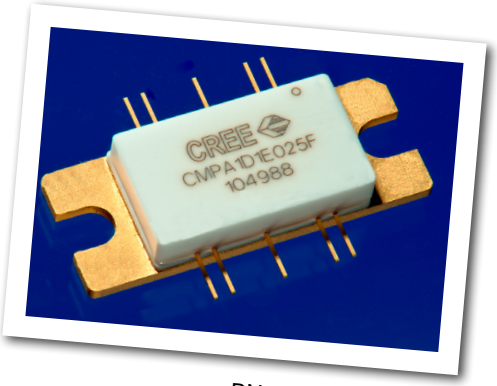
CMPA1D1E025F

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

Cree's CMPA1D1E025F is a gallium nitride (GaN) High Electron Mobility Transistor (HEMT) based monolithic microwave integrated circuit (MMIC) on a silicon carbide (SiC) substrate, using a 0.25 µm gate length fabrication process. The Ku Band 25W MMIC is targeted for commercial Ku Band satellite communications 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.



PN: CMPA1D1E025F
Package Type:440208

Typical Performance Over 13.75-14.5 GHz (T_c = 25°C)

Parameter	13.75 GHz	14.0 GHz	14.25 GHz	14.5 GHz	Units
Small Signal Gain	24	24.5	24.5	24	dB
Linear Output Power	24	23	21	20	W
Power Gain	21	21	20	20	dB
Power Added Efficiency	22	20	18	18	%

Note[1]: Measured at -30 dBc, 1.6 MHz from carrier, in the CMPA1D1E025F-AMP under OQPSK modulation, 1.6 Msps, PN23, Alpha Filter = 0.2.

Features

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

Applications

- Satellite Communications Uplink

Rev 1.1 – February 2016

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[1]	T_S	245	˚C	
Screw Torque	τ	40	in-oz	
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.5	˚C/W	P_{DISS} = 94 W, 85˚C
Case Operating Temperature	T_C	-40, +85	˚C	CW, P_{DISS} = 94 W

Note:
[1] Refer to the Application Note on soldering at www.cree.com/products/wireless_appnotes.asp

Electrical Characteristics (Frequency = 13.75 GHz to 14.5 GHz unless otherwise stated; T_C = 25˚C)

Characteristics	Symbol	Min.	Typ.	Max.	Units	Conditions
DC Characteristics[1]						
Gate Threshold	$V_{GS(TH)}$	-3.8	-3.0	-2.3	V	V_{DS} = 10 V, I_D = 18.2 mA
Gate Quiscent Voltage	V_Q	–	-2.7	–	V	V_{DS} = 40 V, I_D = 240 mA
Saturated Drain Current[2]	I_{DS}	14.6	16.4	–	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 = 18.2 mA
RF Characteristics[3]						
Small Signal Gain	S21	–	24	–	dB	V_{DD} = 40 V, I_{DQ} = 240 mA, P_{IN} = -15 dBm
Input Return Loss	S11	–	-7	–	dB	V_{DD} = 40 V, I_{DQ} = 240 mA, P_{IN} = -15 dBm
Output Return Loss	S22	–	-7	–	dB	V_{DD} = 40 V, I_{DQ} = 240 mA, P_{IN} = -15 dBm
Output Mismatch Stress	VSWR	–	–	5:1	Ψ	No damage at all phase angles, V_{DD} = 40 V, I_{DQ} = 240 mA, P_{OUT} = 41 dBm OQPSK

Notes:
[1] Measured on-wafer prior to packaging.
[2] Scaled from PCM data.
[3] Measured in the CMPA1D1E025F-AMP

Cree, Inc.
4600 Silicon Drive
Durham, North Carolina, USA 27703
USA Tel: +1.919.313.5300
Fax: +1.919.869.2733
Fax: +1.919.869.2733
www.cree.com/RF

Electrical Characteristics Continued... (T_C = 25°C)

Characteristics	Symbol	Min.	Typ.	Max.	Units	Conditions
RF Characteristics[1,2,3,4]						
Power Added Efficiency	PAE1	–	18.6	–	%	V_{DD} = 40 V, I_{DQ} = 240 mA, Frequency = 13.75 GHz
Power Added Efficiency	PAE2	–	16.4	–	%	V_{DD} = 40 V, I_{DQ} = 240 mA, Frequency = 14.5 GHz
Power Gain	G_{P1}	–	23.3	–	dB	V_{DD} = 40 V, I_{DQ} = 240 mA, Frequency = 13.75 GHz
Power Gain	G_{P2}	–	22.1	–	dB	V_{DD} = 40 V, I_{DQ} = 240 mA, Frequency = 14.5 GHz
OQPSK Linearity	ACLR1	–	-40	–	dBc	V_{DD} = 40 V, I_{DQ} = 240 mA, Frequency = 13.75 GHz
OQPSK Linearity	ACLR2	–	-38	–	dBc	V_{DD} = 40 V, I_{DQ} = 240 mA, Frequency = 14.5 GHz

Notes:
[1] Measured in the CMPA1D1E025F-AMP
[2] Under OQPSK modulated signal, 1.6 Msps, PN23, Alpha Filter = 0.2.
[3] Measured at P_{AVE} = 41 dBm.
[4] 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

Cree, Inc.
4600 Silicon Drive
Durham, North Carolina, USA 27703
USA Tel: +1.919.313.5300
Fax: +1.919.869.2733
Fax: +1.919.869.2733
www.cree.com/RF

Typical Performance

Figure 1. - Small Signal S-parameters
CMPA1D1E025F in Test Fixture
V_{DD} = 40V, I_{DQ} = 240 mA, Tcase = 25°C

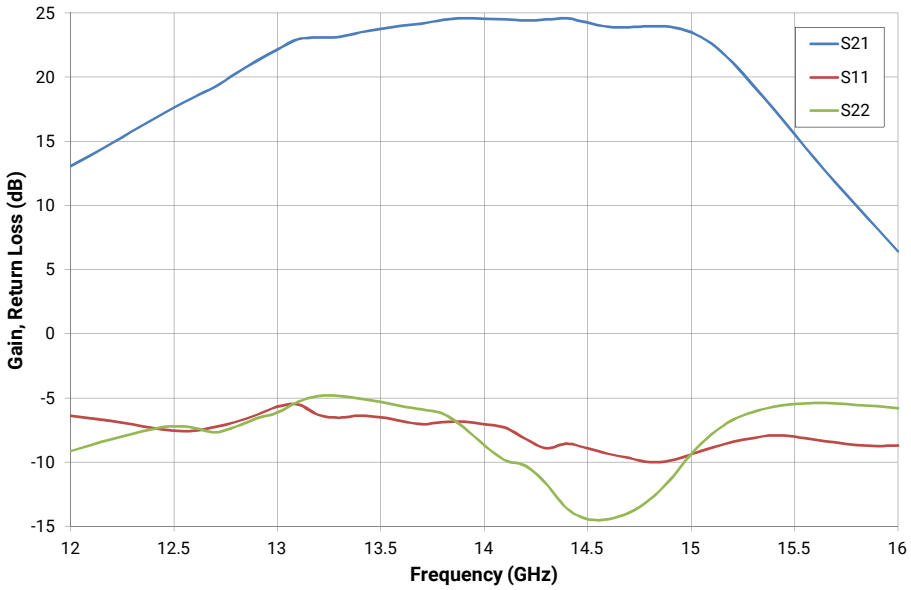
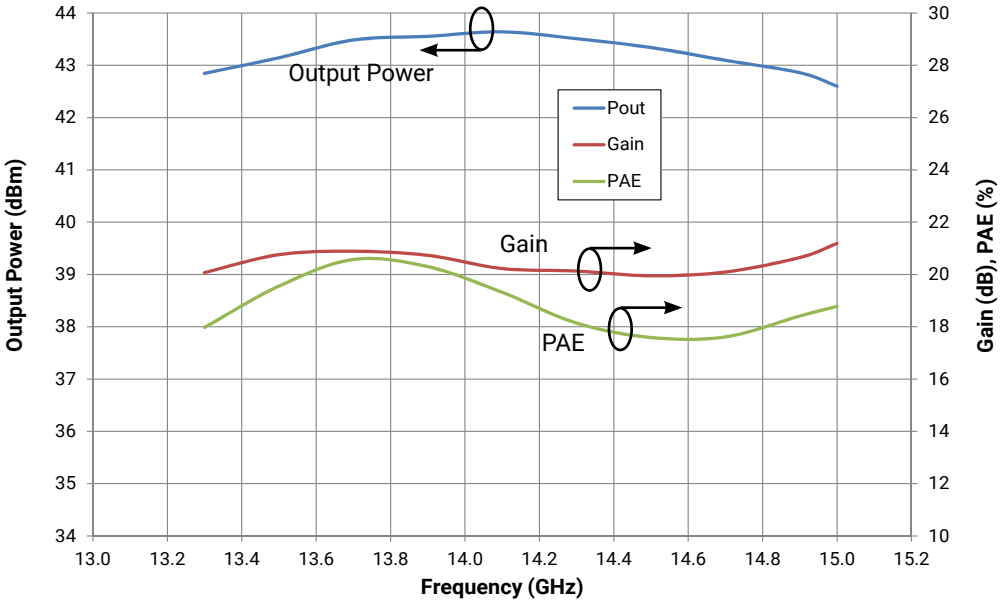


Figure 2. - Modulated @ Spectral Regrowth = -30dBc, 1.6 MHz from Carrier
1.6 Msps OQPSK Modulation
V_{DD} = 40 V, I_{DQ} = 240 mA, Tcase = 25°C



Cree, Inc.
4600 Silicon Drive
Durham, North Carolina, USA 27703
USA Tel: +1.919.313.5300
Fax: +1.919.869.2733
Fax: +1.919.869.2733
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Figure 3. - Spectral Mask @ Average Output Power = 41dBm
1.6 Msps OQPSK Modulation
V_{DD} = 40 V, I_{DQ} = 240 mA, Tcase = 25°C

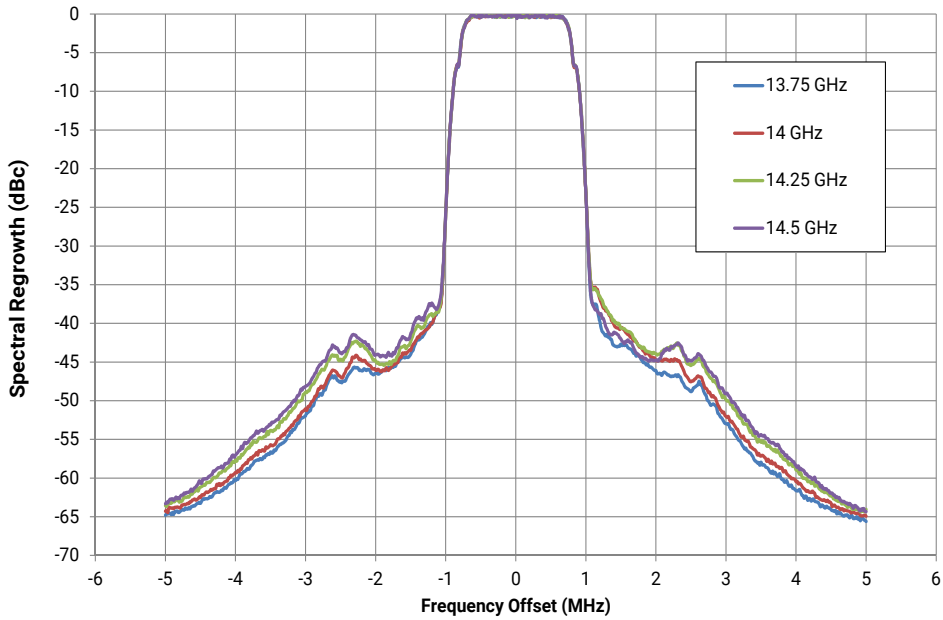
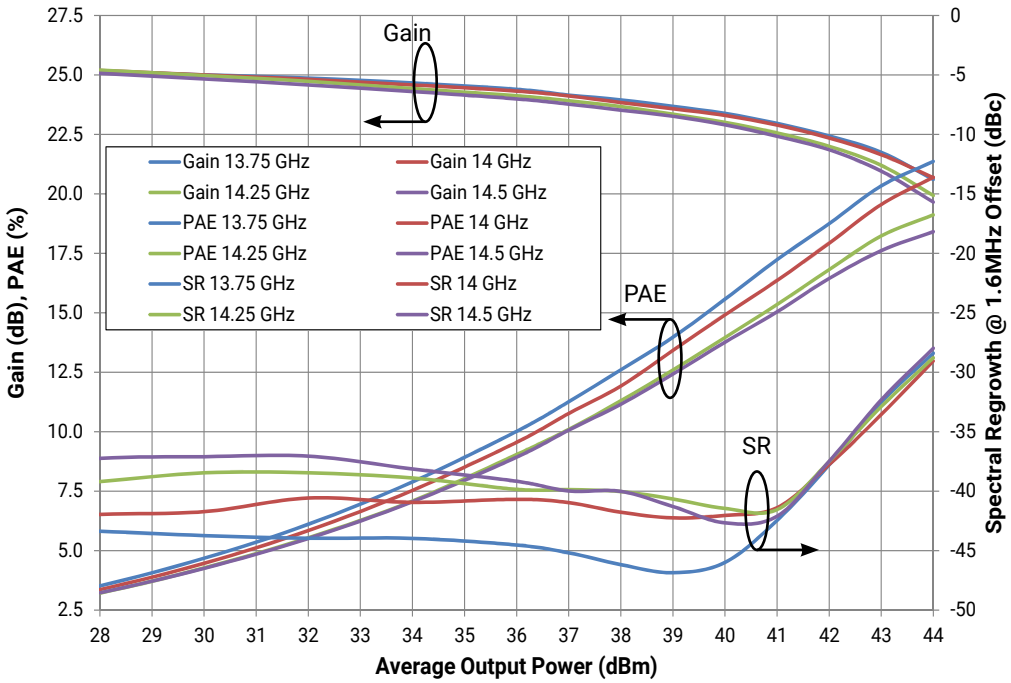


Figure 4. - CMPA1D1E025F Modulated Power Sweep
1.6 Msps OQPSK Modulation
V_{DD} = 40 V, I_{DQ} = 240 mA, Tcase = 25°C



Cree, Inc.
4600 Silicon Drive
Durham, North Carolina, USA 27703
USA Tel: +1.919.313.5300
Fax: +1.919.869.2733
Fax: +1.919.869.2733
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Typical Performance

Figure 5. - Modulated Power Sweep
1.6 Msps OQPSK Modulation
V_{DD} = 40 V, I_{DQ} = 240 mA, Tcase = 25°C

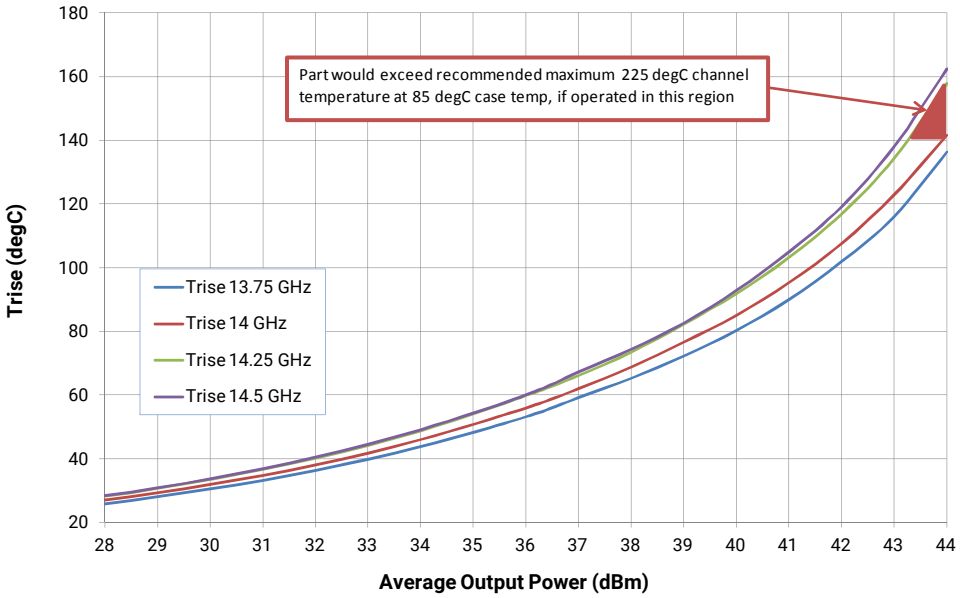
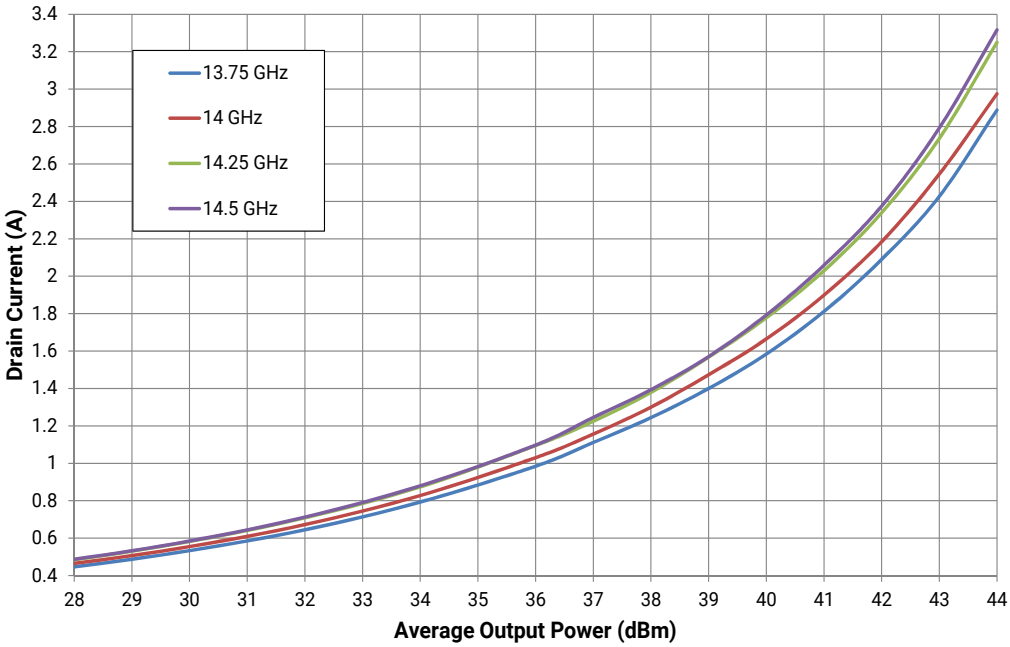


Figure 6. - CMPA1D1E025F Modulated Power Sweep
1.6 Msps OQPSK Modulation
V_{DD} = 40 V, I_{DQ} = 240 mA, Tcase = 25°C



Cree, Inc.
4600 Silicon Drive
Durham, North Carolina, USA 27703
USA Tel: +1.919.313.5300
Fax: +1.919.869.2733
Fax: +1.919.869.2733
www.cree.com/RF

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Figure 7. - CMPA1D1E025F Two Tone Power Sweep
IMD3 @ 1 MHz Carrier Spacing
V_{DD} = 40 V, I_{DQ}= 240 mA, Tcase = 25°C

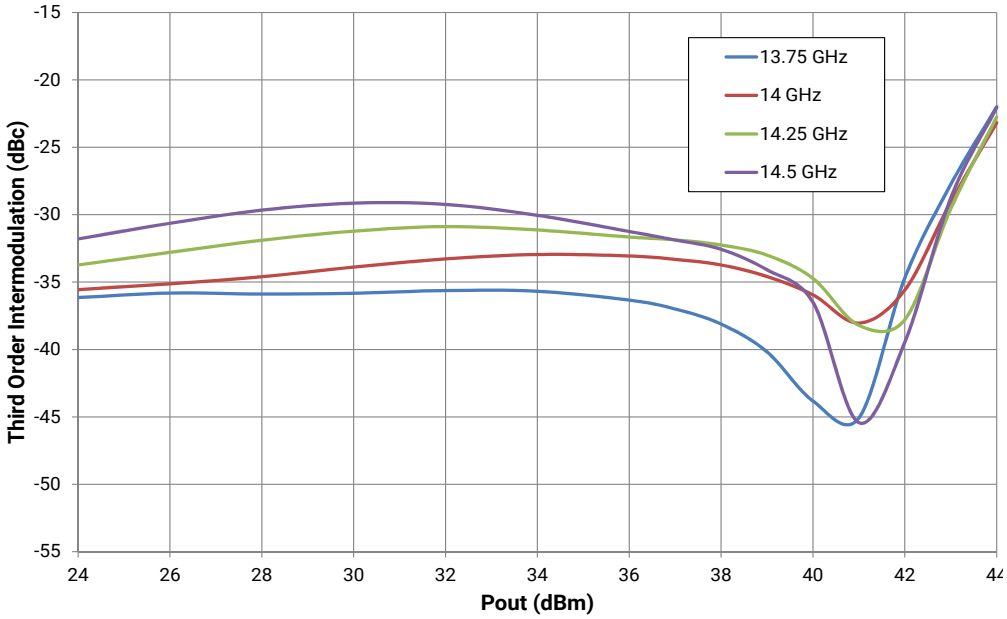
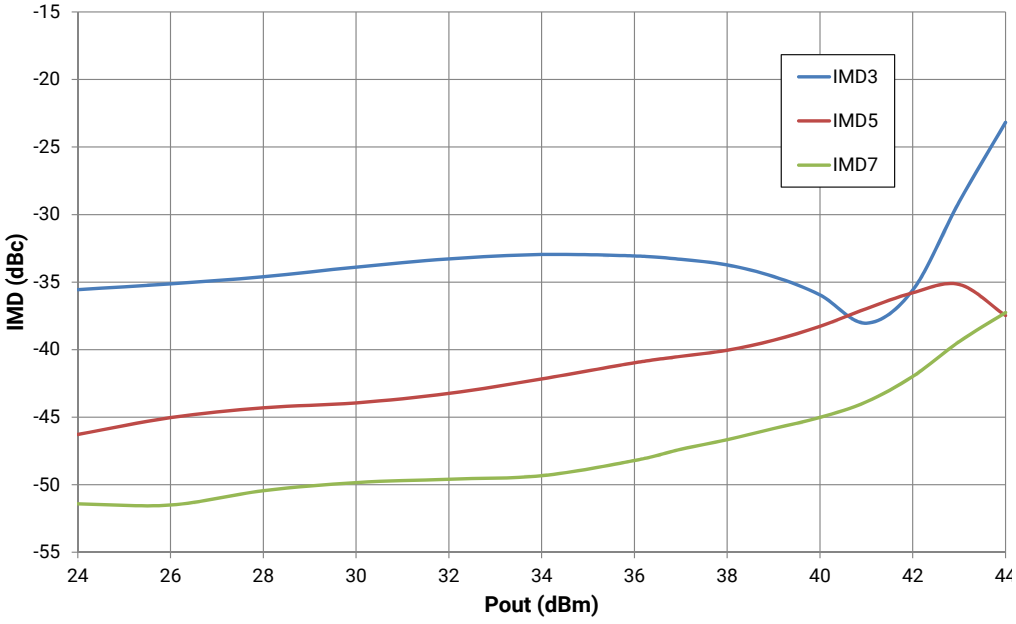


Figure 8. -Two Tone Power Sweep
IMD @ 1 MHz Carrier Spacing, 14 GHz
V_{DD} = 40 V, I_{DQ} = 240 mA, Tcase = 25°C



Cree, Inc.
4600 Silicon Drive
Durham, North Carolina, USA 27703
USA Tel: +1.919.313.5300
Fax: +1.919.869.2733
Fax: +1.919.869.2733
www.cree.com/RF

Typical Performance

Figure 9. - Two Tone Carrier Spacing Sweep @ 38 dBm Average Ouput Power, 14 GHz
V_{DD} = 40 V, I_{DQ} = 1 A, Tcase = 25°C

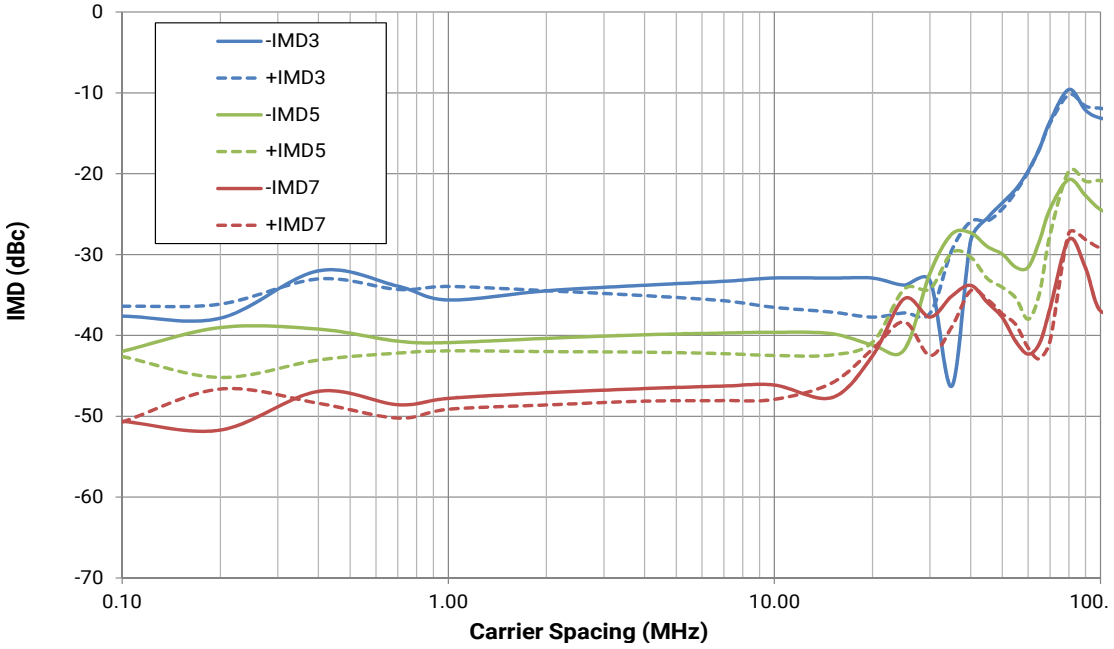
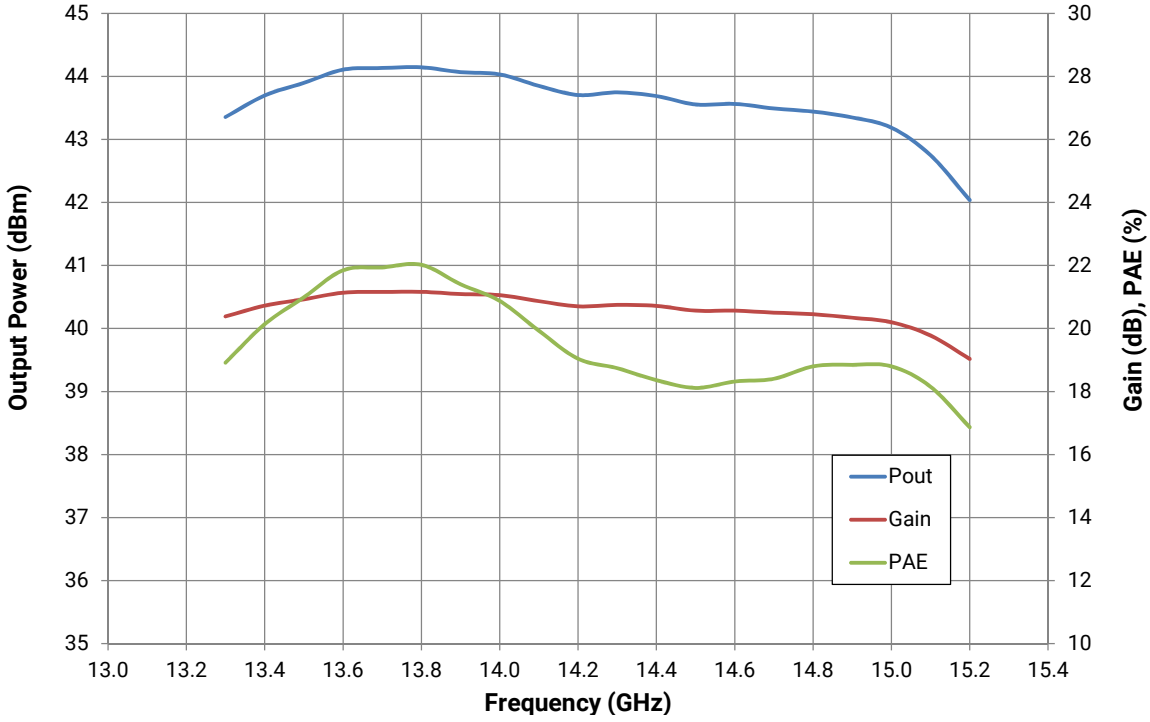


Figure 10. - CW vs. Frequency @ P_{IN} = 23 dBm
V_{DD} = 40 V, I_{DQ} = 240 mA, Tcase = 25°C



Cree, Inc.
4600 Silicon Drive
Durham, North Carolina, USA 27703
USA Tel: +1.919.313.5300
Fax: +1.919.869.2733
Fax: +1.919.869.2733
www.cree.com/RF

Typical Performance

Figure 11. - CW Power Sweep CMPA1D1E025F in Test Fixture
V_{DD} = 40V, I_{DQ} = 240 mA, Tcase = 25°C

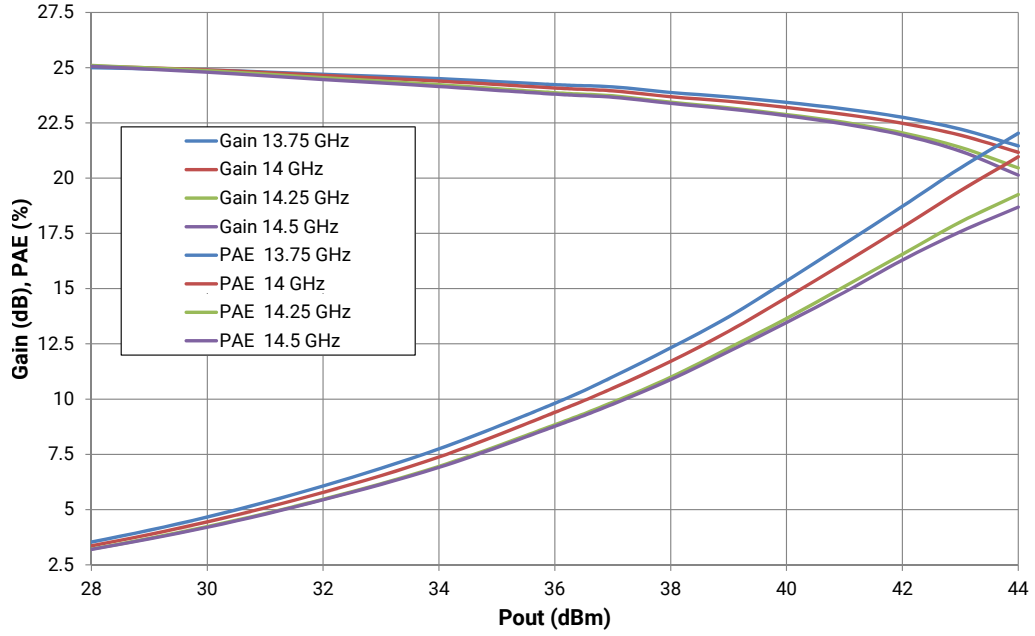
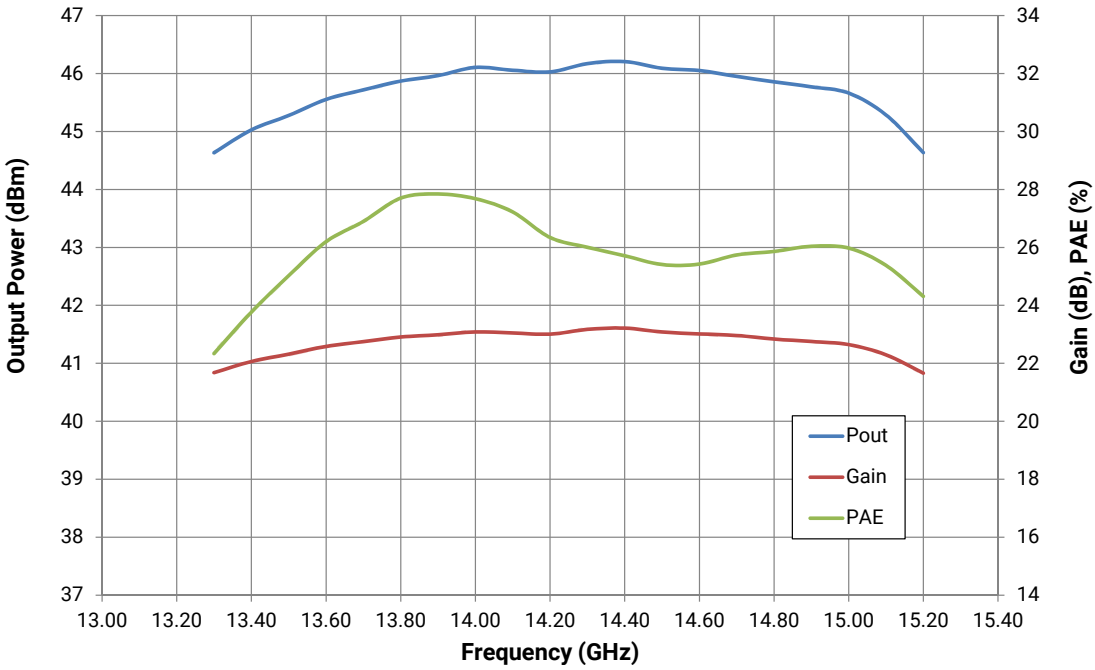


Figure 12. - Pulsed vs. Frequency @ PIN = 23 dBm CMPA1D1E025F in Test Fixture
V_{DD} = 40 V, I_{DQ} = 240 mA, 100 uS Pulse Width, 10% Duty Cycle, Tcase = 25°C



Cree, Inc.
4600 Silicon Drive
Durham, North Carolina, USA 27703
USA Tel: +1.919.313.5300
Fax: +1.919.869.2733
Fax: +1.919.869.2733
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Typical Performance

Figure 13. - Pulsed Power Sweep CMPA1D1E025F in Test Fixture
10% Duty, 100 uS Pulse Width
V_{DD} = 40V, I_{DQ} = 240 mA, Tcase = 25°C

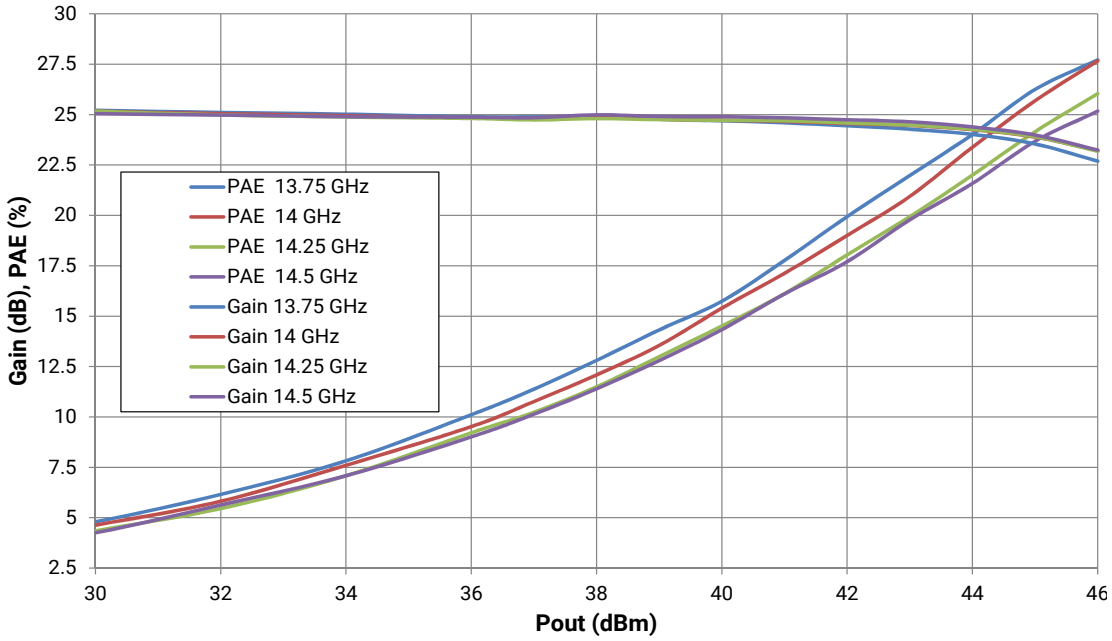
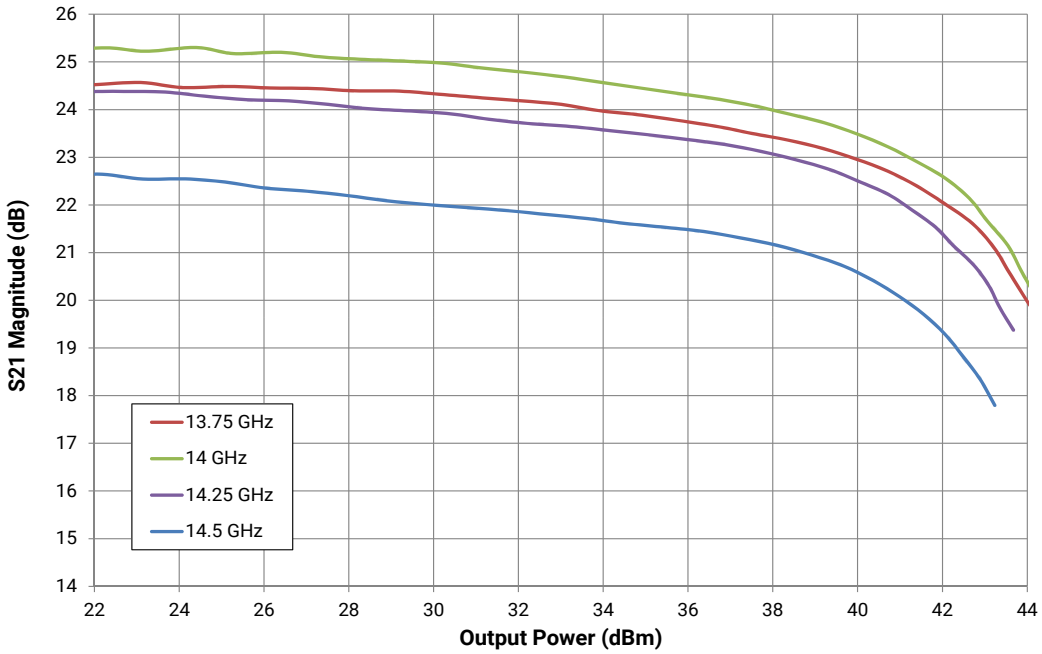


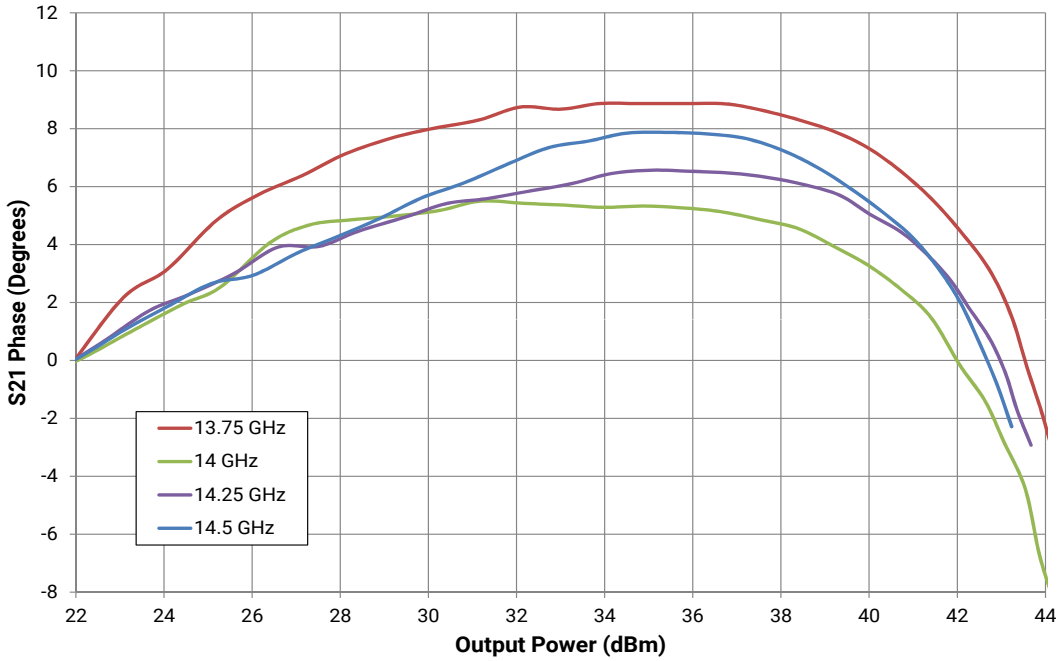
Figure 14. - AM-AM
V_{DD} = 40 V, I_{DQ} = 240 mA, Tcase = 25°C



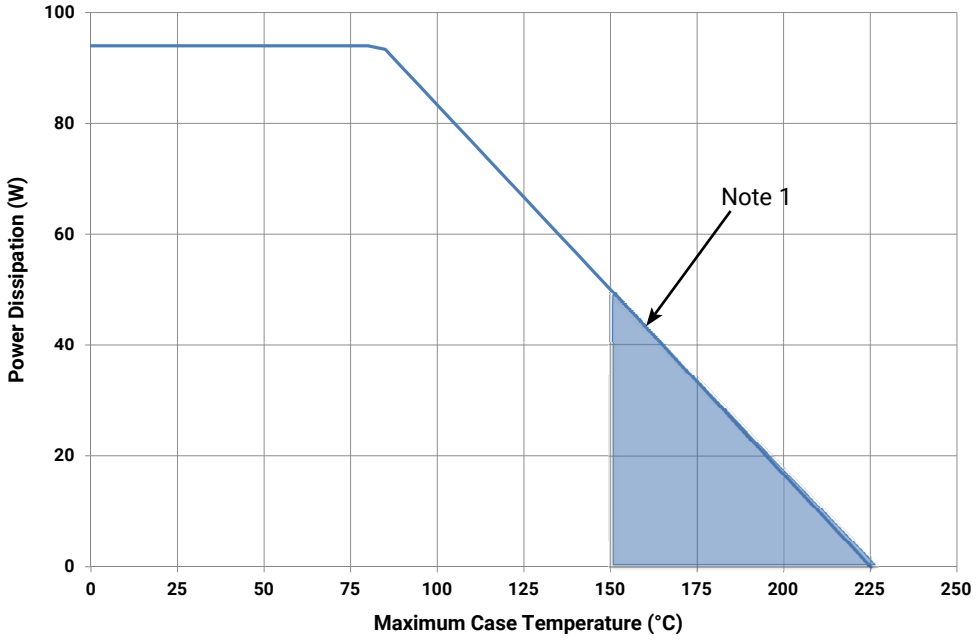
Cree, Inc.
4600 Silicon Drive
Durham, North Carolina, USA 27703
USA Tel: +1.919.313.5300
Fax: +1.919.869.2733
Fax: +1.919.869.2733
www.cree.com/RF

Typical Performance

Figure 15. - AM-PM
V_{DD} = 40 V, I_{DQ} = 240 mA, Tcase = 25°C



CMPA1D1E025F Power Dissipation De-rating Curve



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

Cree, Inc.
4600 Silicon Drive
Durham, North Carolina, USA 27703
USA Tel: +1.919.313.5300
Fax: +1.919.869.2733
Fax: +1.919.869.2733
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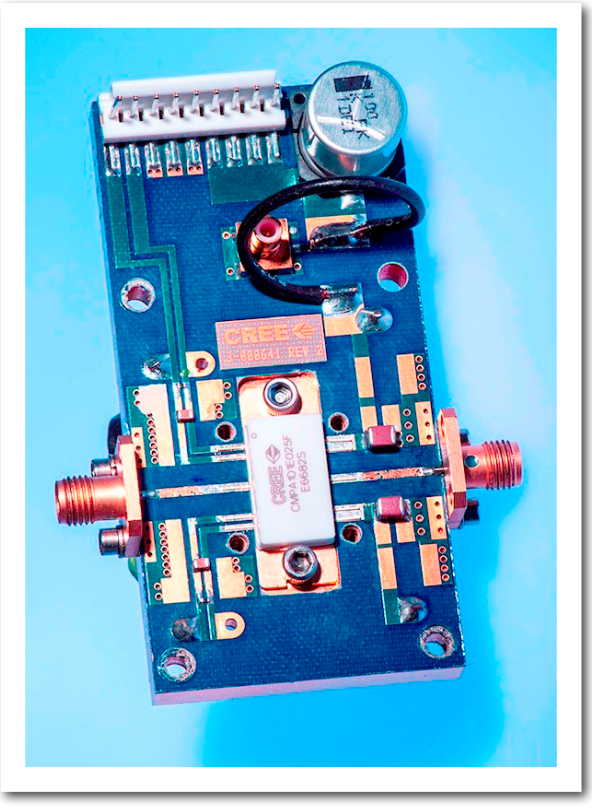
CMPA1D1E025F-AMP Demonstration Amplifier Circuit Bill of Materials

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	CMPA1D1E025F	1

CMPA1D1E025F-AMP Demonstration Amplifier Circuit



Cree, Inc.
4600 Silicon Drive
Durham, North Carolina, USA 27703
USA Tel: +1.919.313.5300
Fax: +1.919.869.2733
Fax: +1.919.869.2733
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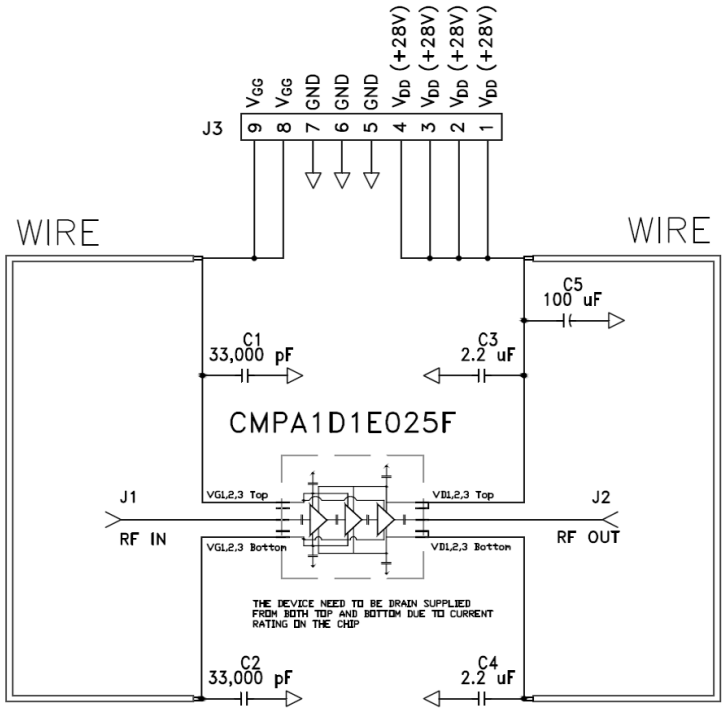
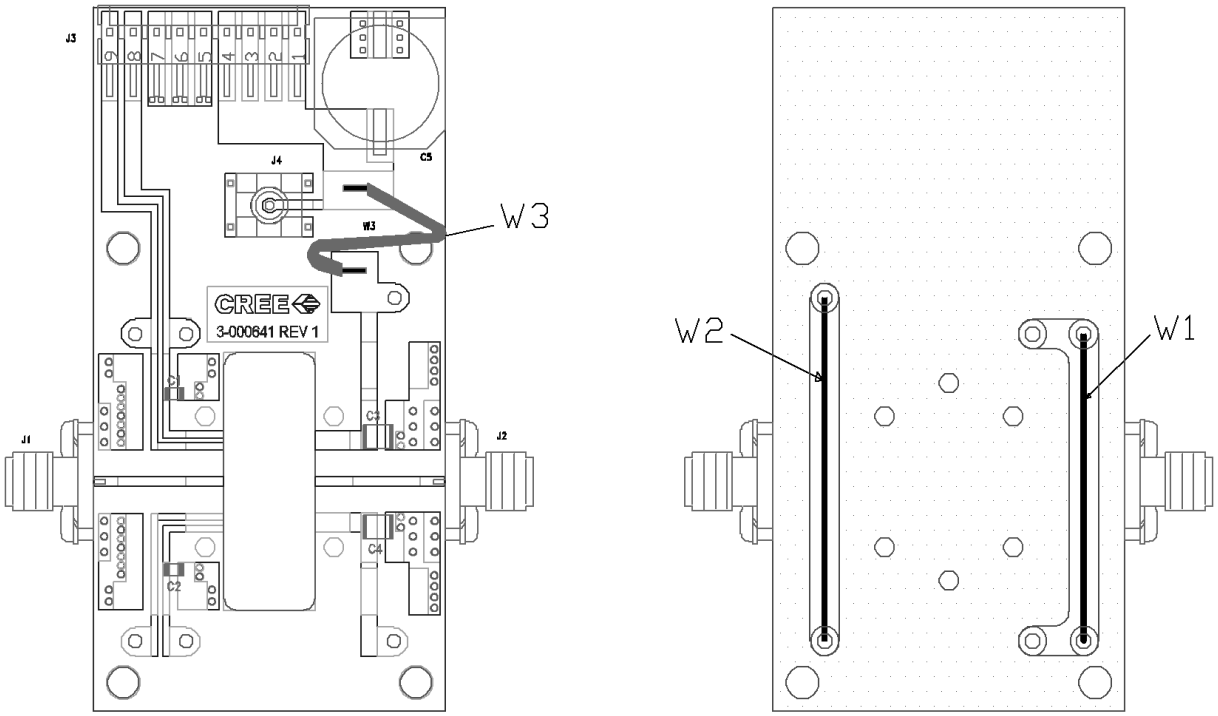
CMPA1D1E025F-AMP Demonstration Amplifier Circuit Schematic



CMPA1D1E025F-AMP Demonstration Amplifier Circuit Outline



Cree, Inc.
4600 Silicon Drive
Durham, North Carolina, USA 27703
USA Tel: +1.919.313.5300
Fax: +1.919.869.2733
Fax: +1.919.869.2733
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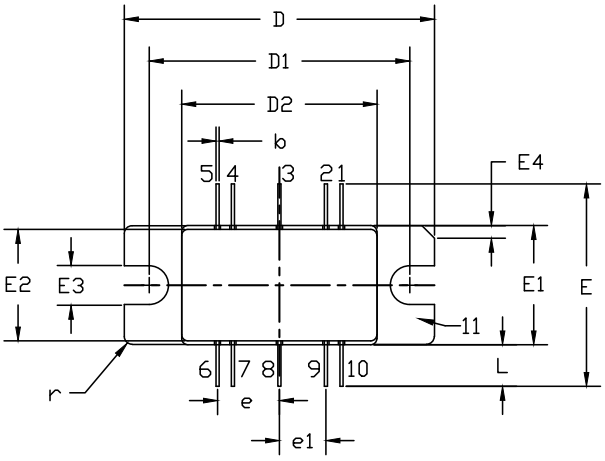
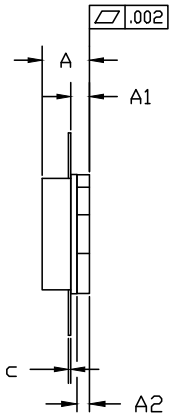
Product Dimensions CMPA1D1E025F (Package Type — 440208)





NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M – 1994.

2. CONTROLLING DIMENSION: INCH.

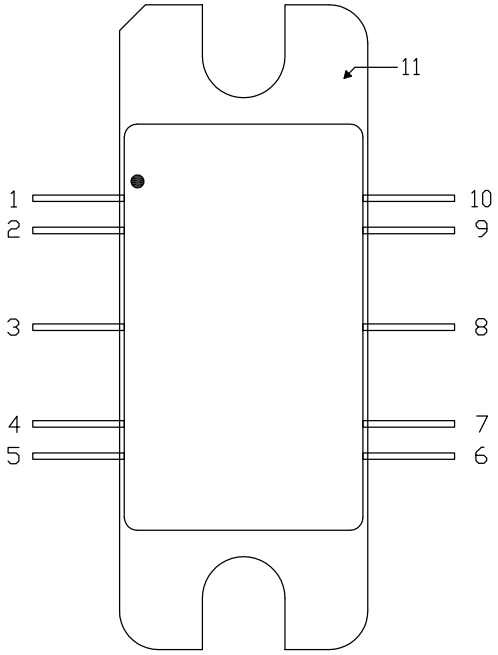
3. ADHESIVE FROM LID MAY EXTEND A MAXIMUM OF 0.020" BEYOND EDGE OF LID.

4. LID MAY BE MISALIGNED TO THE BODY OF PACKAGE BY A MAXIMUM OF 0.008" IN ANY DIRECTION.

	INCHES		MILLIMETERS		NOTES
DIM	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



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4600 Silicon Drive
Durham, North Carolina, USA 27703
USA Tel: +1.919.313.5300
Fax: +1.919.869.2733
Fax: +1.919.869.2733
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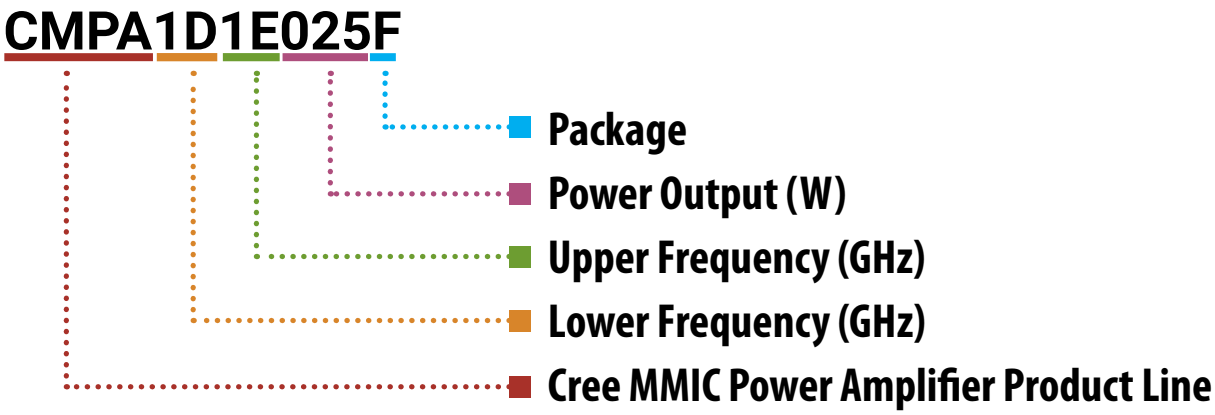
Part Number System



Parameter	Value	Units
Lower Frequency	13.75	GHz
Upper Frequency[1]	14.5	GHz
Power Output	25	W
Package	Flange	-

Table 1.

Note[1]: 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.

Cree, Inc.
4600 Silicon Drive
Durham, North Carolina, USA 27703
USA Tel: +1.919.313.5300
Fax: +1.919.869.2733
Fax: +1.919.869.2733
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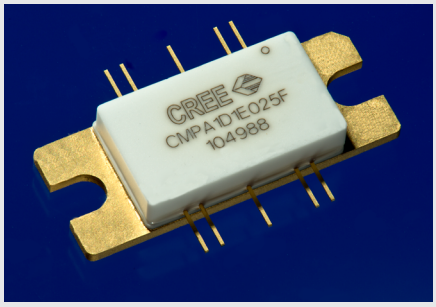
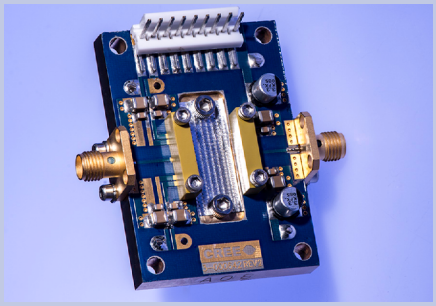
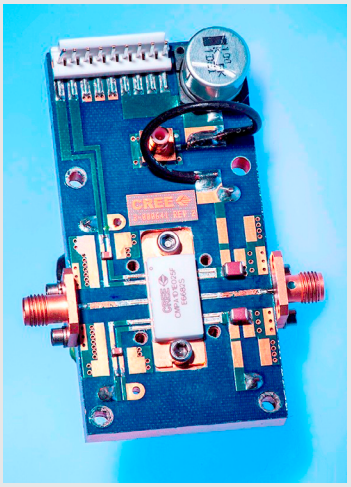
Product Ordering Information

Order Number	Description	Unit of Measure	Image
CMPA1D1E025F	GaN HEMT	Each	
CMPA1D1E025F-TB	Test board without GaN HEMT	Each	
CMPA1D1E025F-AMP	Test board with GaN HEMT installed	Each	

Cree, Inc.
4600 Silicon Drive
Durham, North Carolina, USA 27703
USA Tel: +1.919.313.5300
Fax: +1.919.869.2733
Fax: +1.919.869.2733
www.cree.com/RF

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For more information, please contact:

Cree, Inc.
4600 Silicon Drive
Durham, North Carolina, USA 27703
www.cree.com/RF

Sarah Miller
Marketing & Export
Cree, RF Components
1.919.407.5302

Ryan Baker
Marketing
Cree, RF Components
1.919.407.7816

Tom Dekker
Sales Director
Cree, RF Components
1.919.407.5639

Cree, Inc.
4600 Silicon Drive
Durham, North Carolina, USA 27703
USA Tel: +1.919.313.5300
Fax: +1.919.869.2733
Fax: +1.919.869.2733
www.cree.com/RF