GaN Amplifier 50 V, 50 W
3.4 - 4.0 GHz

MAPC-A2001
Rev. V1

Features

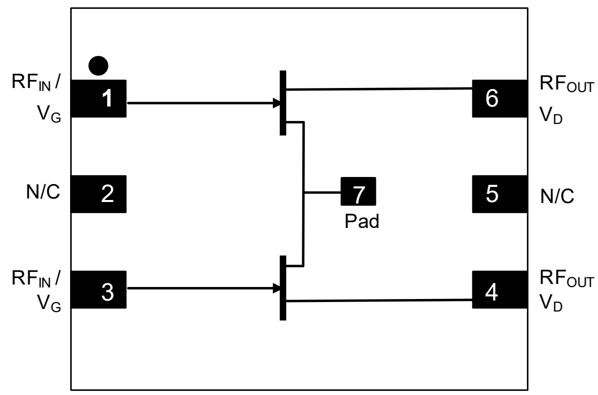
- Optimized for Cellular Base Station Applications
- Designed for Digital Predistortion Error Correction Systems
- High Terminal Impedances for Broadband Performance
- 50 V Operation
- Compatible with MACOM Power Management Bias Controller/Sequencer MABC-11040
- 100 % RF Tested
- RoHS* Compliant

7.0 x 6.5 mm DFN

Description

The MAPC-A2001 is a higher power GaN on Silicon Carbide HEMT D-mode amplifier designed for 5G base station applications and optimized for 3.4 - 4.0 GHz modulated signal operation. The device supports pulsed and linear operation with peak output power levels to 50W (47 dBm) in a 7.0 x 6.5mm DFN package.

Functional Schematic



Typical RF Performance

- WCDMA 3GPP TM1 64 DPCH 9.9 dB PAR @ 0.01% CCDF, V_{DS} = 50 V, I_{DQCAR} = 60 mA, V_{GSPK} = -4.5 V, T_{CASE} = 25°C, P_{OUT} = 38.5 dBm.

Frequency (GHz)	G_P (dB)	η_D (%)	Output PAR (dB)	ACPR (dBc)
3.4	14.9	52	8.1	-29
3.6	16.1	50	8.5	-31
3.8	15.2	50	8.4	-31

Pin Configuration

Pin #	Pin Name	Function
1	RF_{IN} / V_G	RF Input / Gate (Carrier)
2,5	N/C	No Connection
3	RF_{IN} / V_G	RF Input / Gate (Peaking)
4	RF_{OUT} / V_D	RF Output / Drain (Peaking)
6	RF_{OUT} / V_D	RF Output / Drain (Carrier)
7	Pad[1]	Ground / Source

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

Ordering Information

Part Number	Package
MAPC-A2001-AD000	Bulk Quantity
MAPC-A2001-ADTR1	Tape and Reel
MAPC-A2001-ADSB1	Doherty Sample Board

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

RF Electrical Characteristics: T_C = 25°C, V_{DS} = 50 V, I_{DQCAR} = 60 mA, V_{GSPK} = -4.4 V
Note: Performance in MACOM Doherty Evaluation Test Fixture, 50 Ω system.

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Small Signal Gain	Pulsed[2], 3.6 GHz	G_{SS}	-	17.0	-	dB
Saturated Output Power	Pulsed[2], 3.6 GHz	P_{SAT}	-	46.9	-	dBm
Drain Efficiency at Saturation	Pulsed[2], 3.6 GHz	η_{SAT}	-	62	-	%
AM/PM	Pulsed[2], 3.6 GHz	Φ	-	7	-	°
Modulated Peak Power	WCDMA[3], 3.6 GHz	P2.5dB[4]	-	47.7	-	dBm
Gain Flatness in 60MHz	WCDMA[3], P_{OUT} = 38.5dBm	G_F	-	0.5	-	dB
Gain Variation (-25°C to +105°C)	WCDMA[3], 3.6 GHz, P_{OUT} = 38.5dBm	ΔG	-	0.02	-	dB/°C
Power Variation (-25°C to +105°C)	Pulsed[2], 3.6 GHz	ΔP2.5dB[4]	-	0.01	-	dB/°C
Power Gain	WCDMA[3], 3.6 GHz, P_{OUT} = 38.5dBm	G_P	-	16.1	-	dB
Drain Efficiency	WCDMA[3], 3.6 GHz, P_{OUT} = 38.5dBm	η	-	50	-	%
Output CCDF @ 0.01%	WCDMA[3], 3.6 GHz, P_{OUT} = 38.5dBm	PAR	-	8.5	-	dB
Adjacent Channel Power	WCDMA[3], 3.6 GHz, P_{OUT} = 38.5dBm	ACP	-	-31	-	dBc
Input Return Loss	WCDMA[3], 3.6 GHz, P_{OUT} = 38.5dBm	IRL	-	-11	-	dB
Ruggedness: Output Mismatch	All phase angles	Ψ	VSWR = 10:1, No Device Damage			

RF Electrical Characteristics: T_A = 25°C, V_{DS} = 50 V, I_{DQCAR} = 50 mA, V_{GSPK} = -3.6 V
Note: Performance in MACOM Doherty Production Test Fixture, 50 Ω system.

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Power Gain	WCDMA[3], 3.7 GHz, P_{OUT} = 38.5 dBm	G_P	12.2	13.6	-	dB
Drain Efficiency	WCDMA[3], 3.7 GHz, P_{OUT} = 38.5 dBm	η	35.5	40.1	-	%
Output CCDF @ 0.01%	WCDMA[3], 3.7 GHz, P_{OUT} = 38.5 dBm	PAR	6.4	7.5	-	dB
Adjacent Channel Power	WCDMA[3], 3.7 GHz, P_{OUT} = 38.5 dBm	ACP	-	-36.5	-25	dBc
Input Return Loss	WCDMA[3], 3.7 GHz, P_{OUT} = 38.5 dBm	IRL	-	-9.5	-3	dB

2. Pulse details: 100 µs pulse width, 1 ms period, 10% Duty Cycle
3. Modulated Signal: 3.84MHz, WCDMA 3GPP TM1 64 DPCH, 9.9dB PAR @ 0.01% CCDF
4. P2.5dB = P_{OUT} + 7.5 dB where P_{OUT} is the average output power measured using a modulated signal[3] where the output PAR is compressed to 7.5 dB @ 0.01% probability CCDF.

DC Electrical Characteristics: T_C = 25°C

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Carrier Amplifier						
Drain-Source Leakage Current	V_{GS} = -8 V, V_{DS} = 130 V	I_{DLK}	-	-	2.04	mA
Gate-Source Leakage Current	V_{GS} = -8 V, V_{DS} = 0 V	I_{GLK}	-	-	-2.04	mA
Gate Threshold Voltage	V_{DS} = 50 V, I_D = 2.04 mA	V_T	-3.3	-2.9	-	V
Gate Quiescent Voltage	V_{DS} = 50 V, I_D = 50 mA	V_{GSQ}	-	-2.6	-	V
On Resistance	V_{GS} = 2 V, I_D = 20.4 mA	R_{ON}	-	1.6	-	Ω
Maximum Drain Current	V_{DS} = 7 V pulsed, pulse width 300 μs	$I_{D,MAX}$	-	2.43	-	A
Peaking Amplifier						
Drain-Source Leakage Current	V_{GS} = -8 V, V_{DS} = 130 V	I_{DLK}	-	-	3.31	mA
Gate-Source Leakage Current	V_{GS} = -8 V, V_{DS} = 0 V	I_{GLK}	-	-	-3.31	mA
Gate Threshold Voltage	V_{DS} = 50 V, I_D = 3.31 mA	V_T	-3.3	-2.9	-	V
Gate Quiescent Voltage	V_{DS} = 50 V, I_D = 66 mA	V_{GSQ}	-	-2.7	-	V
On Resistance	V_{GS} = 2 V, I_D = 33.1 mA	R_{ON}	-	1.0	-	Ω
Maximum Drain Current	V_{DS} = 7 V pulsed, pulse width 300 μs	$I_{D,MAX}$	-	3.94	-	A

Absolute Maximum Ratings[5,6,7,8,9]

Parameter	Absolute Maximum
Drain Source Voltage, V_{DS}	130 V
Gate Source Voltage, V_{GS}	-10 to 3 V
Gate Current (Carrier), I_G	4.1 mA
Gate Current (Peaking), I_G	6.6 mA
Storage Temperature Range	-65°C to +150°C
Case Operating Temperature Range	-40°C to +120°C
Channel Operating Temperature Range, T_{CH}	-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. Operating at drain source voltage V_{DS} < 55 V will ensure MTTF > 2 x 10^6 hours.
8. Operating at nominal conditions with $T_{CH} \leq 225°C$ will ensure MTTF > 2.51 x 10^6 hours.
9. MTTF may be estimated by the expression MTTF (hours) = A $e^{[B + C/(T+273)]}$ where *T* is the channel temperature in degrees Celsius, *A* = 1.93, *B* = -45.31, and *C* = 29,585.

Thermal Characteristics[10]

Parameter	Test Conditions	Symbol	Typical	Units
Thermal Resistance using Finite Element Analysis	V_{DS} = 50 V T_C = 85°C, T_{CH} = 225°C	R_θ(FEA)	7.49	°C/W
Thermal Resistance using Infrared Measurement of Die Surface Temperature	V_{DS} = 50 V T_C = 85°C, T_{CH} = 225°C	R_θ(IR)	5.25	°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.

Pulsed[2] Load-Pull Performance
Reference Plane at Device Leads

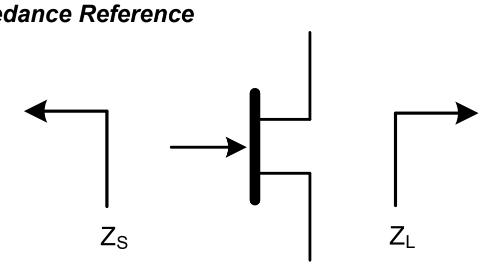
Frequency (GHz)	Z_{SOURCE} (Ω)	Carrier Amplifier: Maximum Output Power					
		V_{DS} = 50 V, I_{DQ} = 40 mA, T_C = 25°C, P2.5dB					
		Z_{LOAD}[11] (Ω)	Gain (dB)	P_{OUT} (dBm)	P_{OUT} (W)	η_D (%)	AM/PM (°)
3.4	7.3 - j36.4	16.9 + j5.5	17.6	43.9	24.5	62	-17.0
3.7	22.6 - j44.4	16.3 + j4.6	17.1	43.8	24.0	63	-43.8
4.0	27.0 - j15.7	16.3 + j4.4	16.1	43.3	21.4	60	-94.7

Frequency (GHz)	Z_{SOURCE} (Ω)	Carrier Amplifier: Maximum Drain Efficiency					
		V_{DS} = 50 V, I_{DQ} = 40 mA, T_C = 25°C, P2.5dB					
		Z_{LOAD}[12] (Ω)	Gain (dB)	P_{OUT} (dBm)	P_{OUT} (W)	η_D (%)	AM/PM (°)
3.4	8.6 - j40.7	11.0 + j12.6	19.5	42.4	17.4	69	-27.7
3.7	42.2 - 49.2	9.0 + j11.3	19.2	42.0	15.8	75	-60.9
4.0	19.3 - j7.9	8.2 + j11.3	17.6	41.4	13.8	71	-120.2

Frequency (GHz)	Z_{SOURCE} (Ω)	Peaking Amplifier: Maximum Output Power					
		V_{DS} = 50 V, I_{DQ} = 66 mA, T_C = 25°C, P2.5dB					
		Z_{LOAD}[11] (Ω)	Gain (dB)	P_{OUT} (dBm)	P_{OUT} (W)	η_D (%)	AM/PM (°)
3.4	10.8 - j44.7	11.0 - j0.6	16.8	46.0	39.8	60	-24.9
3.7	30.3 - j49.9	10.2 - j1.4	16.4	46.1	40.7	62	-49.7
4.0	36.6 - j12.9	9.3 - j1.4	15.8	45.7	37.2	60	-95.2

Frequency (GHz)	Z_{SOURCE} (Ω)	Peaking Amplifier: Maximum Drain Efficiency					
		V_{DS} = 50 V, I_{DQ} = 66 mA, T_C = 25°C, P2.5dB					
		Z_{LOAD}[12] (Ω)	Gain (dB)	P_{OUT} (dBm)	P_{OUT} (W)	η_D (%)	AM/PM (°)
3.4	11.2 - j47.8	7.8 + j4.1	18.4	44.8	30.2	67	-32.8
3.7	43.0 - j57.2	6.2 + j3.1	18.2	44.6	28.8	71	-62.1
4.0	30.1 - j6.1	6.0 + j2.7	17.1	44.4	27.5	69	-122.8

Impedance Reference

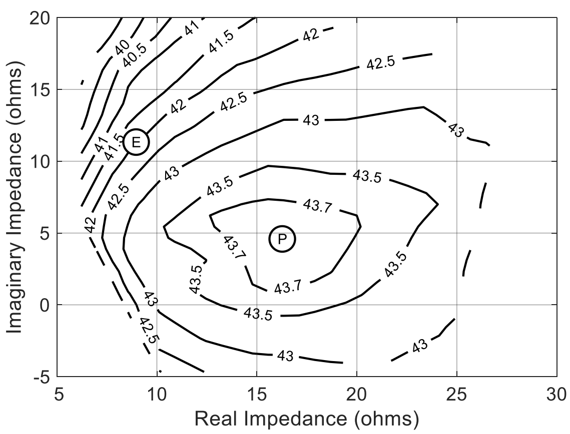


Z_{SOURCE} = Measured impedance presented to the input of the device at package reference plane.
Z_{LOAD} = Measured impedance presented to the output of the device at package reference plane.

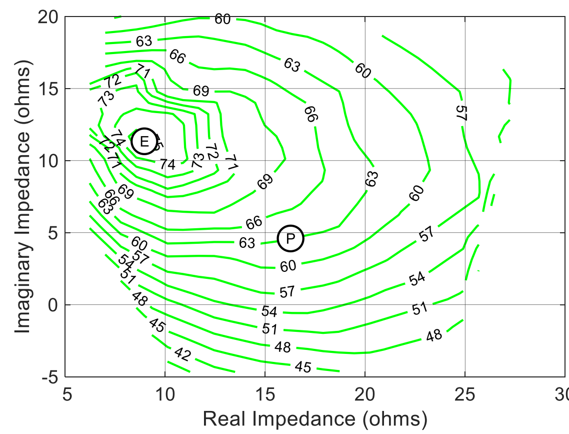
11. Load Impedance for optimum output power.
12. Load Impedance for optimum efficiency.

Pulsed[2] Load-Pull Performance
Carrier Amplifier 3.7 GHz

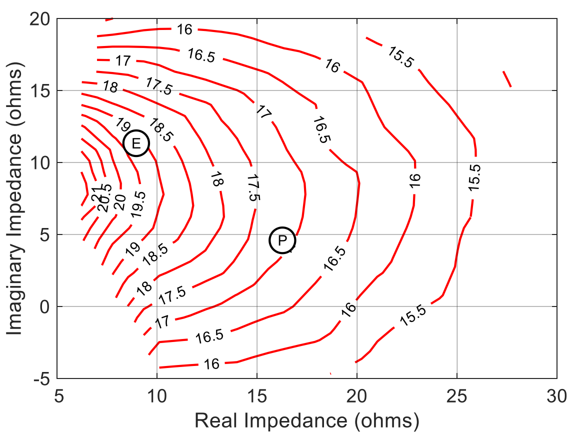
P2.5dB Loadpull Output Power Contours (dBm)



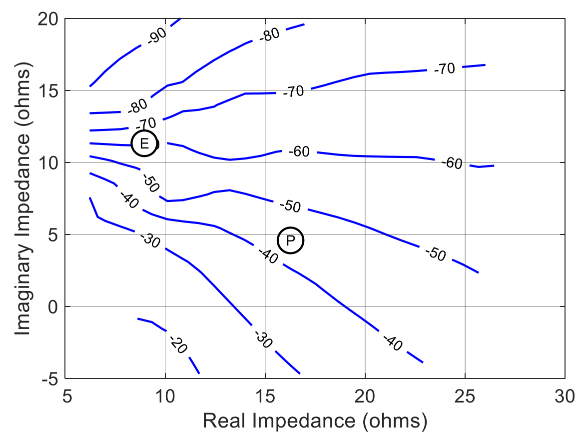
P2.5dB Loadpull Drain Efficiency Contours (%)



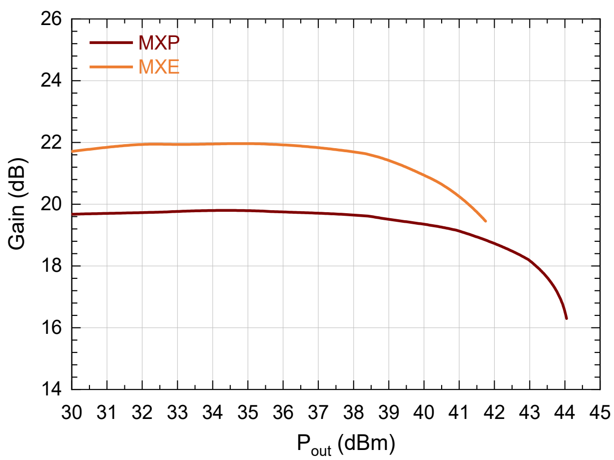
P2.5dB Loadpull Gain Contours (dB)



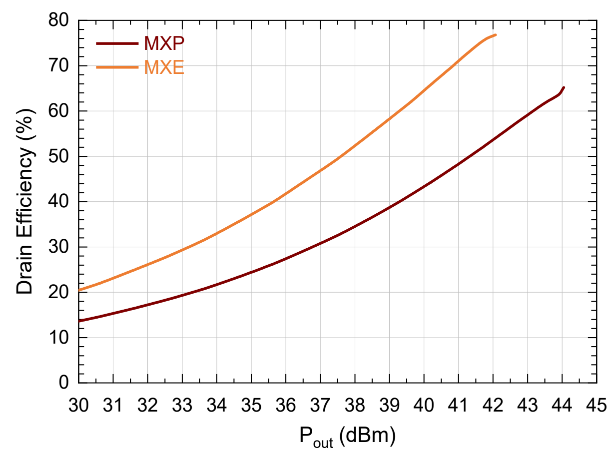
P2.5dB Loadpull AM/PM Contours (°)



Gain vs. Output Power

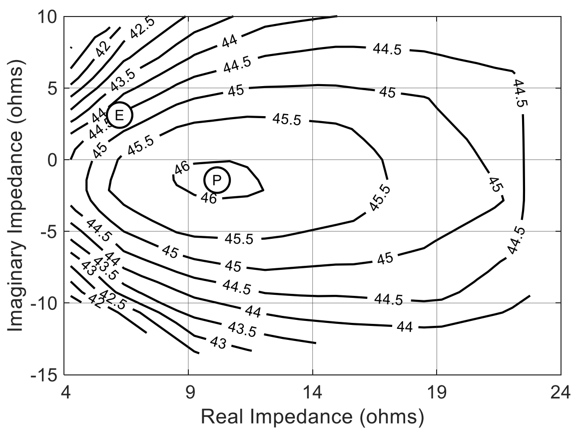


Drain Efficiency vs. Output Power

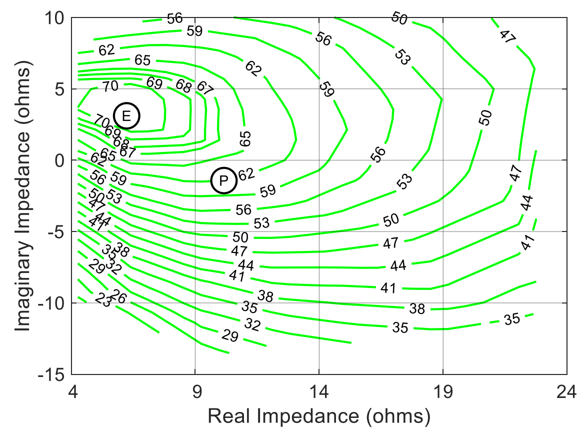


Pulsed[2] Load-Pull Performance
Peaking Amplifier 3.7 GHz

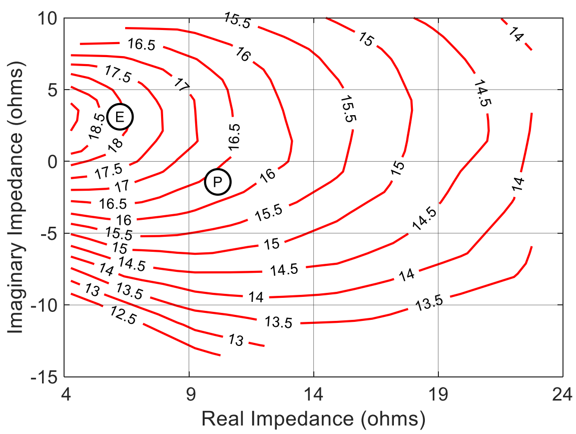
P2.5dB Loadpull Output Power Contours (dBm)



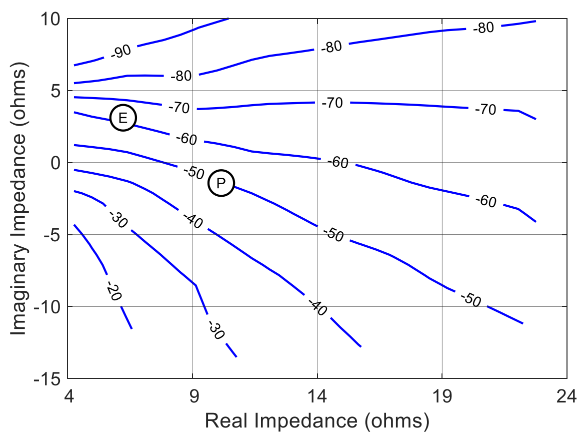
P2.5dB Loadpull Drain Efficiency Contours (%)



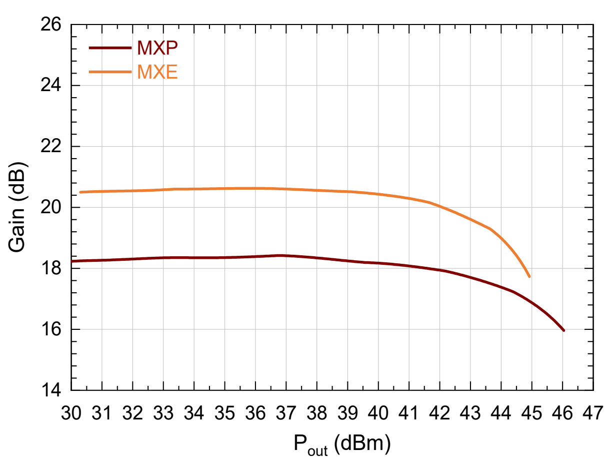
P2.5dB Loadpull Gain Contours (dB)



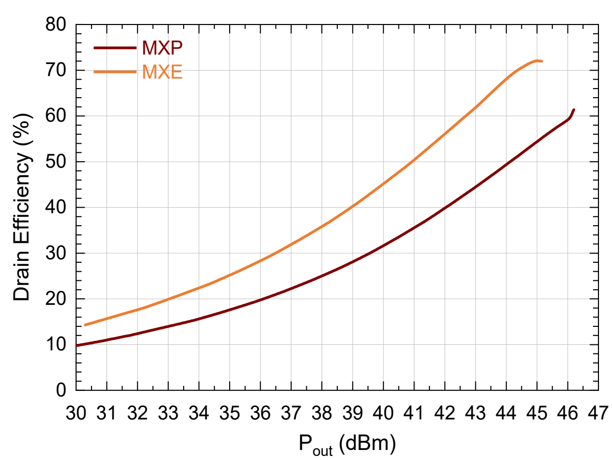
P2.5dB Loadpull AM/PM Contours (°)



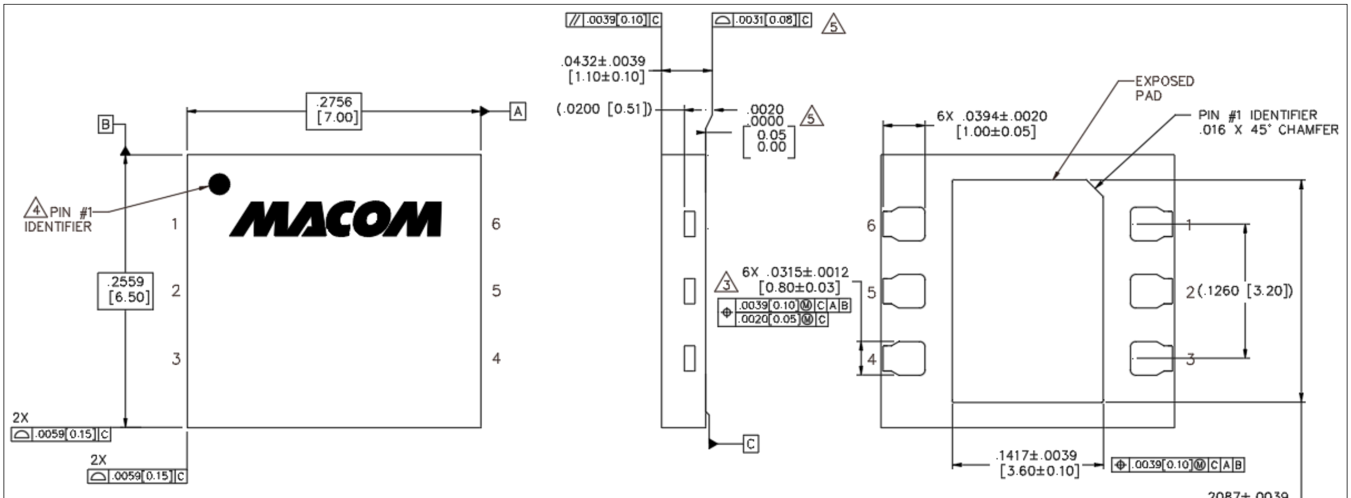
Gain vs. Output Power



Drain Efficiency vs. Output Power



Lead-Free 7.0 x 6.5 mm 6-Lead Package Dimensions†



NOTES:
1. ALL DIMENSIONS AND TOLERANCES ARE BASED ON JEDEC MO–220, VAR WITH SAW SINGULATION. ALL DIMENSIONS SHOWN AS in[mm]. CONTROLLING DIMENSIONS ARE IN mm AND CONVERTED in DIMENSIONS ARE NOT NECESSARILY EXACT.
2. ELECTROSTATIC DISCHARGE CONTROL PROGRAM FOR THE PROTECTION OF ELECTRICAL AND ELECTRONIC PARTS, ASSEMBLIES AND EQUIPMENT SHALL BE IN ACCORANCE WITH ANSI/ESD 20.20.
3. INDICATED DIMENSIONS/TOLERANCES APPLY TO THE PLATED LEAD AND IS MEASURED BETWEEN .0059[0.15] AND .0118[0.30] FROM THE LEAD END. LEAD NECK DOWN FEATURE IS OPTIONAL.
4. EXACT SIZE AND SHAPE OF THIS FEATURE IS OPTIONAL.
5. INDICATED DIMENSIONS/TOLERANCES APPLY TO LEADS AND EXPOSED PAD.
6. ALL MATERIALS DESCRIBED IN THIS DOCUMENT/DRAWING SHALL BE IN COMPLIANCE WITH AND CONTAIN NO SUBSTANCES RESTRICTED OR REQUIRING SPECIAL RECLAMATION UNDER THE LATEST ROHS, WEEE OR ELV DIRECTIVES.

† Reference Application Note S2083 for lead-free solder reflow recommendations.
Meets JEDEC moisture sensitivity level (MSL) 3 requirements.
Plating is NiPdAu.