Features

- *MACOM PURE CARBIDE*™ Amplifier Series
- Optimized for 1.8 - 2.7 GHz Applications
- High Terminal Impedances for Broadband Performance
- 26 - 32 V Operation
- Low Thermal Resistance
- 100% RF Tested
- RoHS* Compliant

4 mm QFN

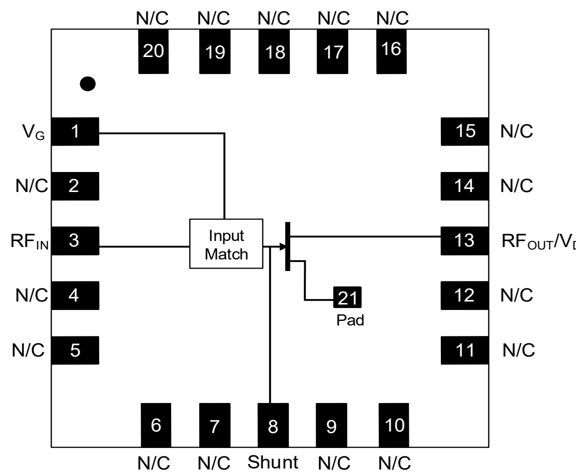
Applications

- 5G Cellular Networks
- Tri-band Small Cells

Description

The MAPC-A2021 is a GaN on Silicon Carbide HEMT D-mode amplifier suitable for applications 1W average power and optimized for 1.8 - 2.7 GHz modulated signal operation. The device supports pulsed, and linear operation with peak output power levels to 8 W (39 dBm) in an 4 mm surface mount QFN package.

Functional Schematic



Typical Circuit Performance:

- WCDMA 3GPP TM1, 10 dB PAR @ 0.01% CCDF. V_{DS} = 32 V, I_{DQ} = 60 mA, T_C = 25°C, P_{OUT} = 32 dBm

Frequency (GHz)	GP (dB)	η_D (%)	Output PAR (dB)	ACPR (dBc)
1.8	16.1	37	7.2	-35.5
2.3	15.9	36	6.9	-37.1
2.7	16.4	38	6.8	-35.5

Pin Configuration

Pin #	Pin Name	Function
1	V_G	Gate Voltage
2, 4-7, 9-12, 14-20	N/C	Not Connected
3	RF_{IN}	RF Input
8	SHUNT	Gate Shunt Capacitor
13	RF_{OUT} / V_D	RF Output / Drain Voltage
21	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-A2021-AQ000	Bulk Quantity
MAPC-A2021-AQTR1	Tape and Reel
MAPC-A2021-AQSB1	Sample Board

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

RF Electrical Characteristics: T_C = 25°C, V_{DS} = 32 V, I_{DQ} = 60 mA
Note: Performance in MACOM Single-ended Class-AB Evaluation Circuit, 50 Ω system.

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Small Signal Gain	Pulsed[2], 2.7 GHz	G_{SS}	-	17.9	-	dB
Saturated Output Power	Pulsed[2], 2.7 GHz	P_{SAT}	-	38.3	-	dBm
Drain Efficiency at Saturation	Pulsed[2], 2.7 GHz	η_{SAT}	-	67	-	%
Modulated Peak Power	WCDMA[3], 2.7 GHz	P2.5dB[4]	-	38.8	-	dBm
Gain Flatness in 60MHz	WCDMA[3], P_{OUT} = 32 dBm	G_F	-	0.1	-	dB
Gain Variation (-25°C to +105°C)	WCDMA[3], 2.7 GHz, P_{OUT} = 32 dBm	ΔG	-	0.015	-	dB/°C
Power Variation (-25°C to +105°C)	Pulsed[2], 2.7 GHz	Δ P2.5dB	-	0.006	-	dBm/°C
Power Gain	WCDMA[3], 2.7 GHz, P_{OUT} = 32 dBm	G_P	-	16.4	-	dB
Drain Efficiency	WCDMA[3], 2.7 GHz, P_{OUT} = 32 dBm	η	-	38	-	%
Output CCDF @ 0.01%	WCDMA[3], 2.7 GHz, P_{OUT} = 32 dBm	PAR	-	6.8	-	dB
Adjacent Channel Power	WCDMA[3], 2.7 GHz, P_{OUT} = 32 dBm	ACP	-	-35.5	-	dBc
Input Return Loss	WCDMA[3], 2.7 GHz, P_{OUT} = 32 dBm	IRL	-	-14	-	dB
Ruggedness: Output Mismatch	All phase angles	Ψ	VSWR = 10:1, No Device Damage			

2. Pulse details: 100 μs pulse width, 1 ms period, 10% Duty Cycle
3. Modulated Signal: 3.84MHz, WCDMA 3GPP TM1 64 DPCH, 9.9 dB 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[5] where the output PAR is compressed to 7.5 dB @ 0.01% probability CCDF.

RF Electrical Characteristics: T_A = 25°C, V_{DS} = 32 V, I_{DQ} = 60 mA
Note: Performance in MACOM Single-ended Class-AB Production Test Fixture, 50 Ω system.

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Power Gain	WCDMA[3], 2.7 GHz, P_{OUT} = 33 dBm	G_P	14.0	14.7	-	dB
Drain Efficiency	WCDMA[3], 2.7 GHz, P_{OUT} = 33 dBm	η	34.0	37.6	-	%
Output CCDF @ 0.01%	WCDMA[3], 2.7 GHz, P_{OUT} = 33 dBm	PAR	6.2	6.6	-	dB
Input Return Loss	WCDMA[3], 2.7 GHz, P_{OUT} = 33 dBm	IRL	-	-6	-	dB

DC Electrical Characteristics: T_C = 25°C

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Drain-Source Leakage Current	V_{GS} = -8 V, V_{DS} = 100 V	I_{DLK}	-	-	1.4	mA
Gate-Source Leakage Current	V_{GS} = -8 V, V_{DS} = 0 V	I_{GLK}	-	-	-1.4	mA
Gate Threshold Voltage	V_{DS} = 32 V, I_D = 1.4 mA	V_T	-	-2.9	-	V
Gate Quiescent Voltage	V_{DS} = 32 V, I_D = 60 mA	V_{GSQ}	-	-2.4	-	V
Maximum Drain Current	V_{DS} = 7 V, pulse width 300 μs	$I_{D, MAX}$	-	1.2	-	A

Absolute Maximum Ratings[5,6,7,8.9]

Parameter	Absolute Maximum
Drain Source Voltage, V_{DS}	100 V
Gate Source Voltage, V_{GS}	-10 to 3 V
Gate Current, I_G	1.4 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} < 36 V will ensure MTTF > 2.51×10^6 hours.
8. Operating at nominal conditions with $T_{CH} \leq 225°C$ will ensure MTTF > 2.51×10^6 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} = 32 V T_C = 85°C, T_{CH} = 225°C	R_θ(FEA)	14.7	°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

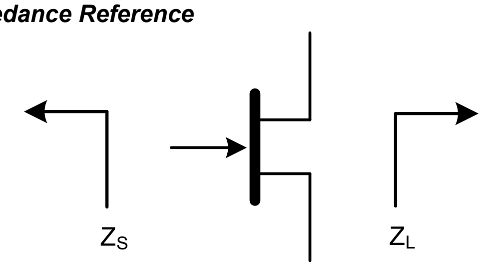
Gallium Nitride Circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these devices.

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

Frequency (GHz)	Z_{SOURCE} (Ω)	Maximum Output Power V_{DS} = 32 V, I_{DQ} = 48 mA, T_C = 25°C, P2.5dB					
		Z_{LOAD}[11] (Ω)	Gain (dB)	P_{OUT} (dBm)	P_{OUT} (W)	η_D (%)	AM/PM (°)
1.8	62.3 - j5.8	34.6 + j8.6	13.8	39.3	8.5	59.2	101.2
2.3	34.0 - j6.8	34.0 + j2.1	13.1	39.6	9.1	57.2	1.4
2.7	31.1 - j32.7	31.1 + j2.0	14.2	39.5	8.9	61.7	25.3

Frequency (GHz)	Z_{SOURCE} (Ω)	Maximum Drain Efficiency V_{DS} = 32 V, I_{DQ} = 48 mA, T_C = 25°C, P2.5dB					
		Z_{LOAD}[12] (Ω)	Gain (dB)	P_{OUT} (dBm)	P_{OUT} (W)	η_D (%)	AM/PM (°)
1.8	51.1 - j1.6	32.1 + j33.4	15.4	37.7	5.9	66.7	89.9
2.3	31.1 - j13.3	33.4 + j28.4	14.2	38.1	6.5	65.4	0.3
2.7	29.7 - j47.9	23.2 + j29.0	15.8	37.4	5.5	74.1	-0.4

Impedance Reference



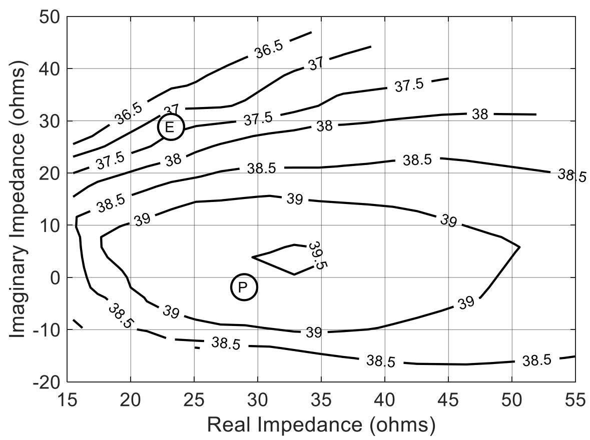
Z_{SOURCE} = Measured impedance presented to the input of the device at package reference plane.
Z_{LOAD} = Measured impedance presented to the output of the device at package reference plane.

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

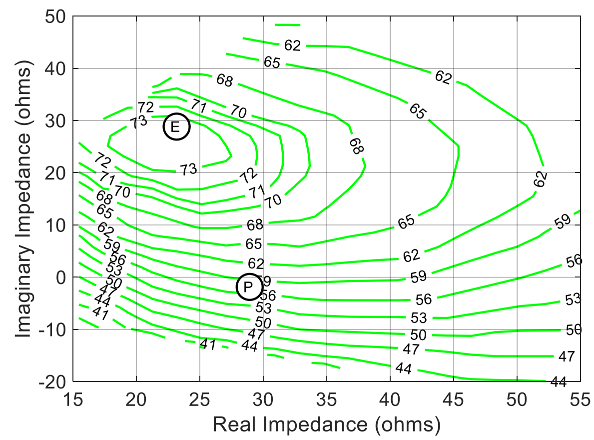
Pulsed[2] Load-Pull Performance

2.7 GHz

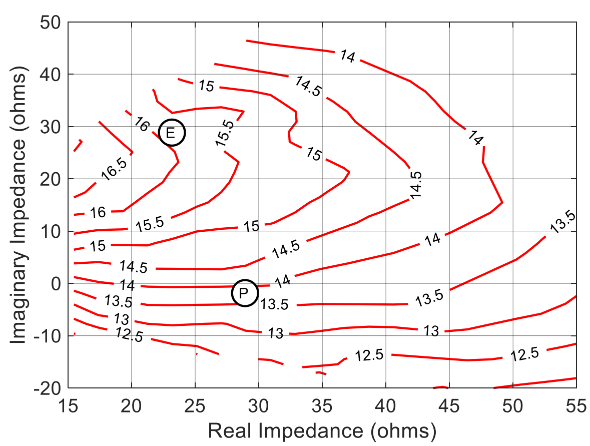
P2.5dB Loadpull Output Power Contours (dBm)



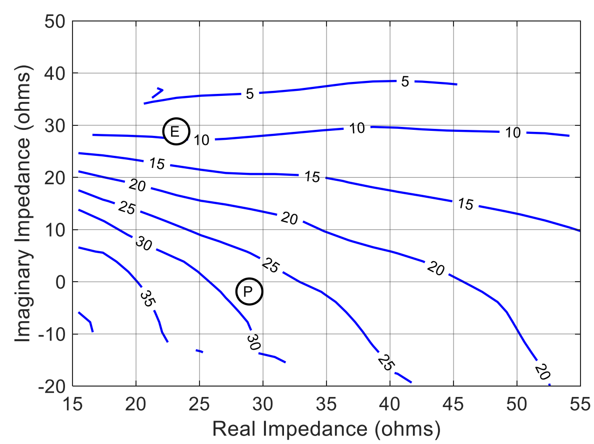
P2.5dB Loadpull Drain Efficiency Contours (%)



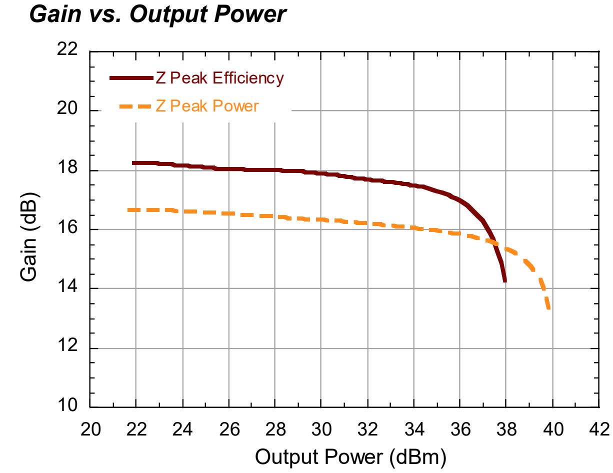
P2.5dB Loadpull Gain Contours (dB)



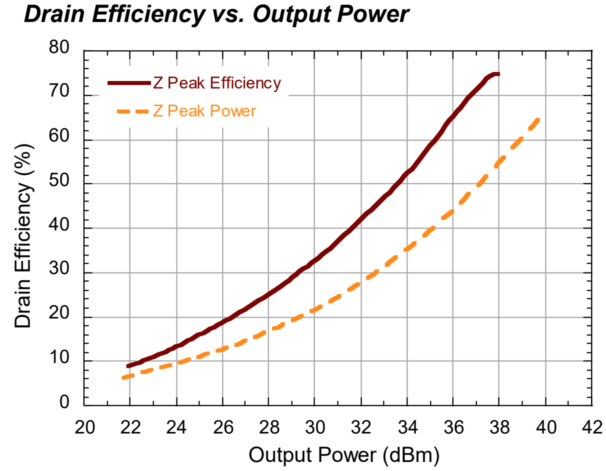
P2.5dB Loadpull AM/PM Contours (°)



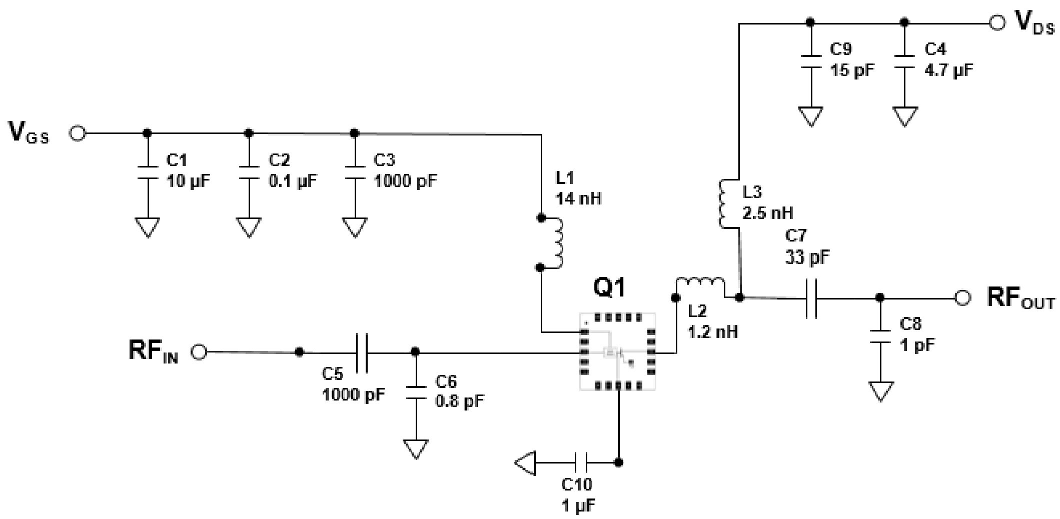
Gain vs. Output Power



Drain Efficiency vs. Output Power



Evaluation Test Fixture and Recommended Tuning Solution 1.8 - 2.7 GHz



Description

Parts measured on evaluation board (20-mil thick RO4350). Matching is provided using a combination of lumped elements and transmission lines as shown in the simplified schematic above. Recommended tuning solution component placement, transmission lines, and details are shown on the next page.

Bias Sequencing

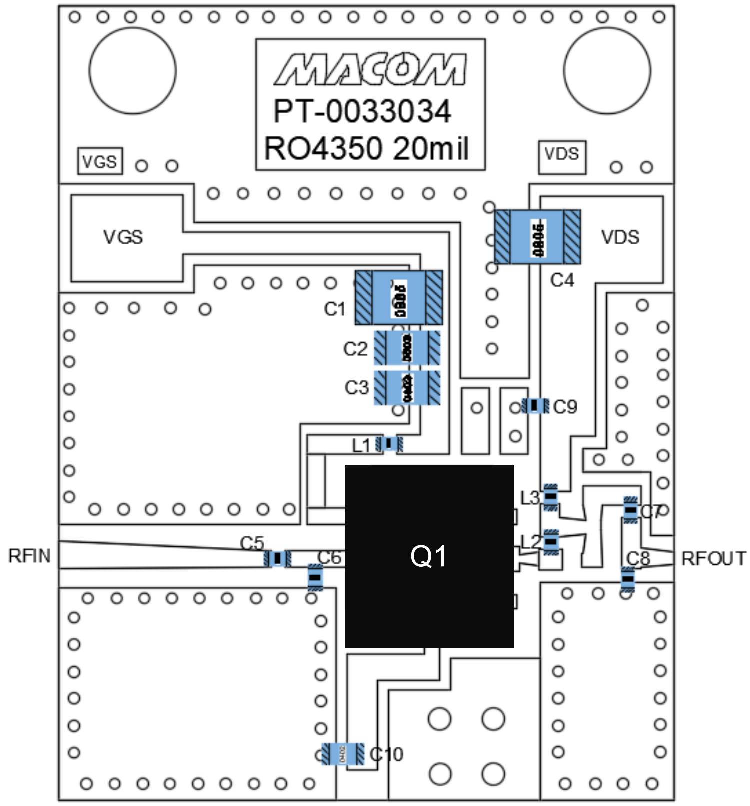
Turning the device ON

1. Set V_{GS} to pinch-off (V_P).
2. Turn on V_{DS} to nominal voltage (32 V).
3. Increase V_{GS} until I_{DS} current is reached.
4. Apply RF power to desired level.

Turning the device OFF

1. Turn the RF power OFF.
2. Decrease V_{GS} down to V_P pinch-off.
3. Decrease V_{DS} down to 0 V.
4. Turn off V_{GS}.

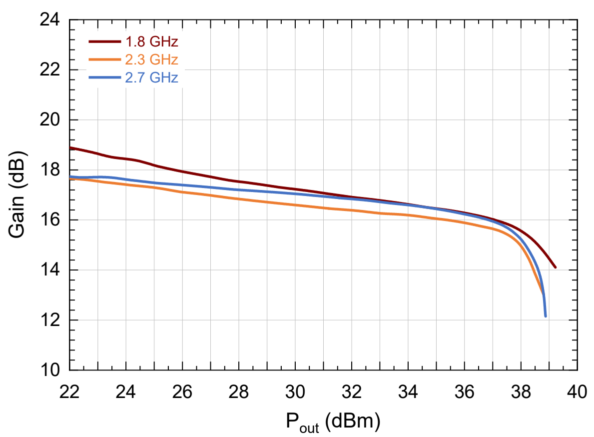
Evaluation Board and Recommended Tuning Solution 1.8 - 2.7 GHz



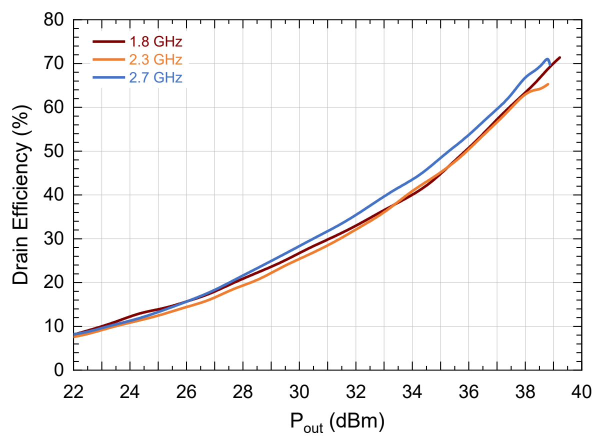
Reference Designator	Value	Tolerance	Manufacturer	Part Number
C1	10 µF	+/- 20%	TDK Corporation	C2012X5R1C106M085AC
C2	0.1 µF	+/- 10%	Murata	GCM21BR72A104KA37L
C3	1000 pF	+/- 5%	Murata	GRM1555C1H102JA01D
C4	4.7 µF	+/- 10%	Murata	GRM21BC81H475KE11L
C5	1000 pF	+/- 5%	Murata	GRM0335C1H102JE01D
C6	0.8 pF	+/- 0.05 pF	Murata	GJM0335C1HR80WB01D
C7	33 pF	+/- 5%	Murata	GRM0335C2A330JA01D
C8	1 pF	+/- 0.05 pF	Murata	GJM0335C1H1R0WB01D
C9	15 pF	+/- 5%	Murata	GRM0335C2A150JA01D
C10	1 µF	+/- 10%	Murata	GRM155Z71A105KE01D
L1	14 nH	+/- 10%	Coilcraft	0201DS-14NXJE
L2	1.2 nH	+/- 10%	Coilcraft	0201DS-1N2XJE
L3	2.5 nH	+/- 10%	Coilcraft	0201DS-2N5XJE
Q1			MACOM	MAPC-A2021
PCB	RO4350, 20 mil, 1 oz. Cu, Tin Lead Finish			

Typical Performance Curves as Measured in the 1.8 - 2.7 GHz Evaluation Board:
Pulsed[2] 2.7 GHz, V_{DS} = 32 V, I_{DQ} = 60 mA, T_C = 25°C

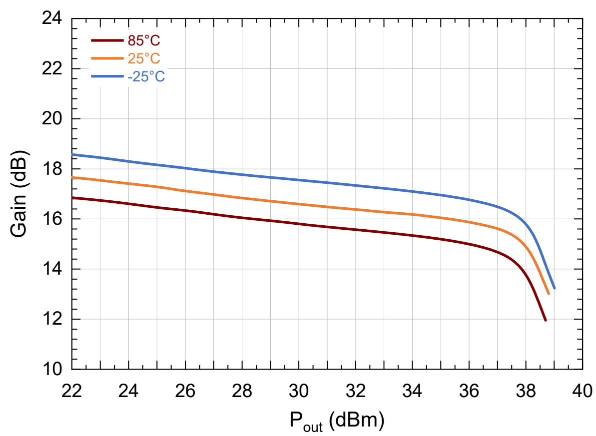
Gain vs. Output Power and Frequency



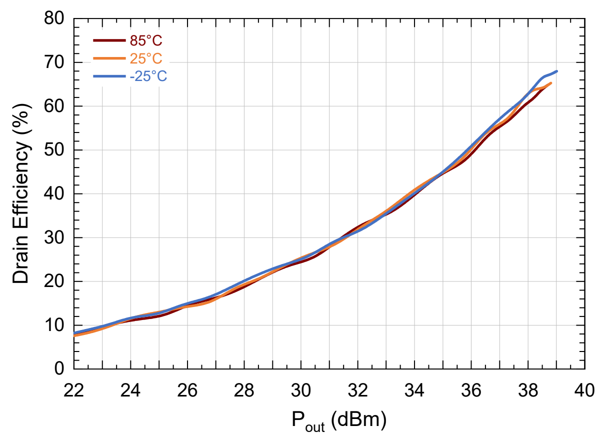
Drain Efficiency vs. Output Power and Frequency



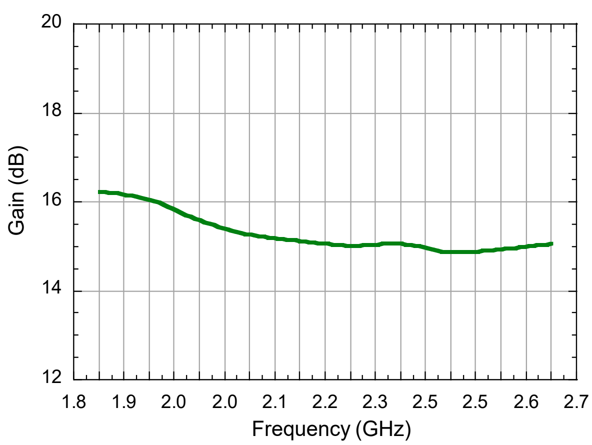
Gain vs. Output Power and T_C



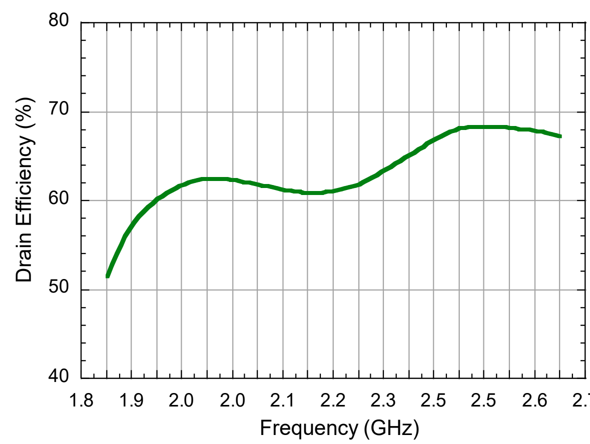
Drain Efficiency vs. Output Power and T_C



Gain vs. Frequency, 3dB Gain Compression

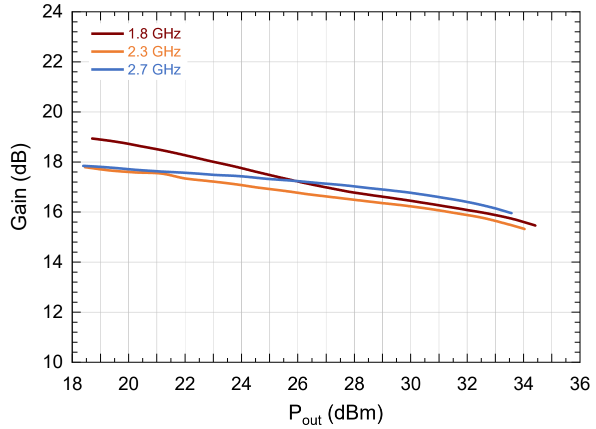


Drain Efficiency vs. Frequency, 3dB Gain Compression

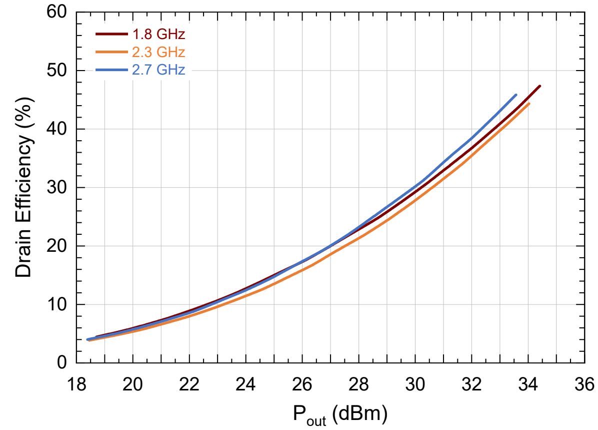


Typical Performance as Measured in the 1.8 - 2.7 GHz Evaluation Board:
WCDMA 3GPP TM1 64 DPCH 9.9 dB PAR @ 0.01% CCDF, V_{DS} = 32 V, I_{DQ} = 60 mA, T_C = 25 °C

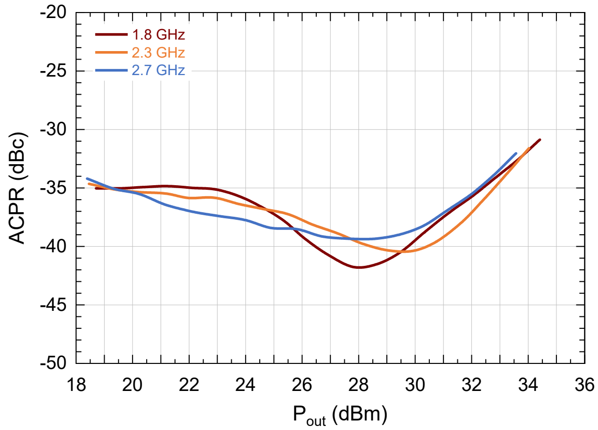
Gain vs. Output Power and Frequency



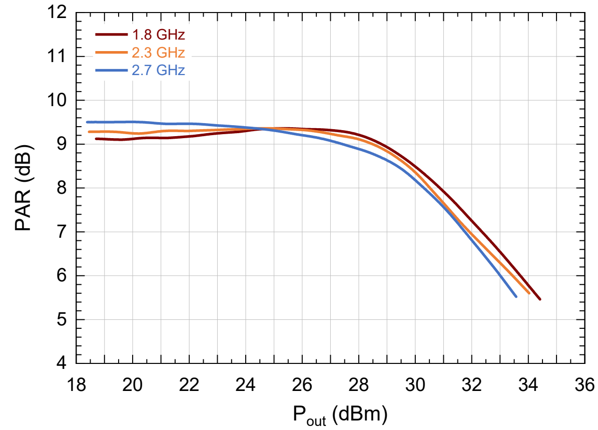
Drain Efficiency vs. Output Power and Frequency



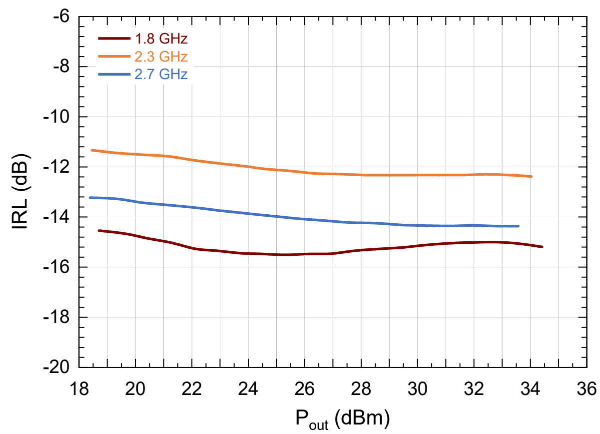
ACPR (Max ±5 MHz) vs. Output Power and Frequency



PAR (CCDF @ 0.01%) vs. Output Power and Frequency

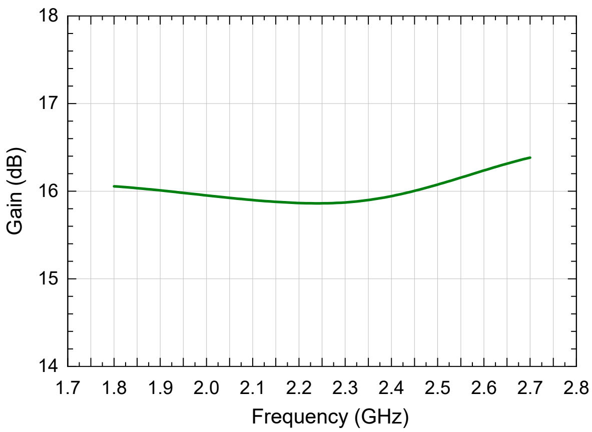


Input Return Loss vs. Output Power and Frequency

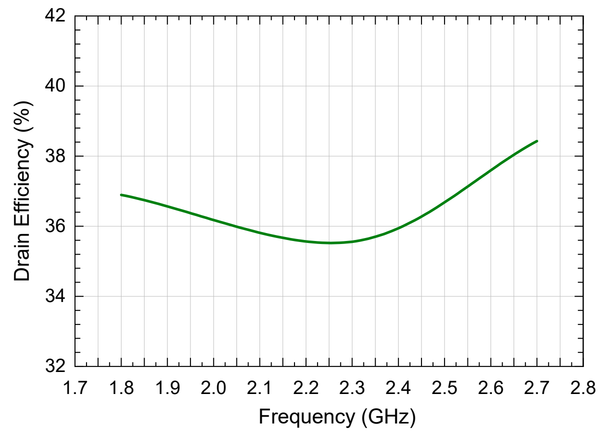


Typical Performance as Measured in the 1.8 - 2.7 GHz Evaluation Board:
WCDMA 3GPP TM1 64 DPCH 9.9 dB PAR @ 0.01% CCDF, V_{DS} = 32 V, I_{DQ} = 60 mA, T_C = 25 °C

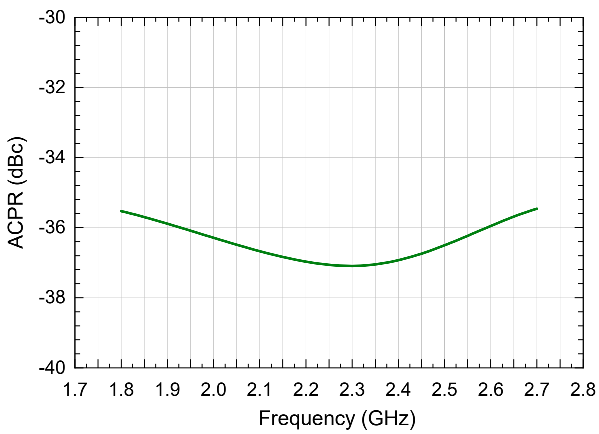
Gain vs. Frequency at P_{OUT} = 32 dBm



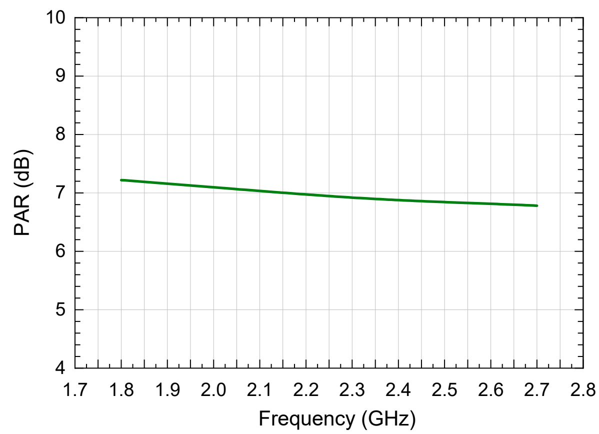
Drain Efficiency vs. Frequency at P_{OUT} = 32 dBm



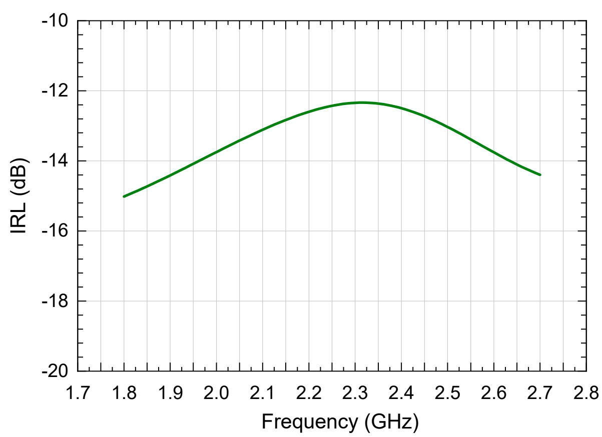
ACPR (Max ±5 MHz) vs. Frequency at P_{OUT} = 32 dBm



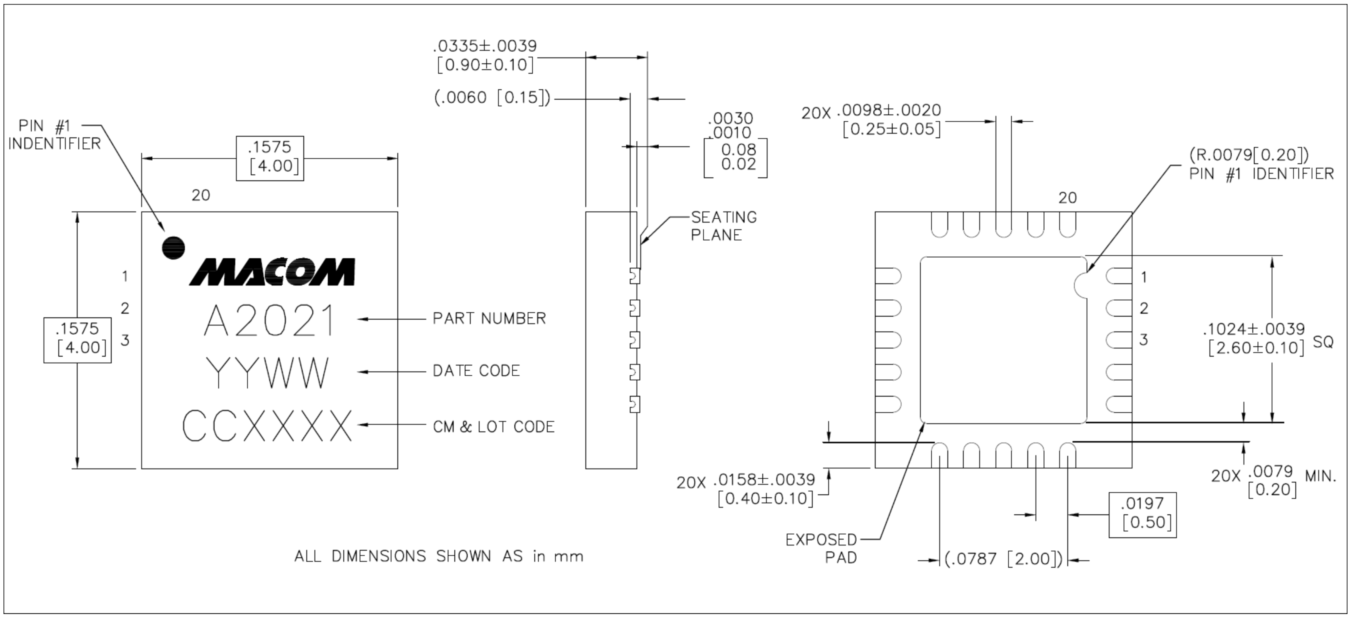
PAR (CCDF @ 0.01%) vs. Frequency at P_{OUT} = 32 dBm



Input Return Loss vs. Frequency at P_{OUT} = 32 dBm



Lead-Free 4 mm 20-Lead Package Dimensions†



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