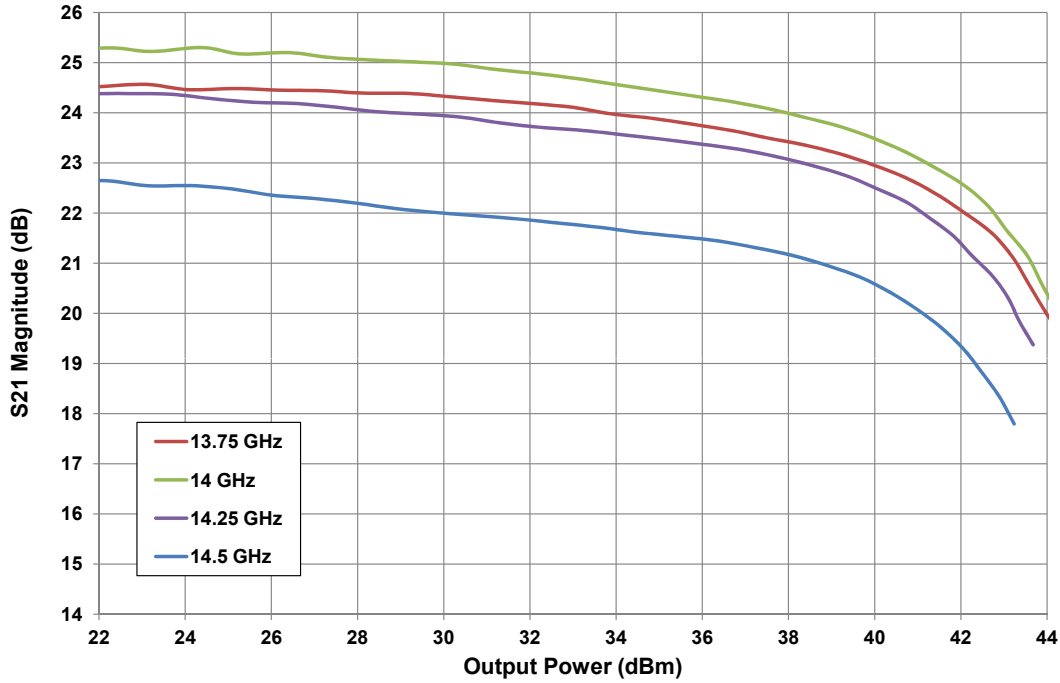


**Figure 6. - CMPA1D1E025F Two Tone Power Sweep**  
**IMD3 @ 1 MHz Carrier Spacing**  
 $V_{DD} = 40\text{ V}$ ,  $I_{DQ} = 240\text{ mA}$ ,  $T_{case} = 25^\circ\text{C}$

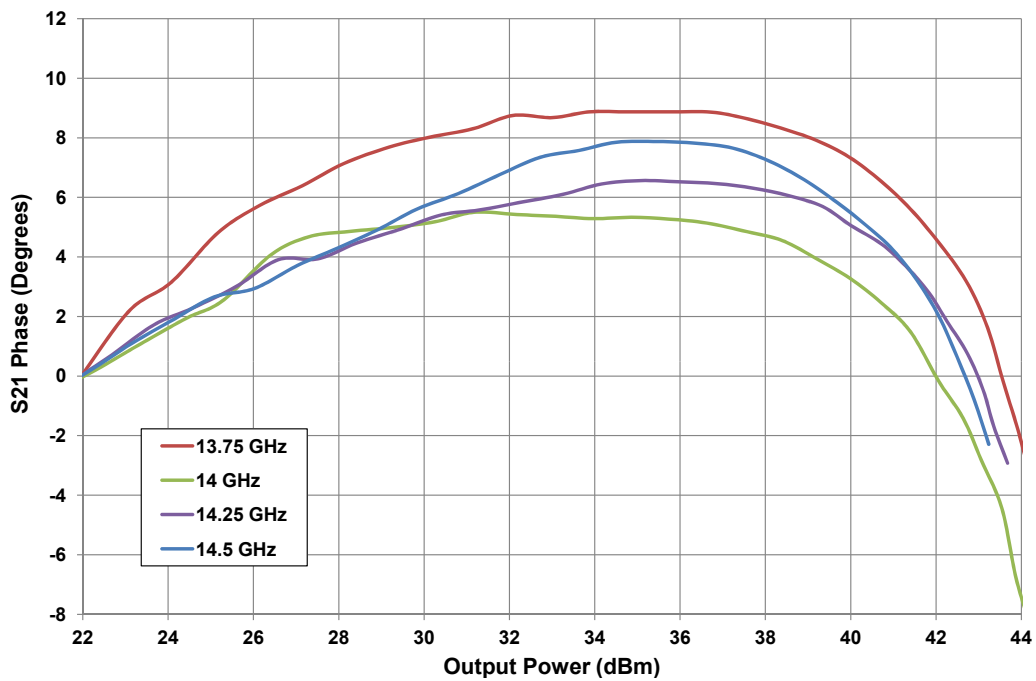


## Typical Performance

**Figure 7. - CMPA1D1E025F AM-AM**  
 $V_{DD} = 40\text{ V}$ ,  $I_{DQ} = 240\text{ mA}$ ,  $T_{case} = 25^\circ\text{C}$

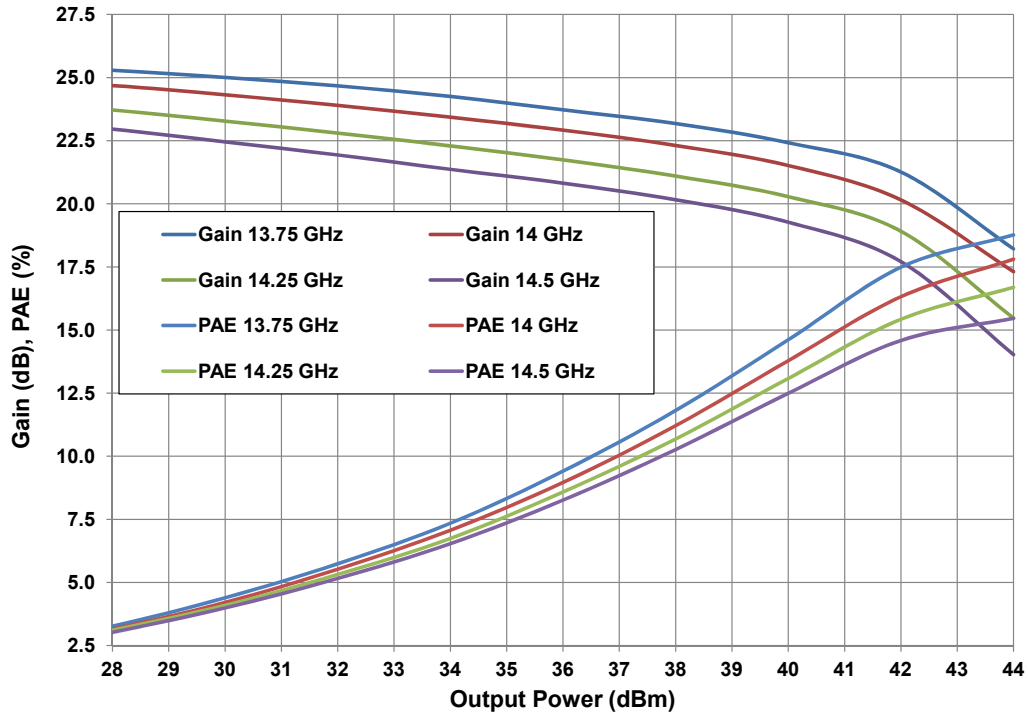


**Figure 8. - CMPA1D1E025F AM-PM**  
 $V_{DD} = 40\text{ V}$ ,  $I_{DQ} = 240\text{ mA}$ ,  $T_{case} = 25^\circ\text{C}$

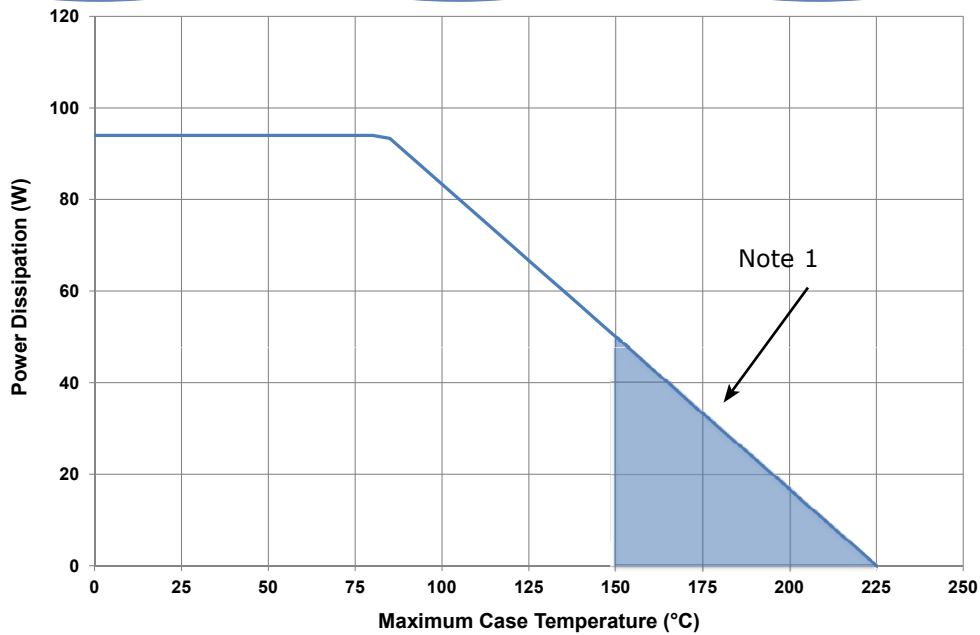


## Typical Performance

**Figure 9. - CMPA1D1E025F Gain and Power Added Efficiency vs CW Output Power**  
 $V_{DD} = 40\text{ V}$ ,  $I_{DO} = 240\text{ mA}$ ,  $T_{case} = 25^\circ\text{C}$



## CMPA1D1E025F Power Dissipation De-rating Curve



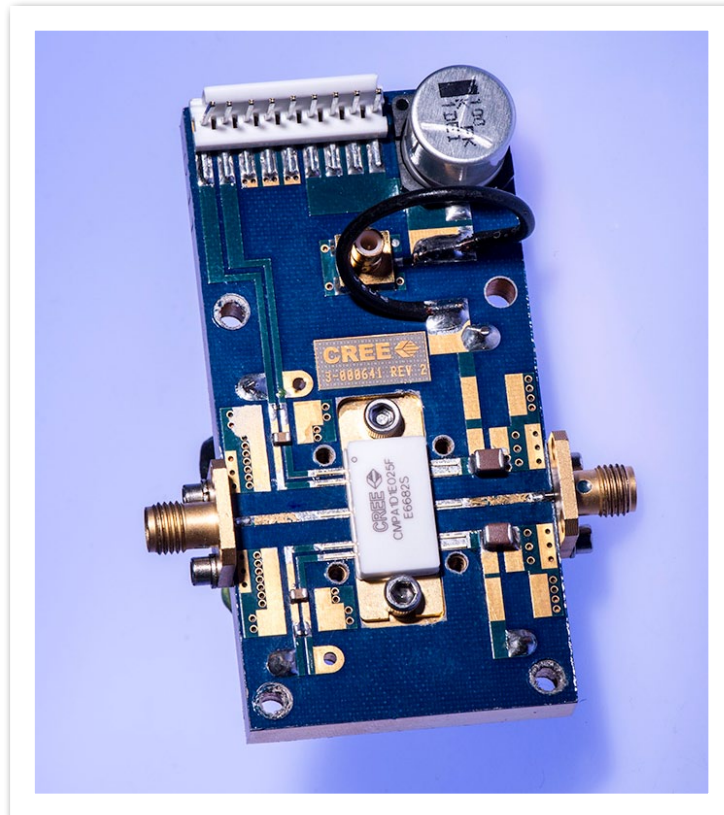
Note 1. Area exceeds Maximum Case Temperature (See Page 2).



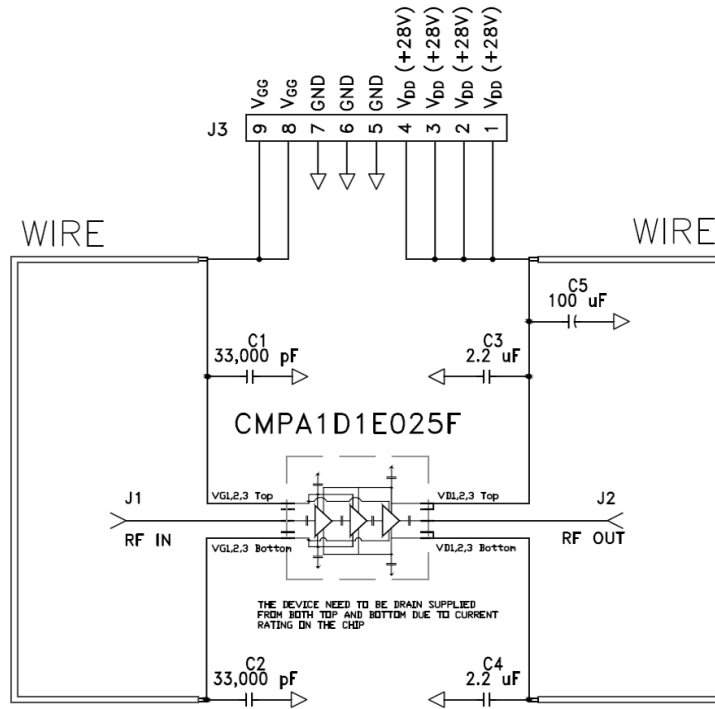
## CPMA1D1E025F-TB Demonstration Amplifier Circuit Bill of Materials

Designator	Description	Qty
C5	CAP ELECT 100UF 80V AFK SMD	1
C1,C2	CAP, 33000PF, 0805,100V, X7R	2
C3,C4	CAP, 2.2UF, 100V, 10%, X7R, 1210	4
J1,J2	CONN, SMA, PANEL MOUNT JACK, FLANGE, 4-HOLE, BLUNT POST, 20MIL	2
J4	CONN, SMB, STRAIGHT JACK RECEPTACLE, SMT, 50 OHM, Au PLATED	1
J3	HEADER RT>PLZ .1CEN LK 9POS	1
W1	WIRE, BLACK, 22 AWG ~ 1.50"	1
W2	WIRE, BLACK, 22 AWG ~ 1.75"	1
W3	WIRE, BLACK, 22 AWG ~ 2.0"	1
	PCB, TEST FIXTURE, TACONICS RF35P, 20 MILS, 440208 PKG	1
	2-56 SOC HD SCREW 1/4 SS	4
-	#2 SPLIT LOCKWASHER SS	4
Q1	CPMA1D1E025F	1

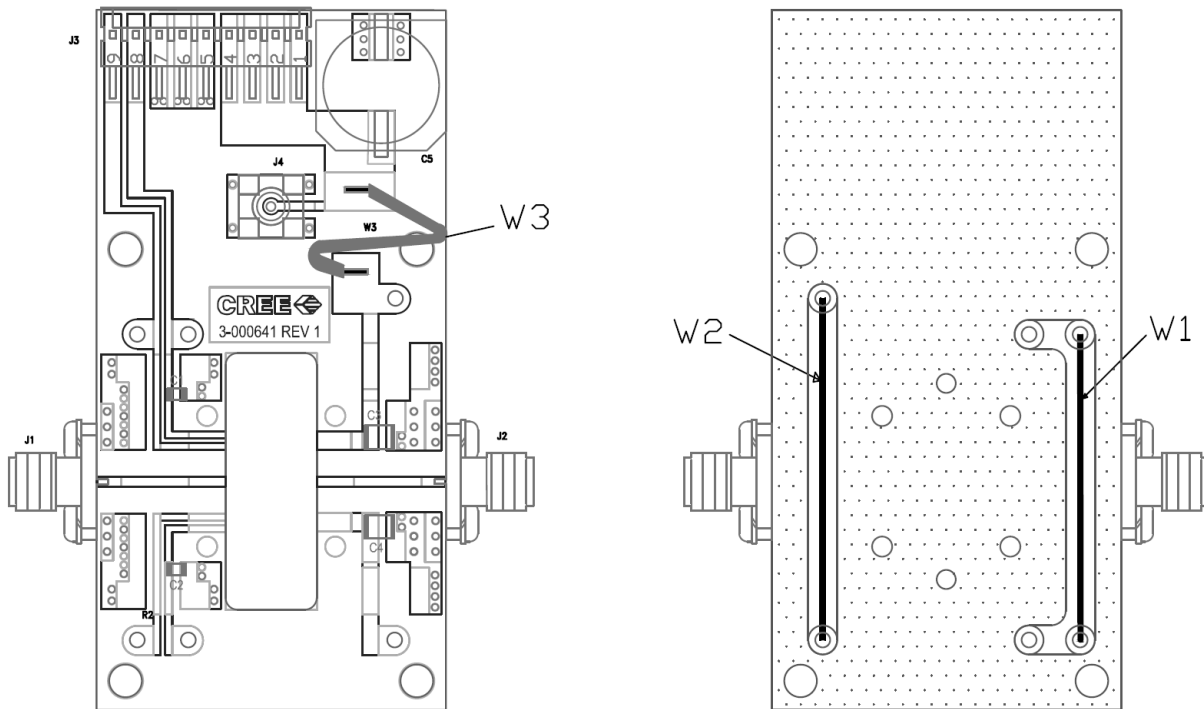
## CPMA1D1E025F-TB Demonstration Amplifier Circuit



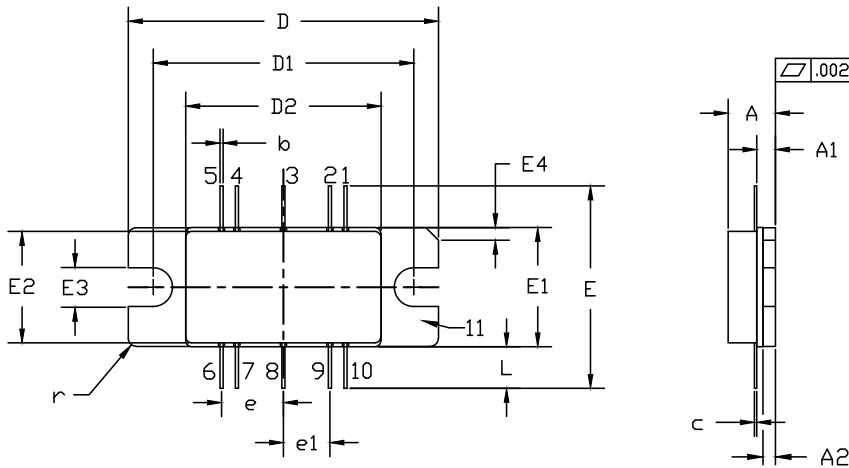
## CMPA1D1E025F-TB Demonstration Amplifier Circuit Schematic



## CMPA1D1E025F-TB Demonstration Amplifier Circuit Outline



## Product Dimensions CMPA1D1E025F (Package Type — 440208)



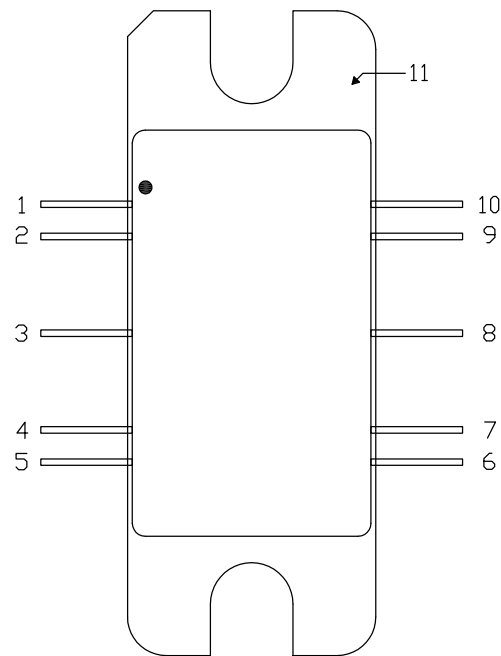
### NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M - 1994.
2. CONTROLLING DIMENSION: INCH.
3. ADHESIVE FROM LID MAY EXTEND A MAXIMUM OF 0.020" BEYOND EDGE OF LID.
4. LID MAY BE MISALIGNED TO THE BODY OF PACKAGE BY A MAXIMUM OF 0.008" IN ANY DIRECTION.

DIM	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	0.148	0.168	3.76	4.27	
A1	0.055	0.065	1.40	1.65	
A2	0.035	0.045	0.89	1.14	
b	0.01	TYP	0.254	TYP	10x
c	0.007	0.009	0.18	0.23	
D	0.995	1.005	25.27	25.53	
D1	0.835	0.845	21.21	21.46	
D2	0.623	0.637	15.82	16.18	
E	0.653	TYP	16.59	TYP	
E1	0.380	0.390	9.65	9.91	
E2	0.355	0.365	9.02	9.27	
E3	0.120	0.130	3.05	3.30	
E4	0.035	0.045	0.89	1.14	45° CHAMFER
e	0.200	TYP	5.08	TYP	4x
e1	0.150	TYP	3.81	TYP	4x
L	0.115	0.155	2.92	3.94	10x
r	0.025	TYP	.635	TYP	3x

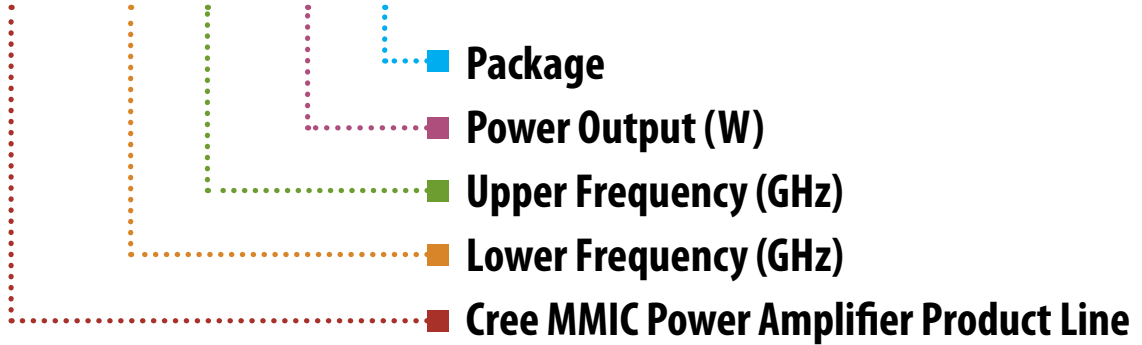
PIN 1: GATE BIAS    6: DRAIN BIAS  
 2: GATE BIAS    7: DRAIN BIAS  
 3: RF IN        8: RF OUT  
 4: GATE BIAS    9: DRAIN BIAS  
 5: GATE BIAS    10: DRAIN BIAS  
                   11: SOURCE

Pin Number	Qty
1	Gate Bias
2	NC
3	RF In
4	NC
5	Gate Bias
6	Drain Bias
7	Drain Bias
8	RF Out
9	Drain Bias
10	Drain Bias
11	Source



## Part Number System

### CMPA1D1E025F



Parameter	Value	Units
Lower Frequency	13.5	GHz
Upper Frequency <sup>1</sup>	14.5	GHz
Power Output	25	W
Package	Flange	-

**Table 1.**

**Note<sup>1</sup>:** Alpha characters used in frequency code indicate a value greater than 9.9 GHz. See Table 2 for value.

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

**Table 2.**

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