

#### **Features**

Saturated Power: 60 W
Power Added Efficiency: 30 %
Large Signal Gain: 25 dB

Small Signal Gain: 20 dB
Input Return Loss: -10 dB
Output Return Loss: -6 dB

CW operation

## **Applications**

• Direct Broadcast Satcom

## **Description**

The CMPA1H1J050F is a 60 W package MMIC HPA utilizing MACOM's high performance, 0.15 µm GaN-on-SiC production process. The CMPA1H1J050F operates from 17.3 - 18.4 GHz and supports Direct Broadcast Satellite communications. The CMPA1H1J050F achieves 60 W of saturated output power with 25 dB of large signal gain and typically 30% power-added efficiency under CW operation.

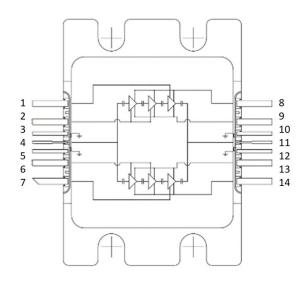
Packaged in a 17.5 x 24 mm bolt-down, flange package, the CMPA1H1J050F provides superior RF performance and thermal management allowing customers to improve SWaP-C benchmarks in their next-generation systems.

## **Ordering Information**

Part Number	Package (MOQ/ Mult)
CMPA1H1J050F	Tray (10/10)
CMPA1H1J050F-AMP	Sample Board (1/1)



#### **Functional Schematic**



## Pin Configuration<sup>1</sup>

Pin #	Function
1, 2	Gate Bias - Top MMIC
3, 5, 10, 12	GND
4	RF Input
6, 7	Gate Bias - Bot MMIC
8, 9	Bias Drain - Top MMIC
11	RF Output
13, 14	Bias Drain - Bot MMIC

The base of the package must be connected to RF, DC and thermal ground.



## RF Electrical Specifications: $V_D = 28 \text{ V}$ , $I_{DQ} = 700 \text{ mA}$ , CW, $T_C = 25^{\circ}\text{C}$ , $Z_0 = 50 \Omega$

Parameter	Test Conditions	Frequency (GHz)	Units	Min.	Тур.	Max.
Output Power		17.3 17.8 18.4	dBm	46.0 47.0 46.0	47.0 48.5 48.0	_
Power Added Efficiency	P <sub>IN</sub> = 23 dBm	17.3 17.8 18.4	%	29 30 29	30 32 32	_
Large Signal Gain		17.3 17.8 18.4	dB	23.0 24.0 23.0	24.0 25.5 25.0	_
Small Signal Gain		17.3 - 18.4	dB	_	30	_
Input Return Loss	P <sub>IN</sub> = -20 dBm	17.3 - 18.4	dB	_	-10	_
Output Return Loss		17.3 - 18.4	dB	_	-6	_
IM3	P <sub>OUT</sub> /Tone = 41 dBm Tone/Spacing = 600 MHz	17.3 17.8 18.4	dBc		-26 -27 -27	_

## **DC Electrical Specifications:**

Parameter	Units	Min.	Тур.	Max.
Drain Voltage	V	_	28	_
Gate Voltage	V	_	-1.9	_
Quiescent Drain Current	mA	_	700	_
Saturated Drain Current	А	_	7.8	_



## **Recommended Operating Conditions**

Parameter	Symbol	Unit	Min.	Тур.	Max.
Input Power	P <sub>IN</sub>	dBm	_	23	_
Drain Voltage	V <sub>D</sub>	V	_	28	_
Gate Voltage	V <sub>G</sub>	V	_	-1.9	_
Quiescent Drain Current	I <sub>DQ</sub>	mA	_	700	_
Operating Temperature	T <sub>C</sub>	°C	-40	_	+85

## **Absolute Maximum Ratings<sup>2,3</sup>**

Parameter	Symbol	Unit	Min.	Max.
Input Power	P <sub>IN</sub>	dBm	_	26
Drain to Source Voltage	V <sub>DS</sub>	V	_	84
Drain Voltage	V <sub>D</sub>	V	_	28
Gate Voltage	V <sub>G</sub>	V	-8	+2
Drain Current	I <sub>D</sub>	А	_	12.8
Gate Current	I <sub>G</sub>	mA	_	24.6
Dissipated Power @ +85°	P <sub>DISS</sub>	W	_	160
VSWR	_	Ratio	_	3:1
Junction Temperature (MTTF > 1E6 Hrs)	TJ	°C	_	+225
Storage Temperature	T <sub>STG</sub>	°C	-55	+150
Mounting Temperature (30 seconds)	T <sub>M</sub>	°C	_	+320
Screw Torque	τ	in-oz	_	40

<sup>2.</sup> Exceeding any one or combination of these limits may cause permanent damage to this device.

#### **Handling Procedures**

Please observe the following precautions to avoid damage:

#### **Static Sensitivity**

These electronic devices are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these devices.

<sup>3.</sup> MACOM does not recommend sustained operation near these survivability limits.



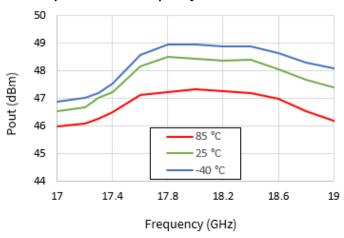
Large Signal vs Temperature

CMPA1H1J050F Rev. V1

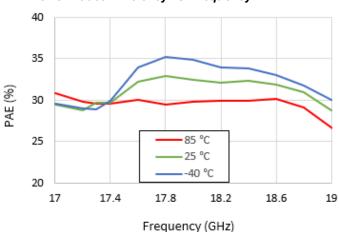
## **Typical Performance Curves - Large Signal over Temperature**

 $V_D$  = 28 V,  $I_{DQ}$  = 700 mA, CW,  $P_{IN}$  = 23 dBm

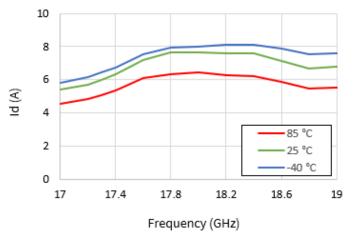
#### **Output Power vs. Frequency**



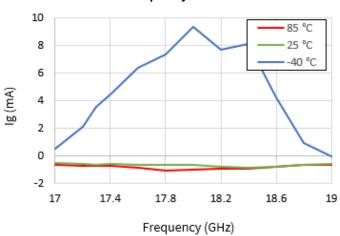
#### Power Added Efficiency vs. Frequency



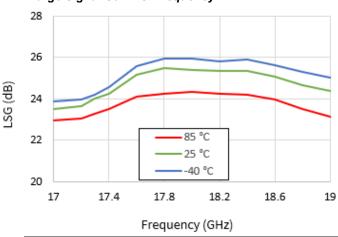
#### Drain Current vs. Frequency



#### Gate Current vs. Frequency



#### Large Signal Gain vs. Frequency



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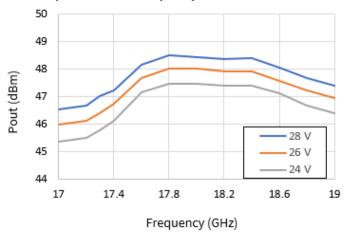
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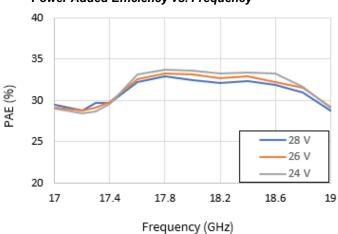
## Typical Performance Curves - Large Signal over V<sub>D</sub>

 $I_{DQ}$  = 700 mA, CW,  $P_{IN}$  = 23 dBm,  $T_{C}$  = 25°C

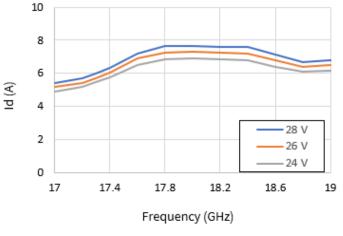
#### Output Power vs. Frequency



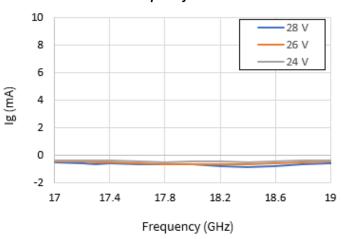
#### Power Added Efficiency vs. Frequency



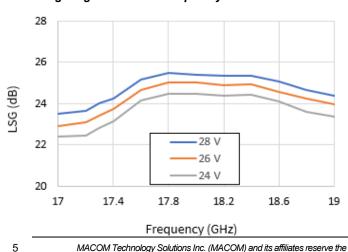
#### Drain Current vs. Frequency



#### Gate Current vs. Frequency



#### Large Signal Gain vs. Frequency



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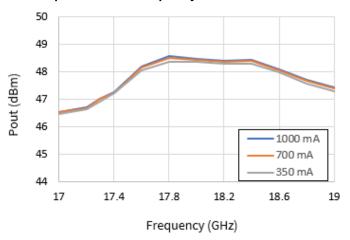
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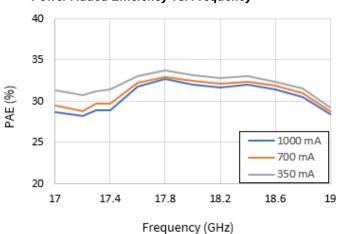
## Typical Performance Curves - Large Signal over IDQ

 $V_D = 28 \text{ V}, \text{ CW}, \text{ P}_{\text{IN}} = 23 \text{ dBm}, \text{ T}_{\text{C}} = 25 ^{\circ}\text{C}$ 

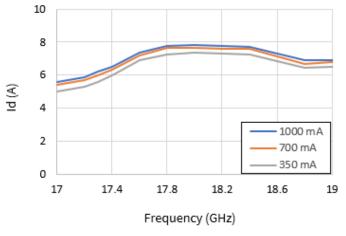
#### Output Power vs. Frequency



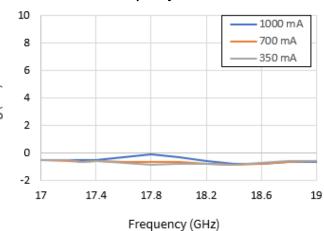
#### Power Added Efficiency vs. Frequency



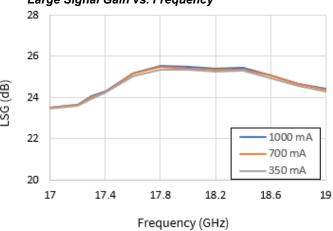
#### Drain Current vs. Frequency



#### Gate Current vs. Frequency



#### Large Signal Gain vs. Frequency



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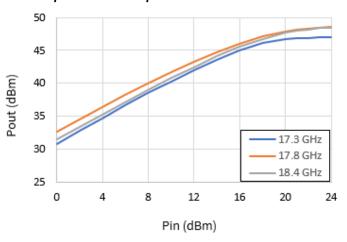
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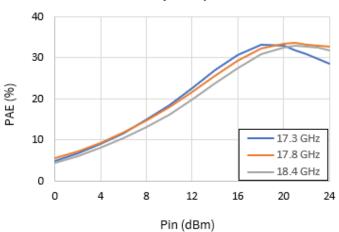
## **Typical Performance Curves - Drive-Up over Frequency**

 $V_D = 28 \text{ V}, I_{DQ} = 700 \text{ mA}, CW, T_C = 25^{\circ}\text{C}$ 

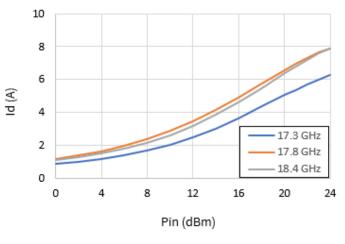
#### Output Power vs. Input Power



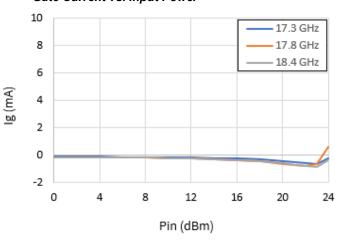
#### Power Added Efficiency vs. Input Power



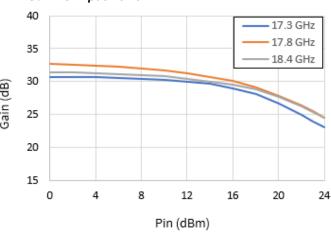
#### Drain Current vs. Input Power



#### Gate Current vs. Input Power



#### Gain vs. Input Power



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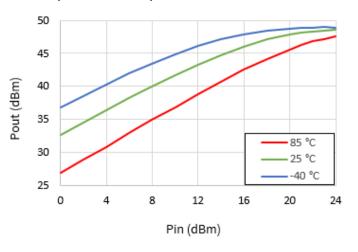
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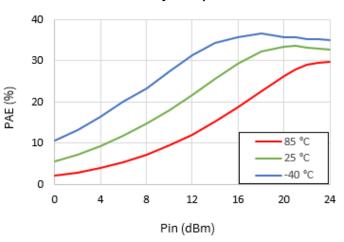
## **Typical Performance Curves - Drive-Up over Temperature**

 $V_D$  = 28 V,  $I_{DQ}$  = 700 mA, CW, Frequency = 17.8 GHz

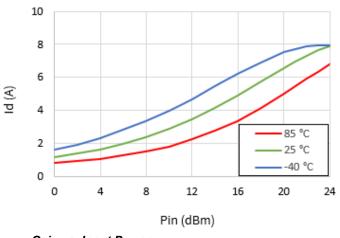
#### Output Power vs. Input Power



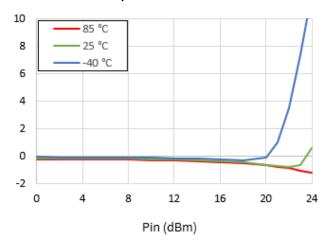
#### Power Added Efficiency vs. Input Power



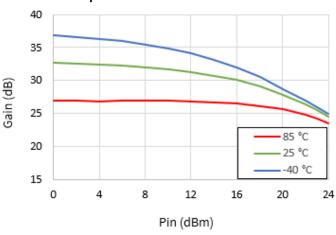
#### Drain Current vs. Input Power



#### Gate Current vs. Input Power



#### Gain vs. Input Power



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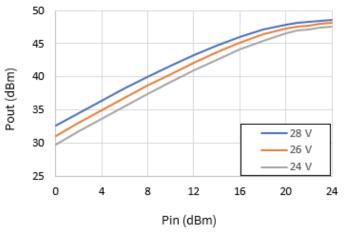
lg (mA)



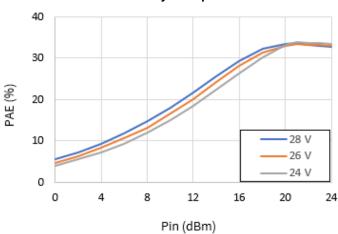
## Typical Performance Curves - Drive-Up over V<sub>D</sub>

 $I_{DQ}$  = 700 mA, CW, Frequency = 17.8 GHz,  $T_{C}$  = 25°C

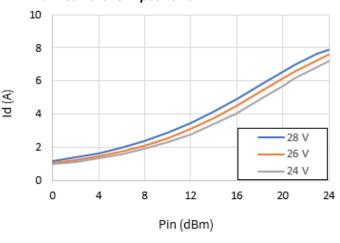
#### Output Power vs. Input Power



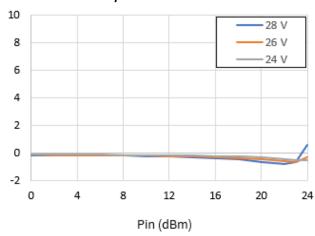
#### Power Added Efficiency vs. Input Power



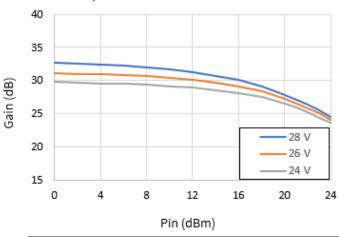
#### Drain Current vs. Input Power



#### Gate Current vs. Input Power



#### Gain vs. Input Power



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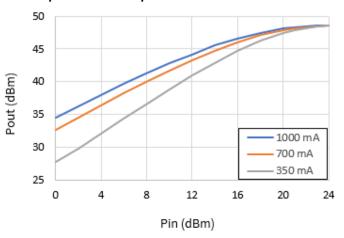
lg (mA)



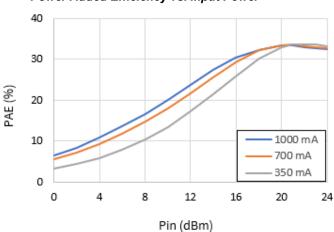
## Typical Performance Curves - Drive-Up over IDQ

 $V_D$  = 28 V, CW, Frequency = 17.8 GHz,  $T_C$  = 25°C

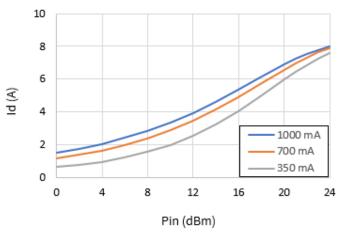
#### Output Power vs. Input Power



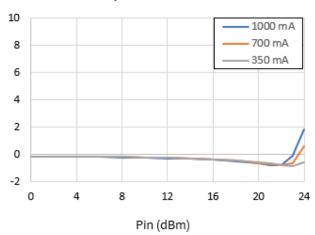
#### Power Added Efficiency vs. Input Power



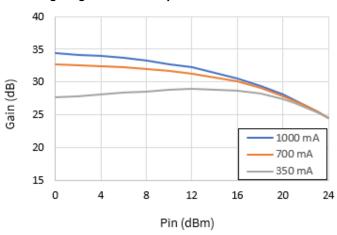
#### Drain Current vs. Input Power



#### Gate Current vs. Input Power



#### Large Signal Gain vs. Input Power



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Ig (mA)



## Typical Performance Curves - Small Signal over Temperature and V<sub>D</sub>

S21 (dB)

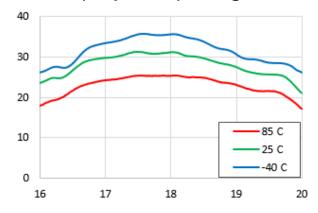
S11 (dB)

 $I_{DQ}$  = 700 mA, CW,  $P_{IN}$  = -20 dBm

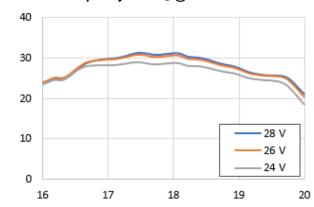
S21 (dB)

S11 (dB)

S21 vs. Frequency over Temperature @  $V_D$  = 28 V

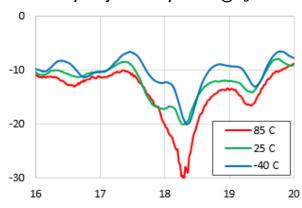


S21 vs. Frequency over V<sub>D</sub> @ 25°C



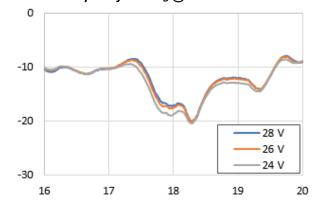
Frequency (GHz)

S11 vs. Frequency over Temperature @  $V_D$  = 28 V



Frequency (GHz)

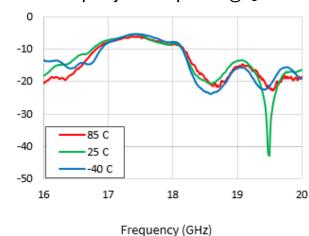
S11 vs. Frequency over V<sub>D</sub> @ 25°C



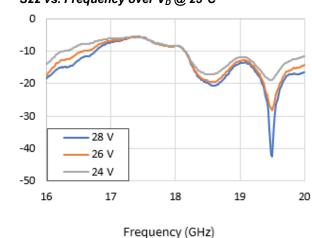
Frequency (GHz)

Frequency (GHz)

S22 vs. Frequency over Temperature @  $V_D$  = 28 V



S22 vs. Frequency over V<sub>D</sub> @ 25°C



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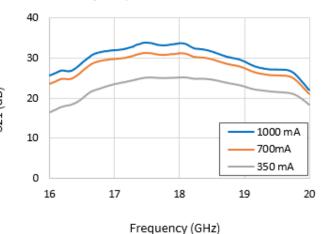
S22 (dB)



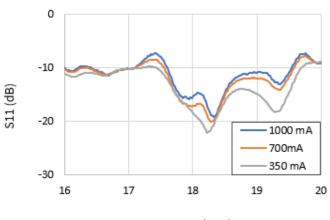
## Typical Performance Curves - Small Signal over IDQ

 $V_D = 28 \text{ V}, \text{ CW}, P_{IN} = -20 \text{ dBm}, T_C = 25^{\circ}\text{C}$ 

#### S21 vs. Frequency over IDQ

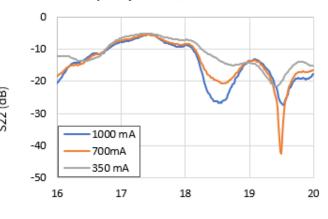


#### S11 vs. Frequency over IDQ



Frequency (GHz)

#### S22 vs. Frequency over IDQ



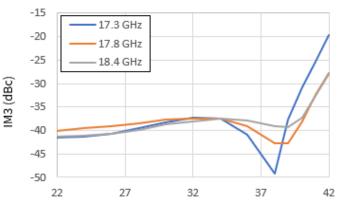
Frequency (GHz)



## Typical Performance Curves - Linearity (IM3 and IM5)

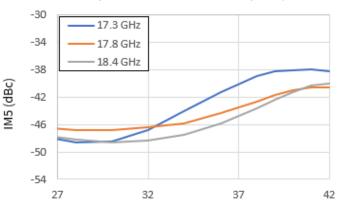
V<sub>D</sub> = 28 V, I<sub>DQ</sub> = 700 mA, CW, Frequency = 17.8 GHz, Tone Spacing = 10 MHz, T<sub>C</sub> = 25°C (unless otherwise stated)

## IM3 vs. Output Power / Tone over Frequency



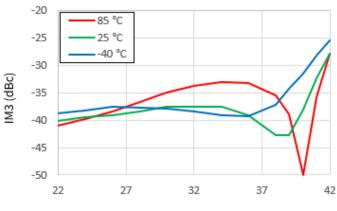
Power Out Per Tone (dBm)

#### IM5 vs. Output Power / Tone over Frequency



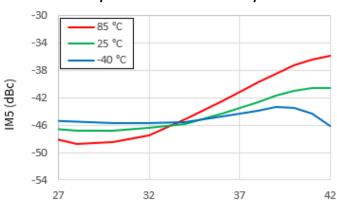
Power Out Per Tone (dBm)

IM3 vs. Output Power / Tone over Temperature



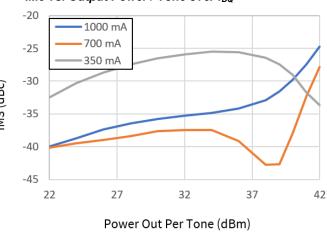
Power Out Per Tone (dBm)

IM5 vs. Output Power / Tone over Temperature

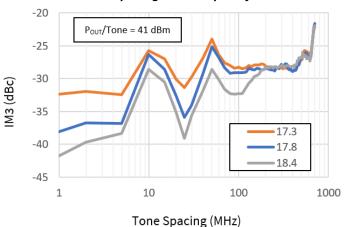


Power Out Per Tone (dBm)

#### IM3 vs. Output Power / Tone over IDQ



IM3 vs. Tone Spacing over Frequency

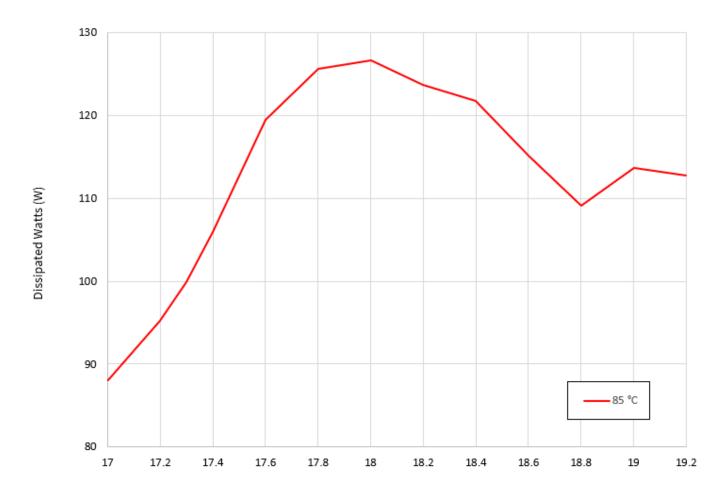




#### **Thermal Characteristics**

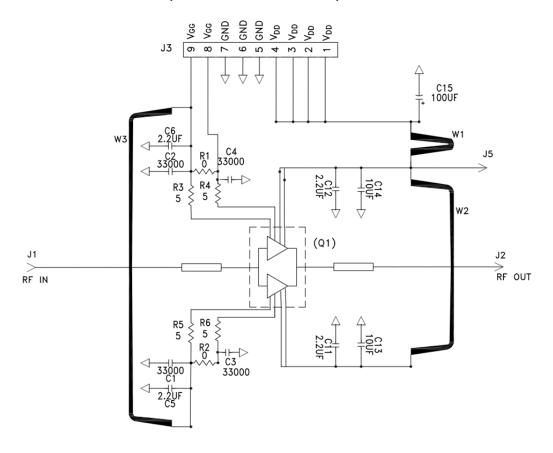
Parameter	Operating Conditions	Value
Operating Junction Temperature $(T_J)$	Freq = 17.8 GHz, $V_D$ = 28 V, $I_{DQ}$ = 700 mA, $I_{DRIVE}$ = 6.35 A, $P_{IN}$ = 23 dBm, $P_{OUT}$ = 47.2 dBm, $P_{DISS}$ = 125.3 W,	215.3°C
Thermal Resistance, Junction to Case ( $R_{\theta JC}$ )	$T_{CASE} = 85^{\circ}C, CW$	1.04°C/W

#### Power Dissipation vs. Frequency ( $T_c = 85^{\circ}C$ )





## **Evaluation Board Schematic (CMPA1H1J050F-AMP)**

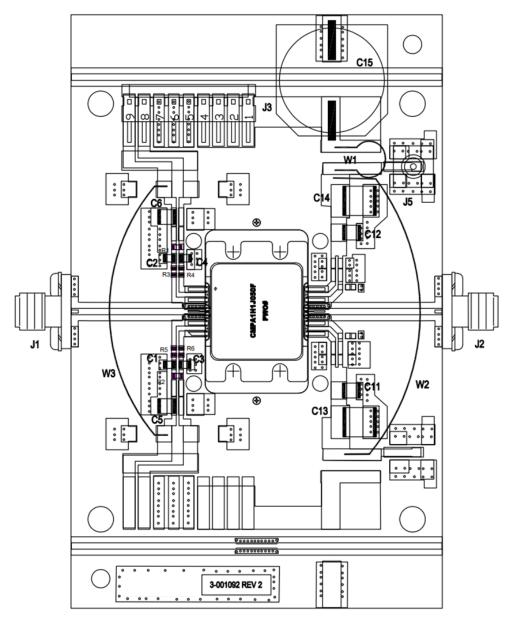


#### **Parts List**

Part	Value	Qty.
C1,C3,C2,C4	CAP, 33000 pF, 0805,100V, X7R	4
C5,C6,C11,C12	CAP, 2.2 μF, 100V, 10%, X7R, 1210	4
C13,C14	CAP, 10 μF, 100V, 10%, X7R, 2220	2
C15	CAP, 100 μF, 20%, 160V, ELEC	1
W1, W2, W3	WIRE, 18 AWG ~ 1.75"	3
J1,J2	CONN, SMA, PANEL MOUNT JACK, FLANGE, 4-HOLE, BLUNT POST, 20MIL	2
J3	HEADER RT>PLZ .1CEN LK 9POS	1
J5	CONN, SMB, STRAIGHT JACK RECEPTACLE, SMT, 50 OHM, Au PLATED	1
Q1	CMPA1H1J050F, MMIC	1
-	PCB, ROGERS 6035 HTC, 2.5x4.0x0.020 IN	1
-	BASEPLATE, CU, 2.5 X 4.0 X 0.5 IN	1
-	2-56 SOC HD SCREW 1/4 SS	4
-	#2 SPLIT LOCKWASHER SS	4
R1,R2	RES,1/16W,0603,1%,0 OHMS	2
R3,R4,R5,R6	RES,1/16W,0603,1%,5.1 OHMS	4



## **Evaluation Board Assembly Drawing (CMPA1H1J050F-AMP)**



## **Bias On Sequence**

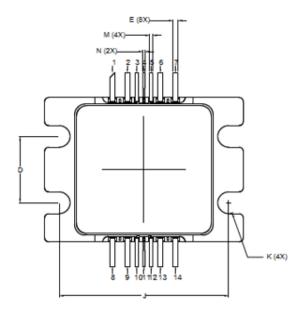
- 1. Ensure RF is turned-off
- 2. Apply pinch-off voltage of -5 V to the gate (V<sub>G</sub>)
- 3. Apply nominal drain voltage (V<sub>D</sub>)
- 4. Adjust Vg to obtain desired quiescent drain current (I<sub>DQ</sub>)
- 5. Apply RF

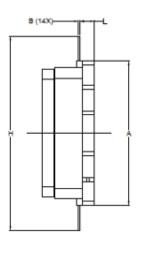
#### **Bias Off Sequence**

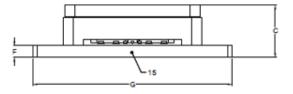
- 1. Turn RF off
- 2. Apply pinch-off to the gate  $(V_G = -5 V)$
- 3. Turn off drain voltage (V<sub>D</sub>)
- 4. Turn off gate voltage (V<sub>G</sub>)



## Mechanical Information<sup>†</sup>







#### NOTES:

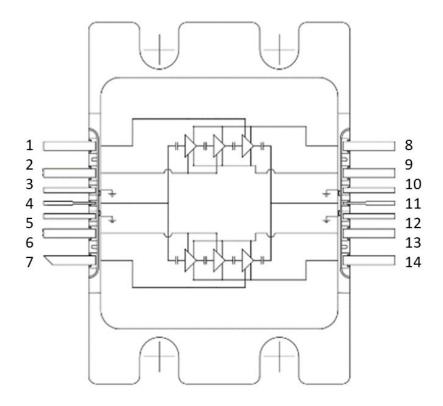
- 1. DIMENSIONING AND TOLERANICING PER ANSI Y14.5M, 1982.
- 2. CONTROLLING DIMENSION: INCH.
- ADHESIVE FROM LID MAY EXTEND A MAXIMUM OF 0.020" BEYOND EDGE OF LID.
- LID MAY BE MISALIGNED TO THE BODY OF THE PACKAGE BY A MAXIMUM OF 0.008" IN ANY DIRECTION.
- 5. ALL PLATED SURFACES ARE NI/AU

	INCHES		MILLIM	ETERS
DIM	MIN	MAX	MIN	MAX
Α	0.679	0.691	17.25	17.55
В	0.003	0.006	0.076	0.152
С	0.234	0.261	5.94	6.63
D	0.307	0.323	7.80	8.20
Ε	0.016	0.032	0.406	0.813
F	0.047	0.063	1.194	1.600
G	0.936	0.954	23.77	24.23
Н	0.912	0.930	23.16	23.62
J	0.795	0.811	20.19	20.60
K	ø0.094	ø0.110	ø2.39	ø2.79
L	0.062	0.078	1.575	1.981
М	0.006	0.022	0.152	0.559
N	0.004	0.018	0.102	0.457



## **Pin Description**

Pin#	Name	Description
1	VG3, Top MMIC	Gate bias - 3rd stage - Top MMIC
2	VG1-2, Top MMIC	Gate bias - 1st and 2nd stages - Top MMIC
3, 5, 10, 12	GND	RF and DC ground
4	RF Input	RF Input. 50-ohm matched. Internally DC blocked.
6	VG1-2, Bot MMIC	Gate bias - 1st and 2nd stages - Bottom MMIC
7	VG3, Bot MMIC	Gate bias - 3rd stage - Bottom MMIC
8, 9	Bias Drain—Top MMIC	Drain bias - Top MMIC - Both must be connected.
11	RF Output	RF Output. 50-ohm matched. Internally DC blocked.
13, 14	Bias Drain—Bot MMIC	Drain bias - Bottom MMIC - Both must be connected.
Base	GND	RF and DC ground



# GaN High Power Amplifier, 60 W 17.3 - 18.4 GHz



CMPA1H1J050F Rev. V1

## **Revision History**

Rev	Date	Change Description
V1	12/20/2024	Production release.

## GaN High Power Amplifier, 60 W 17.3 - 18.4 GHz



CMPA1H1J050F Rev. V1

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