

#### **Features**

Saturated Power: 5 W

Power Added Efficiency: 45%

Large Signal Gain: 32 dB

Small Signal Gain: 40 dB

Input Return Loss: -15 dB

• Output Return Loss: -5 dB

• Pulsed / CW Operation

· Small 4x4 mm footprint



• Military and Commercial Radar

Satellite Communications



MACOM's WSA5080S is a 5W packaged MMIC HPA utilizing MACOM's high performance, 0.15µm GaN on SiC production process. The WSA5080S operates from 8-10.5 GHz and supports both defense and commercial-related radar applications. The WSA5080S achieves 5 W of saturated output power with 32 dB of large signal gain and typically 45% power-added efficiency under pulsed operation. CW operation is also an option.

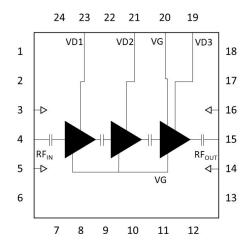
Packaged in a 4x4 mm plastic overmold QFN, the WSA5080S provides superior performance and environmental robustness in a small form factor allowing customers to improve SWaP-C benchmarks in their next-generation systems. Ideal for automated assembly.

#### Ordering Information

Part Number	Package (MOQ/ Mult)
WSA5080S	Tape & Reel (50/50)
WSA5080S-AMP1	Sample Board (1/1)



#### **Functional Schematic**



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

Pin #	Function
1-2, 6-13, 17-18, 22, 24	No Connection
3, 5, 14, 16	RF Ground
4	RF Input
15	RF Output
20	VG
23	VD1
21	VD2
19	VD3

- MACOM recommends connecting No Connection (N/C) pins to ground.
- The exposed pad centered on the package bottom must be connected to RF, DC and thermal ground.



#### RF Electrical Specifications: $V_D = 28 \text{ V}$ , $I_{DQ} = 40 \text{ mA}$ , $T_C = 25^{\circ}\text{C}$ , $Z_0 = 50 \Omega$

Parameter	Test Conditions	Frequency (GHz)	Units	Min.	Тур.	Max.
Output Power		8.5 9.5 10.5	dBm	37 37 37	38 38 38	
Power Added Efficiency	P <sub>IN</sub> = 5 dBm Pulse: 100 μs, 10%	8.5 9.5 10.5	%	44 47 44	47 49 45	-
Large Signal Gain		8.5 9.5 10.5	dB	32 32 32	33 33 33	l
Small Signal Gain	P <sub>IN</sub> = -20 dBm CW	8.5 9.5 10.5	dB	_	40 40 37	_
Input Return Loss		8.5 – 10.5	dB	_	-15	
Output Return Loss		8.5 – 10.5	dB	_	-5	

#### **DC Electrical Specifications:**

Parameter	Units	Min.	Тур.	Max.
Drain Voltage	V	_	28	_
Gate Voltage	V	_	-1.84	_
Quiescent Drain Current		20	40	80
Saturated Drain Current	mA	_	450	_

## GaN High Power Amplifier, 5 W 8 - 10.5 GHz



WSA5080S Rev. V1

#### **Recommended Operating Conditions**

Parameter	Symbol	Unit	Min.	Тур.	Max.
Input Power	P <sub>IN</sub>	dBm		5	
Drain Voltage	$V_D$	V		28	
Gate Voltage	$V_{G}$	V		-1.84	
Quiescent Drain Current	$I_{DQ}$	mA		40	
Operating Temperature	T <sub>C</sub>	°C	-40		+85

#### Absolute Maximum Ratings<sup>3,4</sup>

Parameter	Symbol	Unit	Min.	Max.
Input Power	P <sub>IN</sub>	dBm		8
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>	Α		1.14
Gate Current	I <sub>G</sub>	mA		0.4
Dissipated Power @ +85°	P <sub>DISS</sub>	W		21.63
VSWR		Ratio		5:1
Junction Temperature (MTTF > 1E6 Hrs)	TJ	°C		+225
Storage Temperature	T <sub>STG</sub>	°C	-65	+150
Mounting Temperature (30 seconds)	T <sub>M</sub>	°C		+260

<sup>3.</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 HBM Class 1A and CDM Class C2a devices.

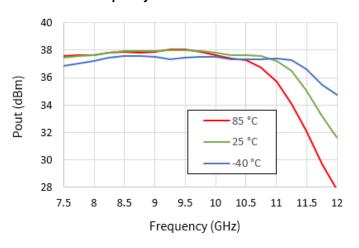
<sup>4.</sup> MACOM does not recommend sustained operation near these survivability limits.



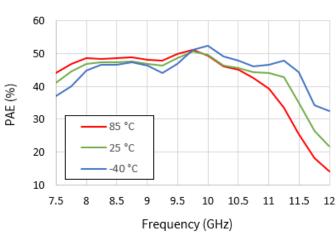
#### **Typical Performance Curves - Large Signal over Temperature:**

 $V_D = 28 \text{ V}, I_{DQ} = 40 \text{ mA}, PW = 100 \mu \text{s}, DC = 10\%, Pin = 5 dBm}$ 

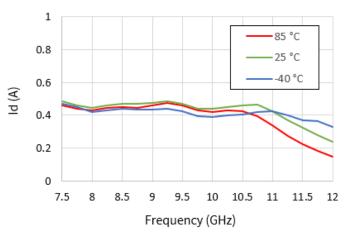
#### Pout vs. Frequency



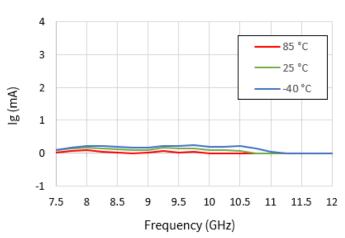
#### PAE vs. Frequency



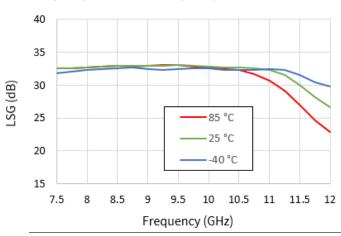
#### Drain Current vs. Frequency



#### Gate Current vs. Frequency



#### Large Signal Gain vs. Frequency





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

 $I_{DQ} = 40 \text{ mA}, PW = 100 \mu \text{s}, DC = 10\%, Pin = 5 dBm, T_{C} = 25^{\circ}\text{C}$ 

#### Pout vs. Frequency 40 38 36 Pout (dBm) 34 28 V 32 26 V 30 24 V 28 8.5 9 9.5 10 10.5 7.5 8 11 11.5 12 Frequency (GHz)

## PAE vs. Frequency 60 50 40 20 10

9.5

Frequency (GHz)

10

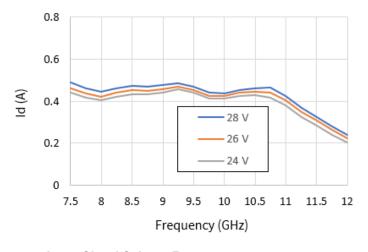
10.5

11

11.5

12

#### Drain Current vs. Frequency



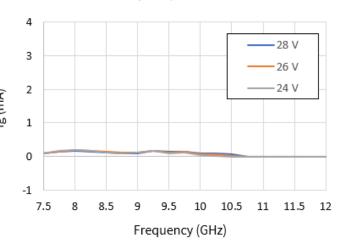
#### Gate Current vs. Frequency

8.5

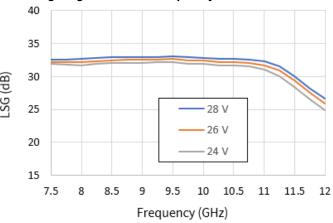
9

8

7.5



#### Large Signal Gain vs. Frequency

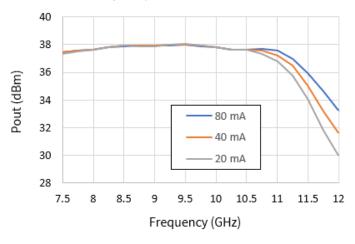




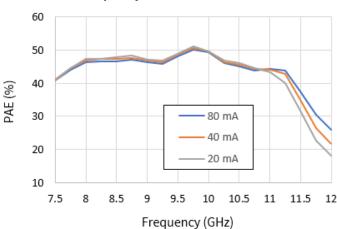
#### Typical Performance Curves - Large Signal over IDQ:

 $V_D = 28 \text{ V}$ , PW = 100  $\mu$ s, DC = 10%, Pin = 5 dBm,  $T_C = 25^{\circ}$ C

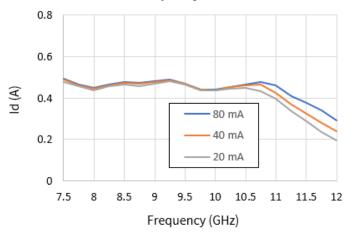
#### Pout vs. Frequency



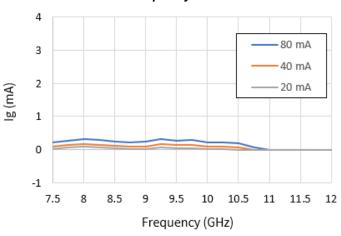
#### PAE vs. Frequency



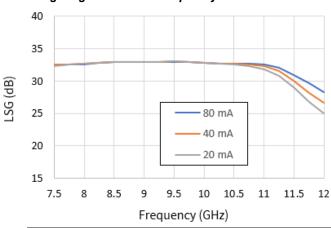
#### Drain Current vs. Frequency



#### Gate Current vs. Frequency



#### Large Signal Gain vs. Frequency

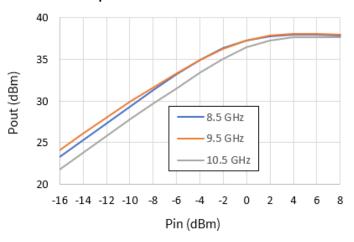




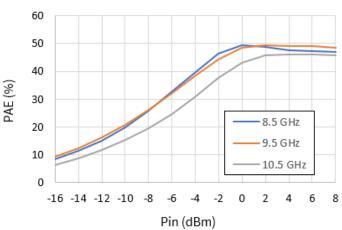
#### **Typical Performance Curves - Drive-Up over Frequency:**

 $V_D = 28 \text{ V}, I_{DQ} = 40 \text{ mA}, PW = 100 \mu s, DC = 10\%, T_C = 25^{\circ}\text{C}$ 

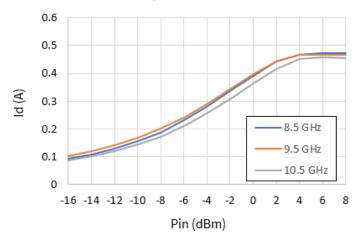
#### Pout vs. Input Power



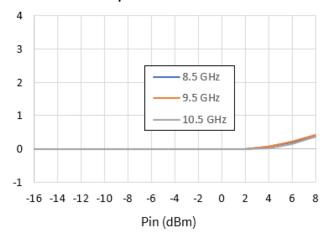
#### PAE vs. Input Power



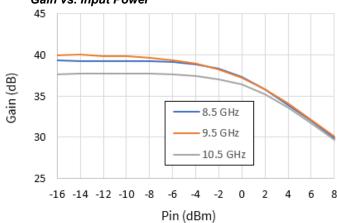
#### Drain Current vs. Input Power



#### Gate Current vs. Input Power



#### Gain vs. Input Power



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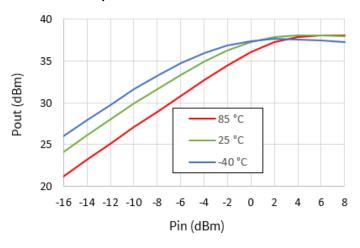
lg (mA)



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

 $V_D = 28 \text{ V}$ ,  $I_{DQ} = 40 \text{ mA}$ , PW = 100  $\mu$ s, DC = 10%, Frequency = 9.5 GHz

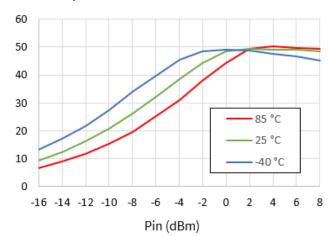
#### Pout vs. Input Power



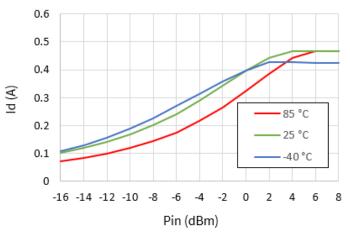
#### PAE vs. Input Power

PAE (%)

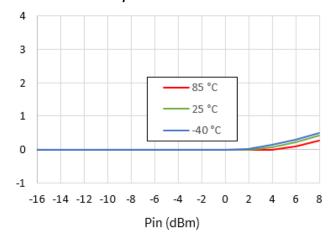
lg (mA)



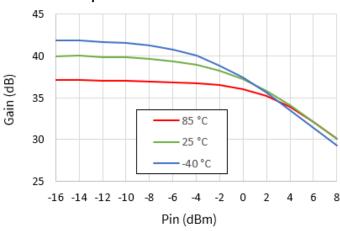
#### Drain Current vs. Input Power



#### Gate Current vs. Input Power



#### Gain vs. Input Power





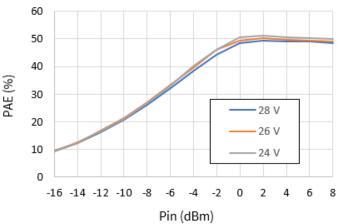
#### Typical Performance Curves - Drive-Up over V<sub>D</sub>:

 $I_{DQ}$  = 40 mA, PW = 100 µs, DC = 10%,  $T_{C}$  = 25°C, Frequency = 9.5 GHz

#### 

Pin (dBm)

#### PAE vs. Input Power

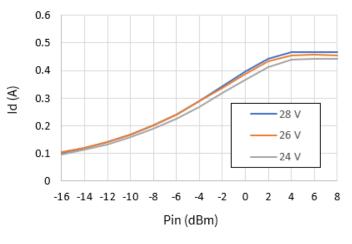


#### Drain Current vs. Input Power

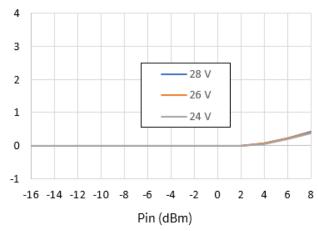
-16 -14 -12 -10 -8

Pout (dBm)

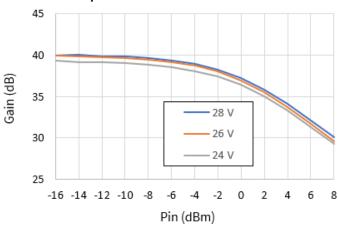
20



#### Gate Current vs. Input Power



#### Gain vs. Input Power



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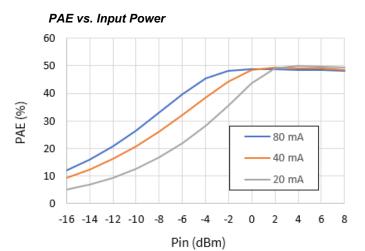
lg (mA)



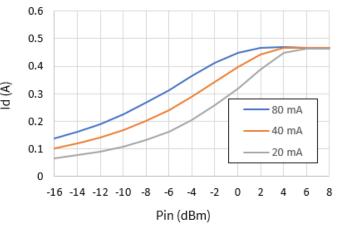
#### Typical Performance Curves - Drive-Up over IDQ:

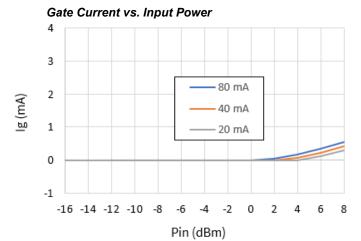
 $V_D = 28 \text{ V}$ , PW = 100  $\mu$ s, DC = 10%,  $T_C = 25$ °C, Frequency = 9.5 GHz

# Pout vs. Input Power 40 35 30 80 mA 40 mA 20 -16 -14 -12 -10 -8 -6 -4 -2 0 2 4 6 8 Pin (dBm)

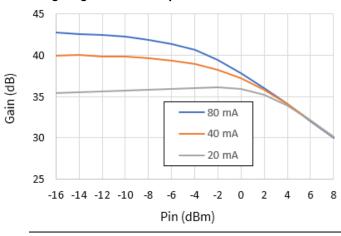


#### Drain Current vs. Input Power





#### Large Signal Gain vs. Input Power



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

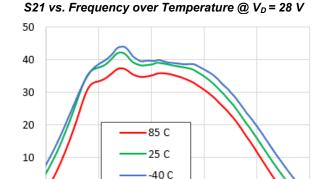
S21 (dB)

 $I_{DQ} = 40 \text{ mA}, CW, Pin = -20 dBm$ 

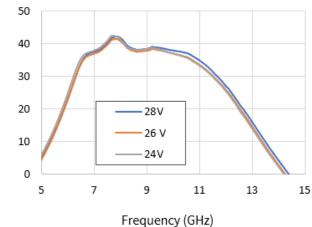
7

0

5



S21 vs. Frequency over  $V_D$  @ 25°C



Frequency (GHz)

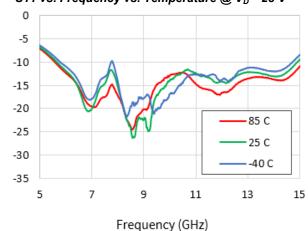
11

13

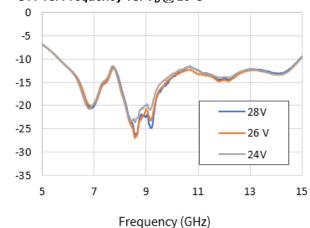
15

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

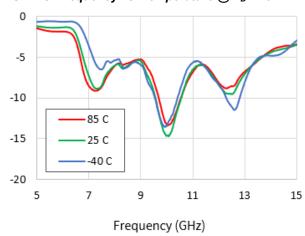
9



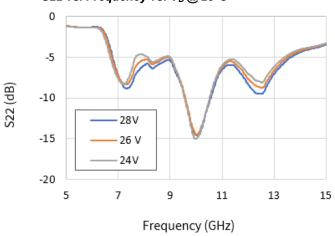
S11 vs. Frequency vs. V<sub>D</sub> @ 25°C



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



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



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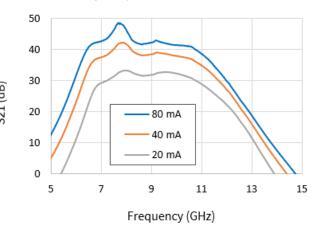
11



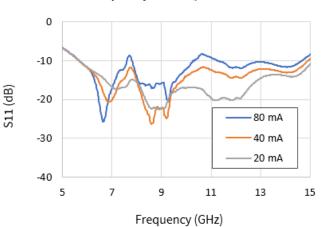
#### Typical Performance Curves - Small Signal over IDQ:

 $V_D$  = 28 V, CW, Pin = -20 dBm,  $T_C$  = 25°C

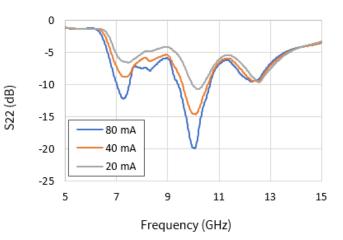
#### S21 vs. Frequency over IDQ



#### S11 vs. Frequency over IDQ



#### S22 vs. Frequency over IDQ

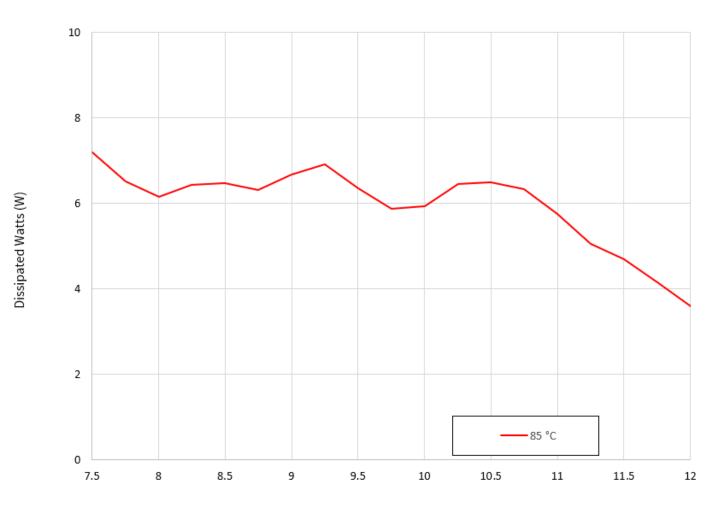




#### **Thermal Characteristics**

Parameter	Operating Conditions	Value
Operating Junction Temperature (T <sub>J</sub> )	Freq = 9.5 GHz, $V_D$ = 28 V, $I_{DQ}$ = 40 mA, $I_{DRIVE}$ = 458mA, $P_{IN}$ = 5 dBm, $P_{OUT}$ = 38 dBm, $P_{DISS}$ = 6.4 W, $T_{CASE}$ = 85°C,	126°C
Thermal Resistance, Junction to Case ( $R_{\theta JC}$ )		6.47°C/W

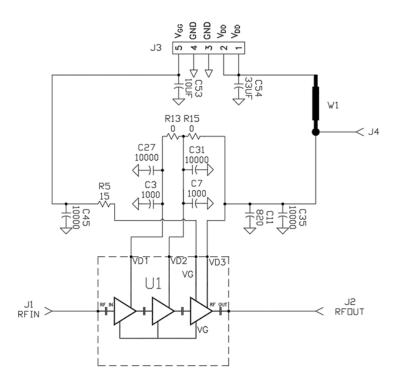
#### Power Dissipation vs. Frequency (T<sub>CASE</sub> = 85°C)



Frequency (GHz)



#### **Evaluation Board Schematic (WSA5080S-AMP1)**

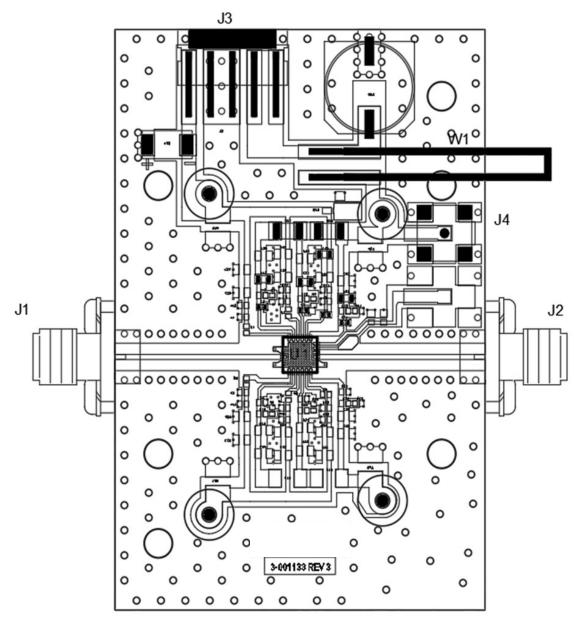


#### **Parts List**

Part	Value	Qty.
C27, C31, C35, C45	CAP, 10nF C0G 0603	4
C3, C7	CAP, 1000pF, C0G, 100V, 0402	2
C11	CAP, 820pF, +/- 5%, 50V, 0402	1
C54	CAP, 33 UF, 20%, G CASE	1
C53	CAP, 10UF, 16V, TANTALUM	1
R5	RES 15 OHM, +/-1%, 1/16W, 0402	1
R13, R15	RES 0.0 OHM 1/16W 1206 SMD	2
J1, J2	CONN, SMA, PANEL MOUNT JACK, FLANGE, 4-HOLE, BLUNT POST, 20MIL	
J4	CONN, SMB, STRAIGHT JACK RECEPTACLE, SMT, 50 OHM, Au PLATED	
J3	HEADER RT>PLZ .1CEN LK 5POS	1
W1	WIRE, BLACK, 20 AWG ~ 3.0"	1
-	PCB, EVAL, WSA5080S, RF-35TC, .010"	1
-	BASEPLATE, 2.6"x1.7"x0.25", AL, 6x6 QFN	1
-	2-56 SOC HD SCREW 3/16 SS	4
-	#2 SPLIT LOCKWASHER SS	4
U1	WSA5080S	1



#### **Evaluation Board Assembly Drawing (WSA5080S-AMP1)**



#### **Bias On Sequence**

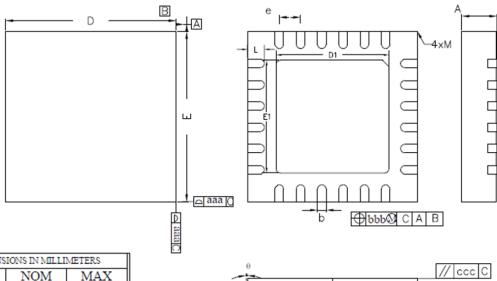
- 1. Ensure RF is turned-off
- 2. Apply pinch-off voltage of -5 V to the gate (V<sub>G</sub>)
- 3. Apply nominal drain voltage (V<sub>D</sub>)
- 4. Adjust Vg to obtain desired quiescent drain current (I<sub>DQ</sub>)
- 5. Apply RF

#### **Bias Off Sequence**

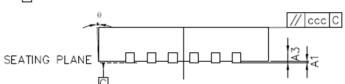
- 1. Turn RF off
- 2. Apply pinch-off to the gate  $(V_G = -5 V)$
- 3. Turn off drain voltage (V<sub>D</sub>)
- 4. Turn off gate voltage (V<sub>G</sub>)



#### **Mechanical Information**



SYMBOLS	DIMENS	DIMENSIONS IN MILLIMETERS			
SINDOLS	MIN	NOM	MAX		
A	0.80	0.90	1.00		
A1	0	0.02	0.05		
A3		0.25REF.			
ь	0.15	0.20	0.25		
D	3.90	4.00	4.10		
D1		2.65BSC			
E	3.90	4.00	4.10		
E1		2.65BSC			
e		0.50BSC			
L	0.30	0.40	0.50		
θ	0		12		
aaa		0.25			
bbb		0.10			
ccc		0.10			
M			0.05		

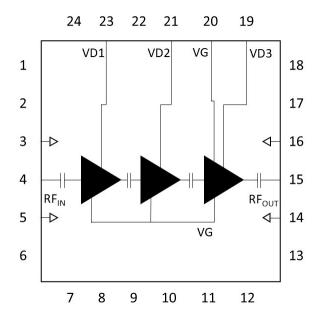


- ALL DIMENSIONS ARE IN MILLMETERS,θ IS IN DEGREES.
- 2.M : THE MAXIMUM ALLOWABLE CORNER ON THE MOLDED PLASTIC BODY CORNERS.
- 3.DIMENSION 'D' DOES NOT INCLUDE MOLD PROTRUSIONS OR GATE BURRS.MOLD PROTRUSIONS AND GATE BURRS SHALL NOT EXCEED 0.15mm PER SIDE.
- 4.DIMENSION 'E' DOES NOT INCLUDE INTERTERMINAL MOLD PROTRUSIONS OR TERMINAL PROTRUSIONS. INTERTERMINAL MOLD PROTRUSIONS AND/OR TERMINAL PROTRUSIONS SHALL NOT EXCEED 0.20mm PER SIDE.
- 5.DIMENSION'6' APPLIES TO PLATED TERMINALS. DIMENSION'A1' IS PRIMARILY Y TERMINAL PLATING, BUT MAY OR MAY NOT INCLUDE A SMALL PROTRUSION OF TERMINAL BELOW THE BOTTOM SURFACE OF THE PACKAGE.
- 6.DIE PADDLE SIZE 2.9mmX2.9mm HAS 2.65mmX2.65mm(BSC) EXPOSED PAD SIZE.
  7.JEDEC STANDARD MO-220.



#### **Pin Description**

Pin #	Name	Description
1,2,6,7,8,9,10,11, 12,13,17,18,22,24	NC	Recommended to connect NC pins to ground.
3	GND	RF and DC ground.
4	RFIN	RF Input. Internally DC blocked.
5	GND	RF and DC ground.
14	GND	RF and DC ground.
15	RFOUT	RF Output. Internally DC blocked.
16	GND	RF and DC ground.
19	VD3	Drain bias for stage 3.
20	VG	Gate bias for entire MMIC.
21	VD2	Drain bias for stage 2.
23	VD1	Drain bias for stage 1.
Paddle	GND	RF and DC ground.



## GaN High Power Amplifier, 5 W 8 - 10.5 GHz



WSA5080S Rev. V1

#### **Revision History**

Rev	Date	Change Description	
V1	09/13/2024	nitial production released document.	

### GaN High Power Amplifier, 5 W 8 - 10.5 GHz



WSA5080S Rev. V1

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