#### Features

- 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-A2500-B is a high power GaN on Silicon Carbide HEMT D-mode amplifier suitable for asymmetrical Doherty base station applications with 60W average power and optimized for 3.3 - 3.8 GHz modulated signal operation. The device supports pulsed, and linear operation with peak output power levels to 420 W (56.2 dBm) in an air cavity ceramic package.

#### **Typical Doherty Performance:**

 WCDMA 3GPP TM1, 10 dB PAR @ 0.01% CCDF. V<sub>DS</sub> = 50 V, I<sub>DQCAR</sub> = 350 mA, V<sub>GSPK</sub> = -5.0 V, T<sub>C</sub> = 25°C, P<sub>OUT</sub> = 47.8 dBm

Frequency (GHz)	GP (dB)	η <sub>D</sub> (%)	Output PAR (dB)	ACPR (dBc)
3.4	12.2	38.3	7.5	-27.6
3.6	13.1	40.5	7.7	-37.8
3.8	12.0	38.1	7.8	-29.1

# AC-780S-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	$\mathrm{RF}_{\mathrm{OUT}}$ / $\mathrm{V}_{\mathrm{D}}$	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-A2500-BS000	Bulk Quantity
MAPC-A2500-BSTR1	Tape and Reel
MAPC-A2500-BSSB1	Sample Board

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



MAPC-A2500-B

Rev. V2

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#### RF Electrical Specifications: $T_c = 25^{\circ}C$ , $V_{DS} = 50 V$ , $I_{DQCAR} = 350 mA$ , $V_{GSPK} = -5.0 V$ 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> , 3.6 GHz	G <sub>SS</sub>	-	14.5	-	dB
Saturated Output Power	Pulsed <sup>2</sup> , 3.6 GHz	P <sub>SAT</sub>	-	55.1	-	dBm
Drain Efficiency at Saturation	Pulsed <sup>2</sup> , 3.6 GHz	η <sub>sat</sub>	-	44	-	%
AM/PM	Pulsed <sup>2</sup> , 3.6 GHz	Φ	-	6	-	o
Modulated Peak Power	WCDMA <sup>3</sup> , 3.6 GHz	P- <sub>2.5dB</sub> <sup>4</sup>	-	55.0	-	dBm
VBW Resonance Point	IMD 3rd Order Inflection Point	$VBW_{RES}$	-	300	-	MHz
Gain Flatness in 400 MHz	WCDMA <sup>3</sup> , P <sub>OUT</sub> = 47.8 dBm	G <sub>F</sub>	-	1.1	-	dB
Gain Variation (-25°C to +105°C)	WCDMA <sup>3</sup> , 3.6 GHz, P <sub>OUT</sub> = 47.8 dBm	ΔG	-	0.015	-	dB/°C
Power Variation (-25°C to +105°C)	Pulsed <sup>2</sup> , 3.6 GHz	$\Delta P_{-1dB}$	-	0.011	-	dB/°C
Power Gain	WCDMA <sup>3</sup> , 3.6 GHz, P <sub>OUT</sub> = 47.8 dBm	G <sub>P</sub>	-	13.1	-	dB
Drain Efficiency	WCDMA <sup>3</sup> , 3.6 GHz, P <sub>OUT</sub> = 47.8 dBm	η	-	40	-	%
Output PAR @ 0.01% CCDF	WCDMA <sup>3</sup> , 3.6 GHz, P <sub>OUT</sub> = 47.8 dBm	PAR	-	7.7	-	dB
Adjacent Channel Power Ratio	WCDMA <sup>3</sup> , 3.6 GHz, P <sub>OUT</sub> = 47.8 dBm	ACPR	-	-37	-	dBc
Input Return Loss	WCDMA <sup>3</sup> , 3.6 GHz, P <sub>OUT</sub> = 47.8 dBm	IRL18 -		dB		
Ruggedness: Output Mismatch	All phase angles	Ψ	VSWR = 10:1, No Device Dam		Damage	

#### RF Electrical Specifications: $T_A = 25^{\circ}C$ , $V_{DS} = 50 V$ , $I_{DQCAR} = 350 mA$ , $V_{GSPK} = -4.8 V$ 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> , 3.6 GHz, P <sub>OUT</sub> = 47.8 dBm	G <sub>P</sub>	11	12.5	-	dB
Drain Efficiency	WCDMA <sup>3</sup> , 3.6 GHz, P <sub>OUT</sub> = 47.8 dBm	η	33	37	-	%
Output PAR @ 0.01% CCDF	WCDMA <sup>3</sup> , 3.6 GHz, P <sub>OUT</sub> = 47.8 dBm	PAR	7.2	7.8	-	dB
Input Return Loss	WCDMA <sup>3</sup> , 3.6 GHz, P <sub>OUT</sub> = 47.8 dBm	IRL	-	-19	-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.

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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#### **MAPC-A2500-B**

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#### 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, I <sub>D</sub> = 17.8 mA	$V_{BDS}$	130	-	-	V	
Gate-Source Leakage Current	$V_{GS}$ = -8 V, $V_{DS}$ = 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>	-	-	3.0	mA	
Gate Threshold Voltage	V <sub>DS</sub> = 50 V, I <sub>D</sub> = 17.8 mA	V <sub>T</sub>	-5.0	-2.7	-	V	
Gate Quiescent Voltage	V <sub>DS</sub> = 50 V, I <sub>D</sub> = 350 mA	V <sub>GSQ</sub>	-3.0	-2.5	-2.0	V	
Maximum Drain Current	m Drain Current $V_{DS}$ = 7 V pulsed, pulse width 300 µs		-	15.1	-	А	
	Peaking Amplifier						
Drain-Source Breakdown Voltage	V <sub>GS</sub> = -8 V, I <sub>D</sub> = 31.2 mA	$V_{BDS}$	130	-	-	V	
Gate-Source Leakage Current	$V_{GS}$ = -8 V, $V_{DS}$ = 0 V	I <sub>GLK</sub>	-	0.027	-	mA	
Gate-Source Leakage Current	$V_{GS}$ = -8 V, $V_{DS}$ = 50 V	I <sub>GLK</sub>	-	-	4.5	mA	
Gate Threshold Voltage	V <sub>DS</sub> = 50 V, I <sub>D</sub> = 31.2 mA	VT	-5.0	-2.8	-	V	
Gate Quiescent Voltage	V <sub>DS</sub> = 50 V, I <sub>D</sub> = 450 mA	$V_{GSQ}$	-3.1	-2.6	-2.1	V	
Maximum Drain Current	$V_{DS}$ = 7 V pulsed, pulse width 300 µs	I <sub>D, MAX</sub>	-	26.5	-	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>	130 V
Gate Source Voltage, V <sub>GS</sub>	-10 to 3 V
Gate Current (Carrier), I <sub>G</sub>	17.8 mA
Gate Current (Peaking), I <sub>G</sub>	31.2 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

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

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 > 2.51 x 10<sup>6</sup> hours. Operating at nominal conditions with T<sub>CH</sub> ≤ 225°C will ensure MTTF > 2.51 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 = 1.93, B = -45.31, and C = 29,585.

## 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	$R_{\theta}(FEA)$	1.07	°C/W
Thermal Resistance using Infrared Measurement of Die Surface Temperature	V <sub>DS</sub> = 50 V T <sub>C</sub> =85°С,T <sub>CH</sub> = 225°С	$R_{\theta}(IR)$	0.87	°C/W

10. Case temperature measured using thermocouple embedded in heat-sink. Contact local applications support team for more details on 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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# **MAPC-A2500-B**

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# 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> = 250 m/	A, T <sub>c</sub> = 25°C, F	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 (°)
3.3	2.7 - j14.3	6.1 - j6.8	16.9	52.3	170.0	57.1	3.2
3.4	3.7 - j15.8	6.8 - j6.7	17.1	52.2	166.0	56.2	0.9
3.6	10.0 - j16.7	7.9 - j5.6	17.3	52.2	166.0	57.3	-5.2
3.8	10.3 - j6.2	7.6 - j3.6	16.9	52.0	158.5	57.4	-0.0
		Carrier Amplifier: Maximum Drain Efficiency					
			V <sub>DS</sub> = 50 V	/, I <sub>DQ</sub> = 250 m/	A, T <sub>c</sub> = 25°C, F	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)	η <sub>⊳</sub> (%)	AM/PM (°)
3.3	2.6 - j14.3	3.4 - j8.7	18.4	51.3	134.9	65.1	3.9
3.4	3.7 - j15.6	4.1 - j9.4	18.6	51.1	128.8	65.0	-1.8
3.6	10.7 - j16.3	6.0 - j10.6	19.1	50.8	120.2	65.5	-20.9
3.8	8.4 - j5.8	9.7 - j9.4	18.4	50.7	117.5	65.5	-8.3
			Peaking A	Amplifier: Max	imum Output	Power	
			V <sub>DS</sub> = 50 V	/, I <sub>DQ</sub> = 450 m/	A, T <sub>c</sub> = 25°C, F	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 (°)
3.3	3.3 - j14.2	5.7 - j8.5	15.1	54.7	295.1	50.0	1.3
3.4	4.7 - j15.2	6.2 - j8.8	15.4	54.6	288.4	49.2	-1.4
3.6	10.4 - j14.8	8.2 - j8.4	15.6	54.5	281.3	48.8	2.4
3.8	10.2 - j6.6	9.0 - j6.1	15.3	54.4	275.4	47.2	9.0
			Peaking A	mplifier: Maxii	mum Drain Ef	ficiency	
			V <sub>DS</sub> = 50 V	/, I <sub>DQ</sub> = 450 m/	A, T <sub>c</sub> = 25°C, F	P2.5dB	
	_	- 12					

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 (%)	АМ/РМ (°)
3.3	3.4 - j14.3	3.0 - j8.9	16.6	53.9	245.5	56.9	2.6
3.4	4.8 - j15.3	3.4 - j9.5	16.8	53.7	234.4	55.0	-2.5
3.6	10.9 - j14.9	4.6 - j10.5	17.1	53.6	229.1	54.4	1.1
3.8	9.0 - j6.2	7.0 - j10.9	16.7	53.4	218.8	52.6	6.1

#### Impedance Reference



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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<sup>5</sup> 

# GaN Amplifier 50 V, 60 W AVG 3.3 - 3.8 GHz



# MACOM PURE CARBIDE.

MAPC-A2500-B Rev. V2

# Pulsed<sup>2</sup> Load-Pull Performance: Carrier Amplifier 3.6 GHz



P2.5dB Loadpull Gain Contours (dB)



Gain vs. Output Power



#### P2.5dB Loadpull Output Power Contours (dBm)



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, 60 W AVG 3.3 - 3.8 GHz



# MACOM PURE CARBIDE.

P2.5dB Loadpull Output Power Contours (dBm)

MAPC-A2500-B Rev. V2

## Pulsed<sup>2</sup> Load-Pull Performance: Peaking Amplifier 3.6 GHz



P2.5dB Loadpull Gain Contours (dB)



Gain vs. Output Power



#### P2.5dB Loadpull Drain Efficiency Contours (%)



P2.5dB Loadpull AM/PM Contours (°)







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<sup>7</sup> 

# GaN Amplifier 50 V, 60 W AVG 3.3 - 3.8 GHz

**MAPC-A2500-B** 

Rev. V2

# 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.

<sup>8</sup> 

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