# MACOM PURE CARBIDE.

### Features

- MACOM PURE CARBIDE® Amplifier Series
- Optimized for Cellular Base Station Applications
- Designed for Digital Predistortion Error Correction
  Systems
- Optimized for Asymmetrical Doherty Application
- High Terminal Impedances for Broadband
  Performance
- 50 V Operation
- 100% RF Tested
- RoHS\* Compliant

### Description

The MAPC-A2520 is a high power GaN on Silicon Carbide HEMT D-mode amplifier suitable for asymmetrical Doherty base station applications with 30 W average power and optimized for 3.8 - 4.2 GHz modulated signal operation. The device supports pulsed, and linear operation with peak output power levels to 250 W (54 dBm) in an air cavity ceramic package.

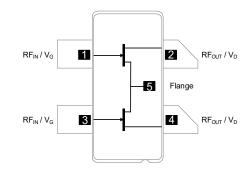
## **Typical Doherty Performance:**

- 3.8 4.2 GHz Evaluation Board
- WCDMA 3GPP TM1, 10 dB PAR @ 0.01% CCDF.
  V<sub>DS</sub> = 50 V, I<sub>DQCAR</sub> = 300 mA, V<sub>GSPK</sub> = -4.5 V,
  T<sub>C</sub> = +25°C, P<sub>OUT</sub> = 44.7 dBm

Frequency (GHz)	GP (dB)	η₀ (%)	Output PAR (dB)	ACPR (dBc)
3.8	13.1	45.5	8.7	-29.1
4.0	14.2	45.3	8.4	-39.0
4.2	13.0	44.0	8.1	-35.4



## Functional Schematic



## **Pin Configuration**

Pin #	Pin Name	Function
1	$RF_{IN} / V_{G}$	RF Input / Gate (Carrier)
2	$RF_{OUT} / V_D$	RF Output / Drain (Carrier)
3	RF <sub>IN</sub> / V <sub>G</sub>	RF Input / Gate (Peaking)
4	RF <sub>OUT</sub> / V <sub>D</sub>	RF Output / Drain (Peaking)
5	Flange <sup>1</sup>	Ground / Source

1. The flange on the package bottom must be connected to RF, DC and thermal ground.

## **Ordering Information**

Part Number	Package
MAPC-A2520-AS000	Bulk Quantity
MAPC-A2520-ASTR1	Tape and Reel
MAPC-A2520-ASSB1	Sample Board

\* Restrictions on Hazardous Substances, compliant to current RoHS EU directive.

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**MAPC-A2520** 

Rev. V1



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### RF Electrical Specifications: T<sub>c</sub> = +25°C, V<sub>DS</sub> = 50 V, I<sub>DQCAR</sub> = 300 mA, V<sub>GSPK</sub> = -4.5 V Note: Performance in MACOM Doherty Evaluation Test Fixture, 50 Ω system.

Parameter	Test Conditions	Symbol	Min.	Тур.	Max.	Units
Small Signal Gain	Pulsed <sup>2</sup> , 4 GHz	G <sub>SS</sub>	-	15.5	-	dB
Saturated Output Power	Pulsed <sup>2</sup> , 4 GHz	P <sub>SAT</sub>	-	53.5	-	dBm
Drain Efficiency at Saturation	Pulsed <sup>2</sup> , 4 GHz	η <sub>sat</sub>	-	56	-	%
AM/PM	Pulsed <sup>2</sup> , 4 GHz	Φ	-	5	-	0
Modulated Peak Power	WCDMA <sup>3</sup> , 4 GHz	P- <sub>2.5dB</sub> <sup>4</sup>	-	53.5	-	dBm
Gain Flatness in 400 MHz	WCDMA <sup>3</sup> , P <sub>OUT</sub> = 44.7 dBm	G <sub>F</sub>	-	1.0	-	dB
Gain Variation (-25°C to +105°C)	WCDMA <sup>3</sup> , 4 GHz, P <sub>OUT</sub> = 44.7 dBm	ΔG	-	0.017	-	dB/∘C
Power Variation (-25°C to +105°C)	Pulsed <sup>2</sup> , 4 GHz	$\Delta P_{-1dB}$	-	0.016	-	dB/∘C
Power Gain	WCDMA <sup>3</sup> , 4 GHz, P <sub>OUT</sub> = 44.7 dBm	G <sub>P</sub>	-	14.2	-	dB
Drain Efficiency	WCDMA <sup>3</sup> , 4 GHz, P <sub>OUT</sub> = 44.7 dBm	η	-	45.2	-	%
Output PAR @ 0.01% CCDF	WCDMA <sup>3</sup> , 4 GHz, P <sub>OUT</sub> = 44.7 dBm	PAR	-	8.4	-	dB
Adjacent Channel Power Ratio	WCDMA <sup>3</sup> , 4 GHz, P <sub>OUT</sub> = 44.7 dBm	ACPR	-	-39.0	-	dBc
Input Return Loss	WCDMA <sup>3</sup> , 4 GHz, P <sub>OUT</sub> = 44.7 dBm	IRL	-	-23	-	dB
Ruggedness: Output Mismatch	All phase angles	Ψ	VSWR =	10:1, No	Device I	Damage

#### RF Electrical Specifications: $T_A = +25^{\circ}C$ , $V_{DS} = 50 V$ , $I_{DQCAR} = 300 mA$ , $V_{GSPK} = -4.5 V$ Note: Performance in MACOM Doherty Production Test Fixture, 50 Ω system.

Parameter	Test Conditions	Symbol	Min.	Тур.	Max.	Units
Power Gain	WCDMA <sup>3</sup> , 4 GHz, P <sub>OUT</sub> = 44.7 dBm	G <sub>P</sub>	12.4	13.4	-	dB
Drain Efficiency	WCDMA <sup>3</sup> , 4 GHz, P <sub>OUT</sub> = 44.7 dBm	η	31.5	37.5	-	%
Output PAR @ 0.01% CCDF	WCDMA <sup>3</sup> , 4 GHz, P <sub>OUT</sub> = 44.7 dBm	PAR	7.8	8.5	-	dB
Input Return Loss	WCDMA <sup>3</sup> , 4 GHz, P <sub>OUT</sub> = 44.7 dBm	IRL	-	-11.7	-6	dB

Pulse details: 100 µs pulse width, 10% Duty Cycle.
 Modulated Signal: 3.84 MHz, WCMDA 3 GPP TM1 64 DPCH, 9.9 dB PAR @ 0.01% CCDF.

4. P2.5dB = P<sub>OUT</sub> + 7.5 dB where P<sub>OUT</sub> is the average output power measured using a modulated signal<sup>3</sup> where the output PAR is compressed to 7.5 dB @ 0.01% probability CCDF.

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# MACOM PURE CARBIDE.

#### MAPC-A2520 Rev. V1

## DC Electrical Characteristics T<sub>A</sub> = 25°C

Parameter	Test Conditions	Symbol	Min.	Тур.	Max.	Units		
Carrier Amplifier								
Drain-Source Breakdown Voltage	V <sub>GS</sub> = -8 V, V <sub>DS</sub> = 130 V	V <sub>BDS</sub>	130	-	-	V		
Gate-Source Leakage Current	V <sub>GS</sub> = -8 V, V <sub>DS</sub> = 0 V	I <sub>GLK</sub>	-	0.008	-	mA		
Gate-Source Leakage Current	$V_{GS}$ = -8 V, $V_{DS}$ = 50 V	I <sub>GLK</sub>	-	-	0.90	mA		
Gate Threshold Voltage	V <sub>DS</sub> = 50 V, I <sub>D</sub> = 10.56 mA	V <sub>T</sub>	-4.0	-3.1	-	V		
Gate Quiescent Voltage	V <sub>DS</sub> = 50 V, I <sub>D</sub> = 130 mA	V <sub>DS</sub> = 50 V, I <sub>D</sub> = 130 mA V <sub>GSQ</sub> -3.1		-2.8	-2.1	V		
Maximum Drain Current	$V_{DS}$ = 7 V pulsed, pulse width 300 µs I <sub>D, N</sub>		-	9.0	-	А		
	Peaking Amplifier							
Drain-Source Breakdown Voltage	V <sub>GS</sub> = -8 V, V <sub>DS</sub> = 130 V	V <sub>BDS</sub>	130	-	-	V		
Gate-Source Leakage Current	V <sub>GS</sub> = -8 V, V <sub>DS</sub> = 0 V	I <sub>GLK</sub>	-	0.016	-	mA		
Gate-Source Leakage Current	$V_{GS}$ = -8 V, $V_{DS}$ = 50 V	I <sub>GLK</sub>	-	-	1.79	mA		
Gate Threshold Voltage	V <sub>DS</sub> = 50 V, I <sub>D</sub> = 21.12 mA	VT	-4.0	-3.1	-	V		
Gate Quiescent Voltage	V <sub>DS</sub> = 50 V, I <sub>D</sub> = 250 mA V <sub>GSQ</sub> -3.1 -2.8		-2.1	V				
Maximum Drain Current	$V_{DS}$ = 7 V pulsed, pulse width 300 µs	I <sub>D, MAX</sub>	-	18.0	-	А		

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## Absolute Maximum Ratings<sup>5,6,7,8.9</sup>

Parameter	Absolute Maximum
Drain Source Voltage, V <sub>DS</sub>	200 V
Gate Source Voltage, V <sub>GS</sub>	-15 to 3 V
Gate Current (Carrier), I <sub>G</sub>	10.6 mA
Gate Current (Peaking), I <sub>G</sub>	21.1 mA
Storage Temperature Range	-65°C to +150°C
Case Operating Temperature Range	-40°C to +120°C
Channel Operating Temperature Range, T <sub>CH</sub>	-40°C to +225°C
Absolute Maximum Channel Temperature	+250°C

Exceeding any one or combination of these limits may cause permanent damage to this device. 5

6. MACOM does not recommend sustained operation above maximum operating conditions.

7.

8.

Operating at drain source voltage V<sub>DS</sub> < 55 V will ensure MTTF > 1.22 x 10<sup>6</sup> hours Operating at nominal conditions with T<sub>CH</sub> ≤ 225°C will ensure MTTF > 1.22 x 10<sup>6</sup> hours. MTTF may be estimated by the expression MTTF (hours) = A  $e^{[B + C/(T+273)]}$  where *T* is the channel temperature in degrees Celsius. 9.

A = 0.84, B = -34.75, and C = 24,369.

## Thermal Characteristics<sup>10</sup>

Parameter	Test Conditions	Symbol	Typical	Units
Thermal Resistance using Finite Element Analysis	V <sub>DS</sub> = 50 V T <sub>C</sub> = 85°C,T <sub>CH</sub> = 225°C	R <sub>θ</sub> (FEA)	2.3	°C/W
Thermal Resistance using Infrared Measurement of Die Surface Temperature	V <sub>DS</sub> = 50 V T <sub>C</sub> = 85°C,T <sub>CH</sub> = 225°C	R <sub>0</sub> (IR)	1.84	°C/W

Case temperature measured using thermocouple embedded in heat-sink. Contact local applications support team for more details on 10. this measurement.

#### Handling Procedures

Please observe the following precautions to avoid damage:

#### Static Sensitivity

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

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# MACOM PURE CARBIDE.

## Pulsed<sup>2</sup> Load-Pull Performance: Reference Plane at Device Leads

			Carrier Amplifier: Maximum Output Power							
			V <sub>DS</sub> = 50 V, I <sub>DQ</sub> = 130 mA, T <sub>C</sub> = 25°C, P2.5dB							
Frequency (GHz)	Z <sub>SOURCE</sub> (Ω)	Z <sub>LOAD</sub> <sup>11</sup> (Ω)	Gain (dB)	Р <sub>оит</sub> (dBm)	Р <sub>оит</sub> (W)	η₀ (%)	AM/PM (°)			
3.8	19.0 - j30.0	8.5 - j4.1	16.0	49.8	95.5	55.4	4.3			
4.0	45.1 - j37.1	8.8 - j3.1	16.3	49.7	93.3	55.8	2.3			
4.2	55.1 - j19.0	8.0 - j3.2	15.7	49.7	93.3	55.2	3.8			

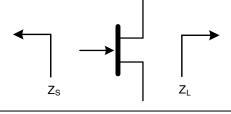
			Carrier Amplifier: Maximum Drain Efficiency $V_{DS}$ = 50 V, $I_{DQ}$ = 130 mA, T <sub>C</sub> = 25°C, P2.5dB							
		42	$v_{\rm DS} = 50$ V	v, i <sub>dq</sub> = 130 m/	$A, I_C = 25^{\circ}C, I$	2.50B				
Frequency (GHz)	Z <sub>SOURCE</sub> (Ω)	Z <sub>LOAD</sub> <sup>12</sup> (Ω)	Gain (dB)	Р <sub>оит</sub> (dBm)	Р <sub>оυт</sub> (W)	η₀ (%)	AM/PM (°)			
3.8	19.0 - j30.0	4.9 - j9.1	18.6	48.0	63.1	66.7	-3.7			
4.0	45.1 - j37.1	7.0 - j9.7	19.3	48.1	64.6	66.2	-5.6			
4.2	55.1 - j19.0	9.0 - j12.3	18.5	47.5	56.2	67.1	5.7			

		Peaking Amplifier: Maximum Output Power V <sub>DS</sub> = 50 V, I <sub>DQ</sub> = 250 mA, T <sub>C</sub> = 25°C, P2.5dB						
Frequency (GHz)	Z <sub>SOURCE</sub> (Ω)	Z <sub>LOAD</sub> <sup>11</sup> (Ω)	Gain (dB)	Р <sub>оит</sub> (dBm)	Р <sub>оит</sub> (W)	η₀ (%)	AM/PM (°)	
3.8	6.0 - j19.0	4.9 - j5.3	16.6	52.6	182.0	51.0	4.4	
4.0	9.5 - j22.0	4.5 - j5.0	16.5	52.5	177.8	50.6	5.2	
4.2	34 - j9.0	3.9 - j5.1	16.1	52.6	182.0	51.9	5.3	

			Peaking Amplifier: Maximum Drain Efficiency $V_{DS}$ = 50 V, $I_{DQ}$ = 250 mA, $T_C$ = 25°C, P2.5dB						
Frequency (GHz)	Z <sub>SOURCE</sub> (Ω)	Z <sub>LOAD</sub> <sup>12</sup> (Ω)	Gain (dB)	Р <sub>оит</sub> (dBm)	Р <sub>оит</sub> (W)	η₀ (%)	AM/PM (°)		
3.8	6.0 - j19.0	3.9 - j8.0	18.8	51.7	147.9	60.1	2.8		
4.0	9.5 - j22.0	4.9 - j8.9	19.5	51.1	128.8	60.1	6.3		
4.2	34 - j9.0	5.9 - j8.5	18.2	51.1	128.8	61.5	4.1		

#### Impedance Reference

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Z<sub>SOURCE</sub> = Measured impedance presented to the input of the device at package reference plane.

 $Z_{LOAD}$  = Measured impedance presented to the output of the device at package reference plane.

11. Load Impedance for optimum output power.

12. Load Impedance for optimum efficiency.

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# GaN Amplifier 50 V, 30 W AVG 3.8 - 4.2 GHz

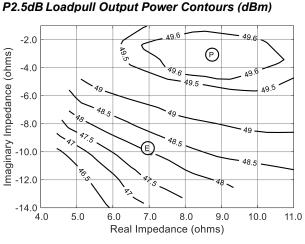


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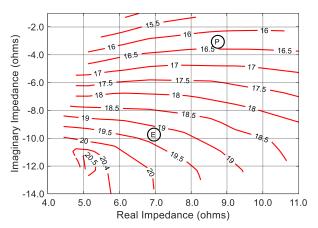
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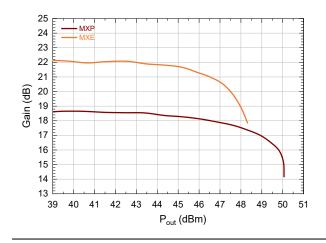
## Pulsed<sup>2</sup> Load-Pull Performance: Carrier Amplifier 4.0 GHz



P2.5dB Loadpull Gain Contours (dB)

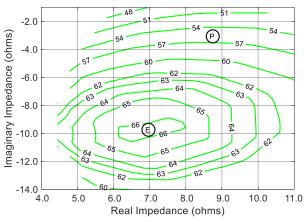


Gain vs. Output Power

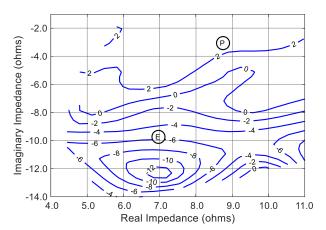


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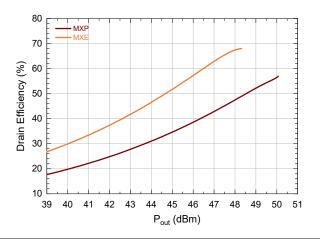
P2.5dB Loadpull Drain Efficiency Contours (%)



P2.5dB Loadpull AM/PM Contours (°)



Drain Efficiency vs. Output Power



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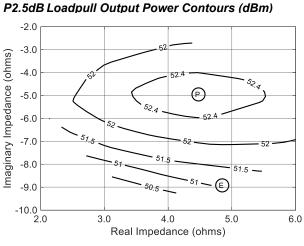
# GaN Amplifier 50 V, 30 W AVG 3.8 - 4.2 GHz



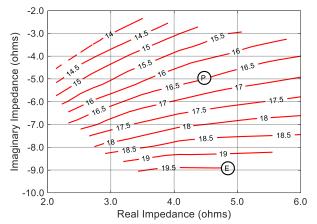
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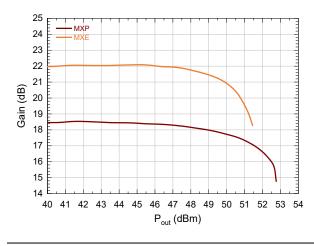
## Pulsed<sup>2</sup> Load-Pull Performance: Peaking Amplifier 4.0 GHz



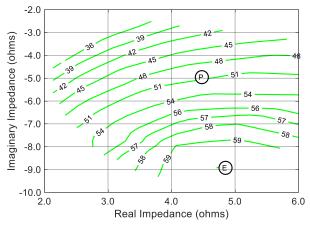




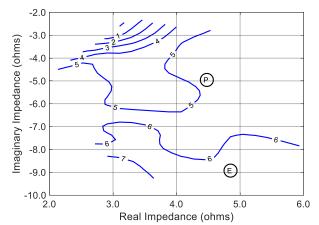




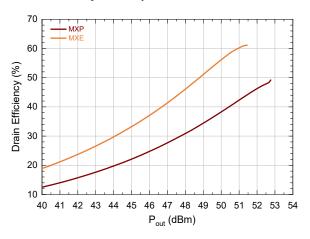
P2.5dB Loadpull Drain Efficiency Contours (%)



P2.5dB Loadpull AM/PM Contours (°)



Drain Efficiency vs. Output Power



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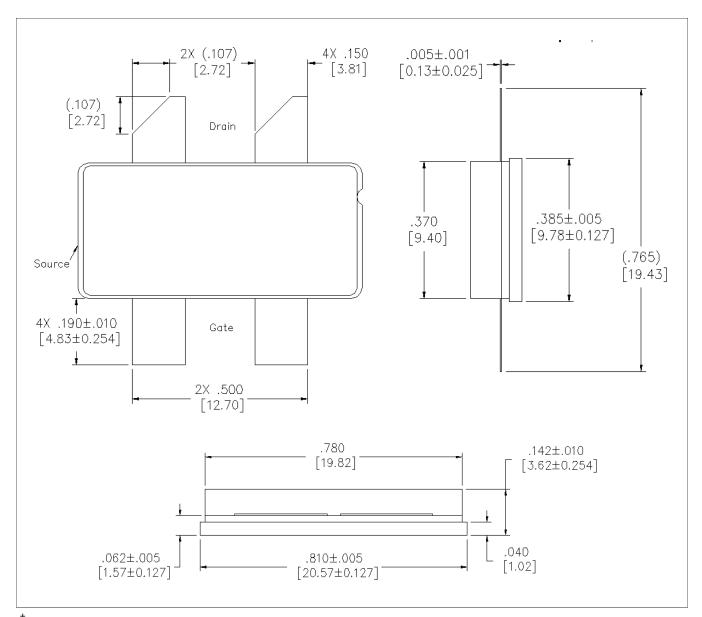
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# GaN Amplifier 50 V, 30 W AVG 3.8 - 4.2 GHz



## MACOM PURE CARBIDE.

Lead-Free AC-780S-4 Package Dimensions<sup>†</sup>



 Reference Application Note AN0004363 for lead-free solder reflow recommendations. Meets JEDEC moisture sensitivity level 3 requirements. Plating is Au.

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