MAGB-101836-025B0P

GaN Amplifier 50 V, 4 W AVG
1.8 - 3.6 GHz

Rev. V1

Features

- Optimized for Cellular Base Station Applications
- High Terminal Impedances for Broadband Performance
- 50 V Operation
- 100% RF Tested
- RoHS* Compliant

Description

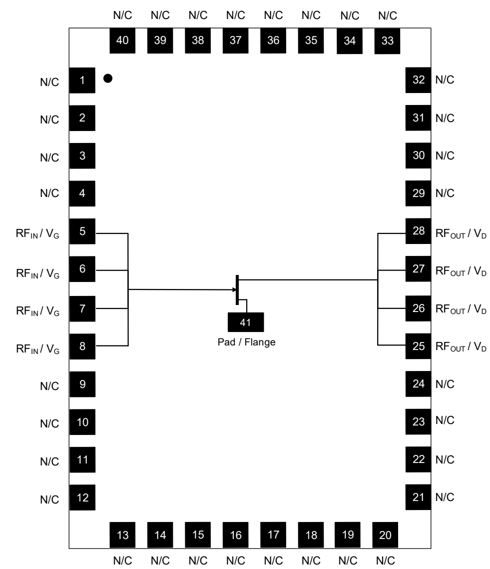
The MAGB-101836-025B0P GaN HEMT is a D-mode amplifier designed for base station applications and optimized for modulated signal operation in the 1.8 - 3.6 GHz frequency bands. This device supports pulsed and linear operation with peak output power levels to 25 W (44 dBm) in a 5 x 7 mm QFN package.

Typical Performance:

- WCDMA 3GPP TM1 64 DPCH 9.9 dB PAR @ 0.01% CCDF. V_{DS} = 50 V, I_{DQ} = 75 mA , P_{OUT} = 36 dBm

Frequency (MHz)	GP (dB)	η_D (%)	Output PAR (dB)	ACPR (dBc)
3400	16.2	29	8.2	-36.0
3500	16.9	29	8.2	-37.0
3600	16.6	29	8.0	-37.5

Functional Schematic



Pin Configuration

Pin #	Pin Name	Function
1 - 4, 9 - 24, 29 - 40	N/C	No Connection
5 - 8	RF_{IN} / V_G	RF Input / Gate
25 - 28	RF_{OUT} / V_D	RF Output / Drain
41	Pad[3]	Ground / Source

3. The exposed pad centered on the package bottom must be connected to RF and DC ground. This path must also provide a low thermal resistance heat path.

Ordering Information[1,2]

Part Number	Package
MAGB-101836-025B0P	Bulk Quantity
MAGB-1B1836-025B0P	3.6 GHz Class-AB Sample Board
MAGB-101836-025BTP	1000 Piece Reel

1. Sample Board includes two loose parts.
2. Reference Application Note M513 for reel size information.

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

RF Electrical Characteristics: T_C = 25°C, V_{DS} = 50 V, I_{DQ} = 75 mA
Note: Performance in MACOM Evaluation Test Board, 50 Ω system

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Small Signal Gain	Pulsed[4], 3500 MHz	G_{SS}	-	18	-	dB
Saturated Output Power	Pulsed[4], 3500 MHz	P_{SAT}	-	43.5	-	dBm
Drain Efficiency at Saturation	Pulsed[4], 3500 MHz	η_{SAT}	-	55	-	%
AM/PM	Pulsed[4], 3500 MHz	Φ	-	-10	-	°
Modulated Peak Power	WCDMA[5], 3500 MHz	P3dB[6]	-	43.5	-	dBm
VBW Resonance Point	IMD 3rd Order Inflection Point	VBW_{RES}	-	300	-	MHz
Gain Flatness in 60 MHz	WCDMA[5], P_{OUT} = 36 dBm	G_F	-	0.4	-	dB
Gain Variation (-25°C to +105°C)	WCDMA[5], 3500 MHz, P_{OUT} = 36 dBm	ΔG	-	0.02	-	dB/°C
Power Variation (-25°C to +105°C)	Pulsed[4], 3500 MHz	ΔP1dB	-	0.02	-	dB/°C
Power Gain	WCDMA[5], 3500 MHz, P_{OUT} = 36 dBm	G_P	-	16.9	-	dB
Drain Efficiency	WCDMA[5], 3500 MHz, P_{OUT} = 36 dBm	η	-	29	-	%
Output PAR @ 0.01% CCDF	WCDMA[5], 3500 MHz, P_{OUT} = 36 dBm	PAR	-	8.2	-	dB
Adjacent Channel Power Ratio	WCDMA[5], 3500 MHz, P_{OUT} = 36 dBm	ACPR	-	-37	-	dBc
Input Return Loss	WCDMA[5], 3500 MHz, P_{OUT} = 36 dBm	IRL	-	-12	-	dB
Ruggedness: Output Mismatch	All phase angles	Ψ	VSWR = 10:1, No Device Damage			

RF Electrical Specifications: T_A = 25°C, V_{DS} = 50 V, I_{DQ} = 75 mA
Note: Performance in MACOM Production Test Fixture, 50 Ω system

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Power Gain	WCDMA[5], 3500 MHz, P_{OUT} = 36 dBm	G_P	13.5	15.2	-	dB
Drain Efficiency	WCDMA[5], 3500 MHz, P_{OUT} = 36 dBm	η	24.5	28	-	%
Output PAR @ 0.01% CCDF	WCDMA[5], 3500 MHz, P_{OUT} = 36 dBm	PAR	6.7	7.3	-	dB
Adjacent Channel Power Ratio	WCDMA[5], 3500 MHz, P_{OUT} = 36 dBm	ACPR	-	-35.2	-33	dBc
Input Return Loss	WCDMA[5], 3500 MHz, P_{OUT} = 36 dBm	IRL	-	-6.5	-4	dB

4. Pulse details:100 µs pulse width, 1 ms period, 10% Duty Cycle
5. Modulated Signal: 3.84 MHz, WCMDA 3 GPP TM1 64 DPCH, 9.9 dB PAR @ 0.01% CCDF
6. P3dB = P_{OUT} 7 dB where P_{OUT} is the average output power measured using a modulated signal[3] where the output PAR is compressed to 7 dB @ 0.01% probability CCDF.

DC Electrical Characteristics: T_A = 25°C

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Drain-Source Leakage Current	V_{GS} = -8 V, V_{DS} = 130 V	I_{DLK}	-	-	3.3	mA
Gate-Source Leakage Current	V_{GS} = -8 V, V_{DS} = 0 V	I_{GLK}	-	-	1.65	mA
Gate Threshold Voltage	V_{DS} = 50 V, I_D = 3.3 mA	V_T	-2.6	-2.0	-1.6	V
Gate Quiescent Voltage	V_{DS} = 50 V, I_D = 75 mA	V_{GSQ}	-2.4	-1.7	-1.4	V
On Resistance	V_{DS} = 2 V, I_D = 25 mA	R_{ON}	-	1.45	-	W
Maximum Drain Current	V_{DS} = 7 V pulsed, pulse width 300 µs	$I_{D,MAX}$	-	1.9	-	A

Absolute Maximum Ratings[7,8,9,10,11]

Parameter	Absolute Maximum
Drain Source Voltage, V_{DS}	130 V
Gate Source Voltage, V_{GS}	-10 to 3 V
Gate Current, I_G	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

7. Exceeding any one or combination of these limits may cause permanent damage to this device.
8. MACOM does not recommend sustained operation above maximum operating conditions.
9. Operating at drain source voltage V_{DS} < 55 V will ensure MTTF > 1 x 10^7 hours.
10. Operating at nominal conditions with T_{CH} ≤ 225°C will ensure MTTF > 1 x 10^7 hours.
11. 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* = 3.686, *B* = -35.00, and *C* = 25,416.

Thermal Characteristics[12]

Parameter	Test Conditions	Symbol	Typical	Units
Thermal Resistance using Finite Element Analysis	V_{DS} = 50 V, P_D = 13 W, T_C = 120°C, T_{CH} = 225°C	R_θ(FEA)	8.9	°C/W
Thermal Resistance using Infrared Measurement of Die Surface Temperature	V_{DS} = 50 V, P_D = 13 W, T_C = 135°C, T_{CH} = 225°C	R_θ(IR)	7.7	°C/W

12. 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

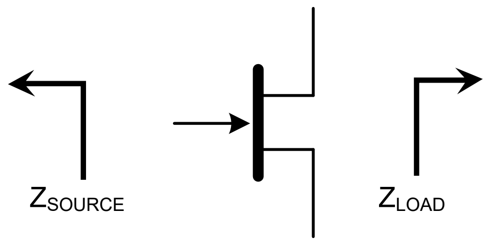
Gallium Nitride Circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these HBM class 1A and CDM class C1 devices.

Pulsed[13] Load-Pull Performance: Reference Plane at Device Leads

Frequency (MHz)	Z_{SOURCE} (Ω)	Maximum Output Power V_{DS} = 50 V, I_{DQ} = 75 mA, T_C = 25°C, P2.5dB					
		Z_{LOAD}[14] (Ω)	Gain (dB)	P_{OUT} (dBm)	P_{OUT} (W)	η_D (%)	AM/PM (°)
2300	2.8 + j6.1	2.6 - j0.8	17.5	44.2	26.3	59	1
2400	2.9 + j5.4	2.5 - j1.1	17.8	44.3	28.8	61	1
2500	3.0 + j7.7	2.6 - j1.3	16.5	44.3	26.9	60	1
3400	8.0 + j18.5	9.5 - j9.9	15.5	44.0	25.1	48.7	2.3
3500	6.1 + j19.6	9.0 - j9.4	15.2	44.1	25.7	49.9	1.9
3600	7.8 + j21.6	8.9 - j8.8	15.0	44.1	25.7	49.7	2.9

Frequency (MHz)	Z_{SOURCE} (Ω)	Maximum Drain Efficiency V_{DS} = 50 V, I_{DQ} = 75 mA, T_C = 25°C, P2.5dB					
		Z_{LOAD}[15] (Ω)	Gain (dB)	P_{OUT} (dBm)	P_{OUT} (W)	η_D (%)	AM/PM (°)
2300	2.8 + j6.1	2.0 + j0.3	19.5	42.7	18.6	67.5	5
2400	2.9 + j5.4	1.8 + j0.2	18.7	42.7	18.6	69	5
2500	3.0 + j7.7	1.7 + j0.1	18.0	42.7	18.6	65	5
3400	7.9 + j20.0	5.5 + j11.6	16.7	43.3	21.4	53.1	-0.5
3500	6.4 + j21.5	5.8 + j11.5	16.3	43.4	21.9	54.4	0.0
3600	8.1 + j23.7	5.7 + j11.3	15.9	43.3	21.4	55.4	1.8

Impedance Reference

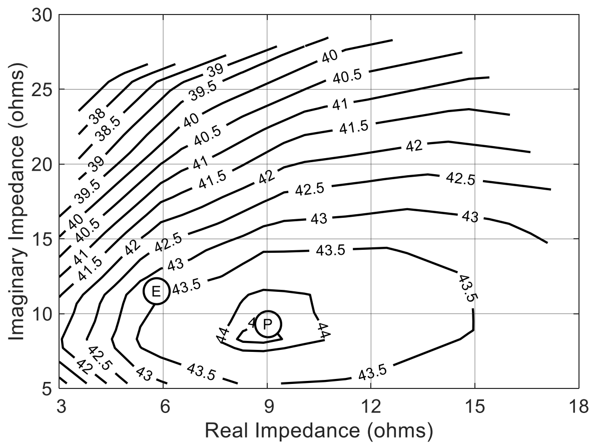


Z_{SOURCE} = Measured impedance presented to the input of the device at package reference plane.
Z_{LOAD} = Measured impedance presented to the output of the device at package reference plane.

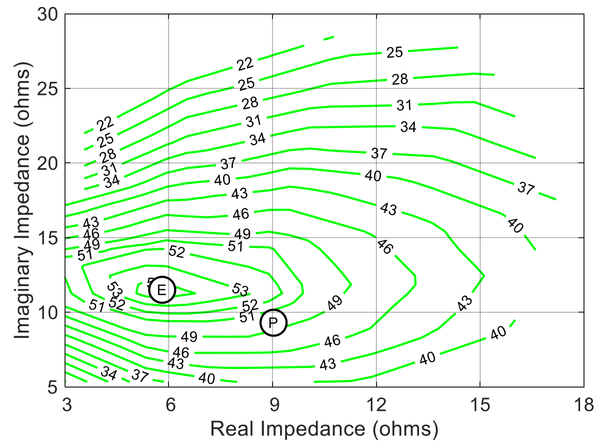
13. Pulse details: 100 μs pulse width, 1 ms period, 10% duty cycle.
14. Load Impedance for optimum output power.
15. Load Impedance for optimum efficiency.

Pulsed[13] Load-Pull Performance: 3500 MHz

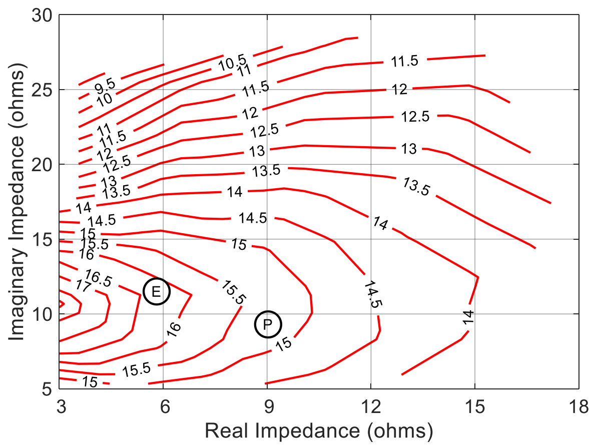
P2.5dB Loadpull Output Power Contours (dBm)



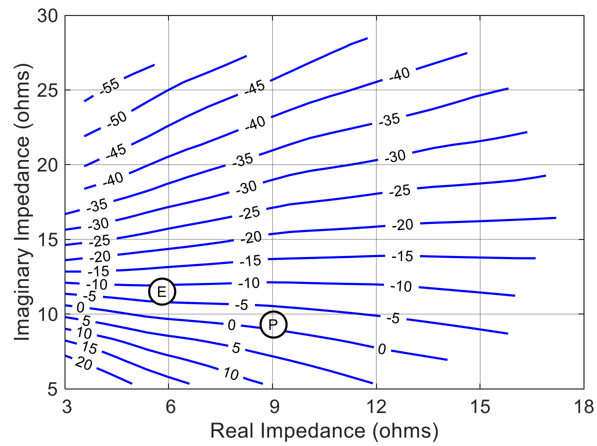
P2.5dB Loadpull Drain Efficiency Contours (%)



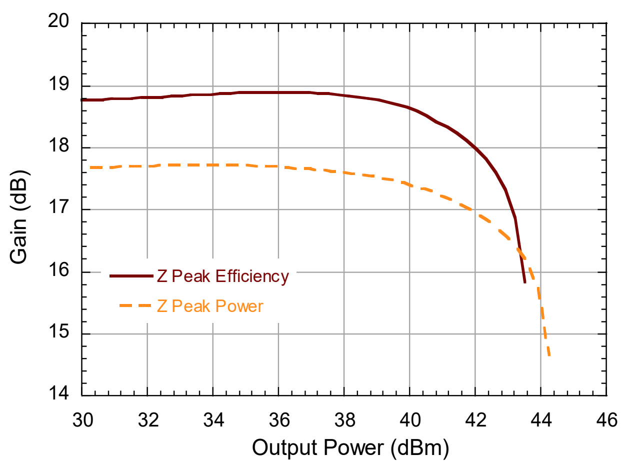
P2.5dB Loadpull Gain Contours (dB)



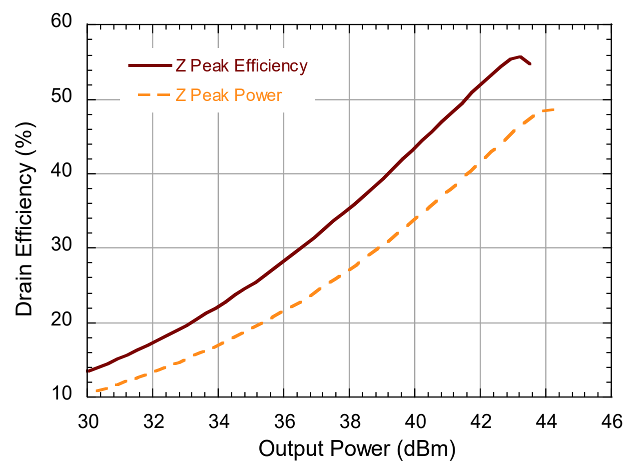
P2.5dB Loadpull AM/PM Contours (°)



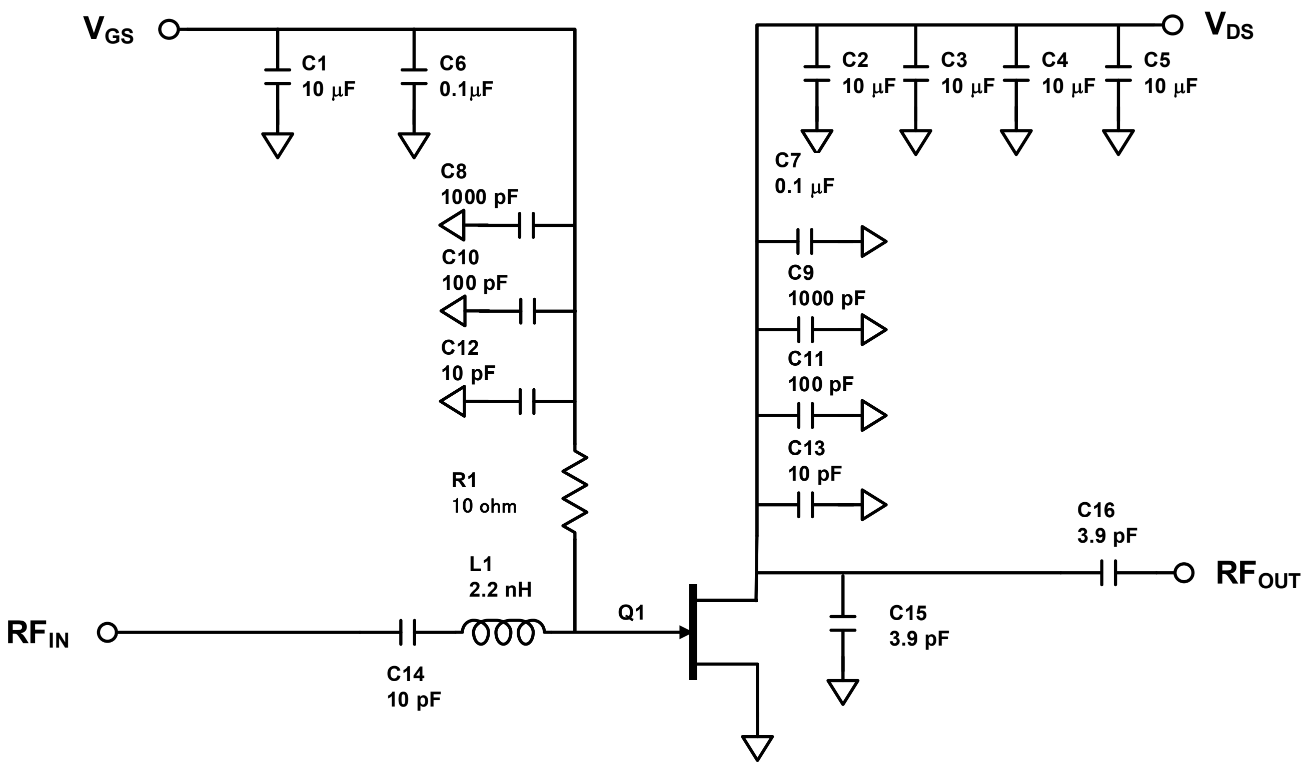
Gain vs. Output Power



Drain Efficiency vs. Output Power



Evaluation Test Board and Recommended Tuning Solution 3.4 - 3.6 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.

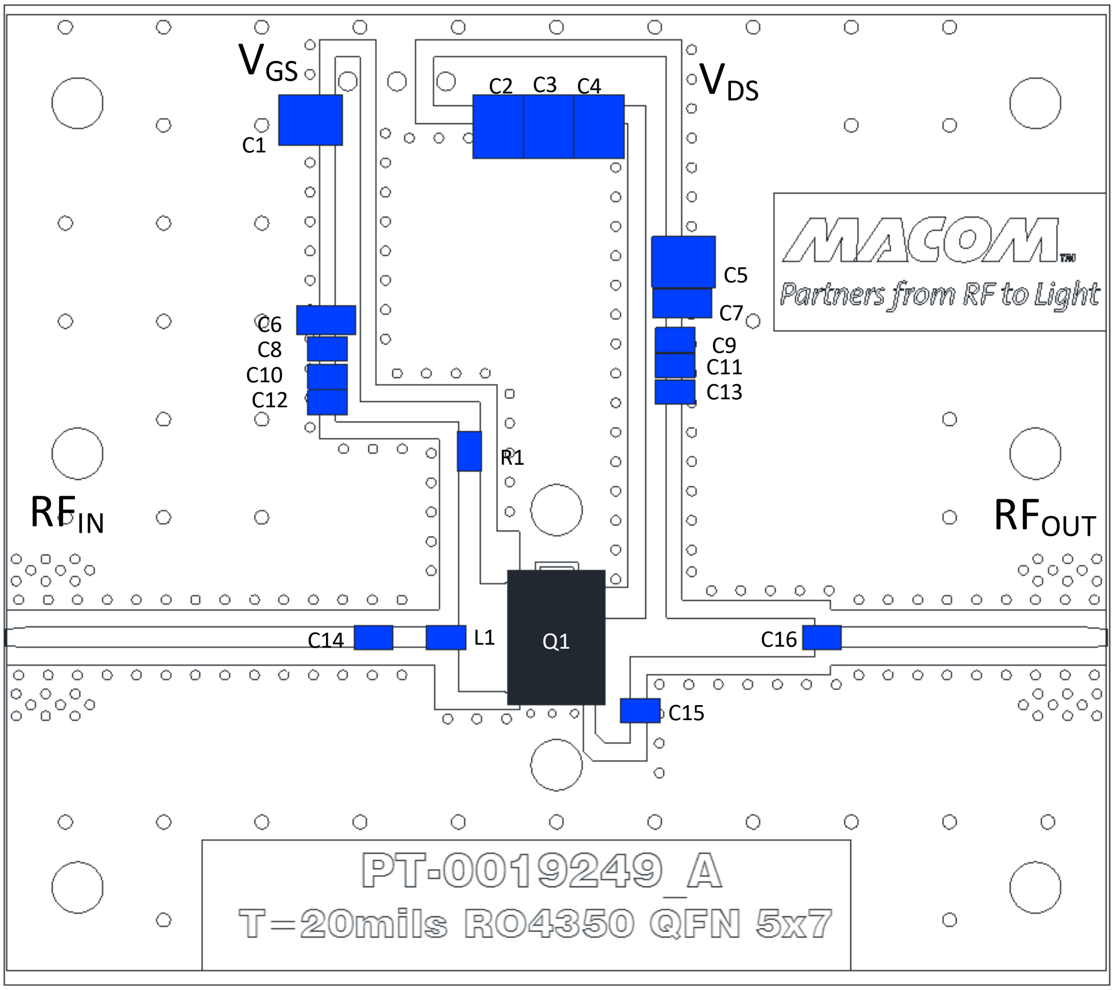
Turning the device ON

1. Set V_{GS} to the pinch-off (V_P), typically -5 V.
2. Turn on V_{DS} to nominal voltage (50 V).
3. Increase V_{GS} until the 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.
3. Decrease V_{DS} down to 0 V.
4. Turn off V_{GS}.

Evaluation Test Board and Recommended Tuning Solution 3.4 - 3.6 GHz

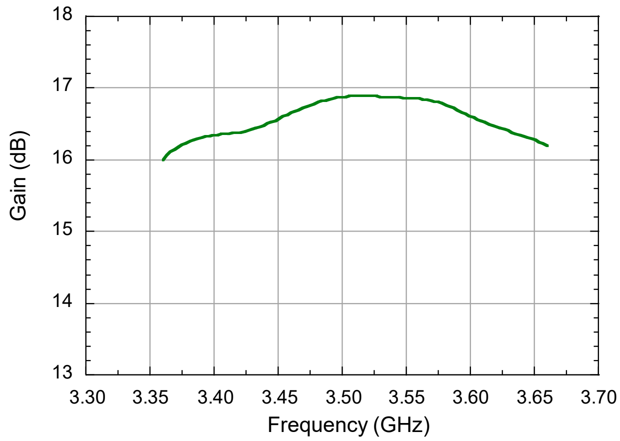


Parts List

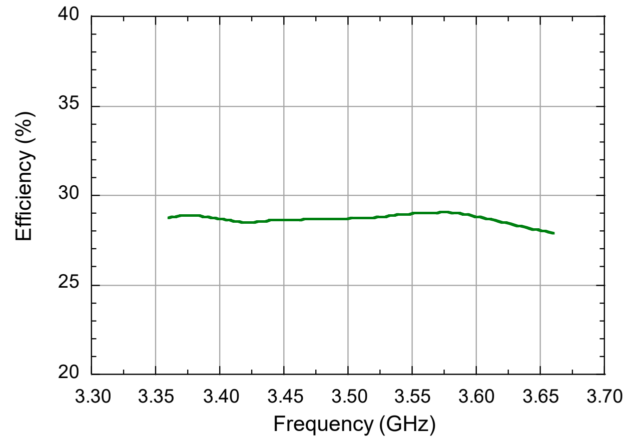
Reference Designator	Value	Tolerance	Manufacturer	Part Number
C1,C2,C3,C4,C5	10 µF	10%	Murata	GRM32EC72A106KE05L
C6,C7	0.1 µF	10%	Kemet	C1206C104K1RACTU
C8,C9	1000 pF	10%	Kemet	C0805C102K2RACTU
C10,C11	100 pF	5%	Murata	GQM2195C2E101JB12
C12,C13,C14	10 pF	±0.1 pF	Murata	GQM2195C2E100FB12
C15,C16	3.9 pF	±0.1 pF	Murata	GQM2195C2E3R9BB12
L1	2.2 nH	±0.2 nH	AVX	L08052R2CES
R1	10 Ω	1%	Panasonic	ERJ-6ENF10R0V
PCB	Rogers RO4350, e_r=3.66, 20 mil			

Typical Performance as Measured in the 3.4 - 3.6 GHz Evaluation Test Board:
WCMDA 3GPP TM1 64 DPCH, 9.9 dB PAR @ 0.01% CCDF Performance
V_{DS} = 50 V, I_{DQ} = 75 mA at T_C = 25ºC

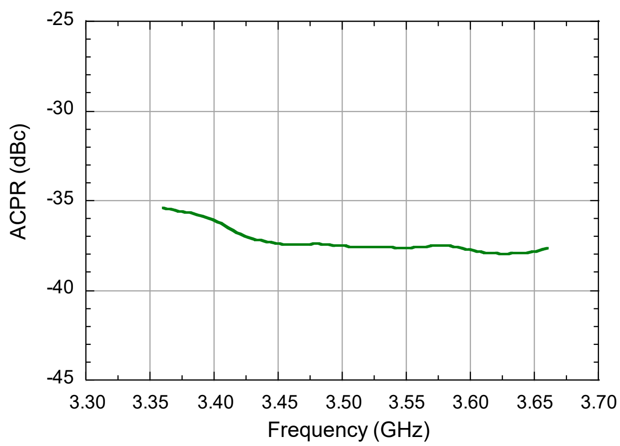
Gain vs. Frequency at P_{OUT} = 36 dBm



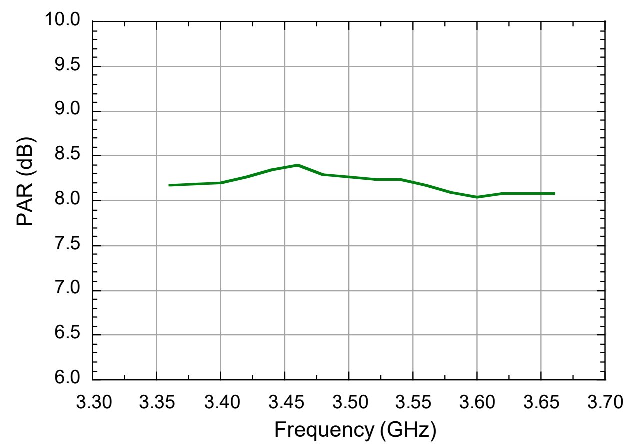
Efficiency vs. Frequency at P_{OUT} = 36 dBm



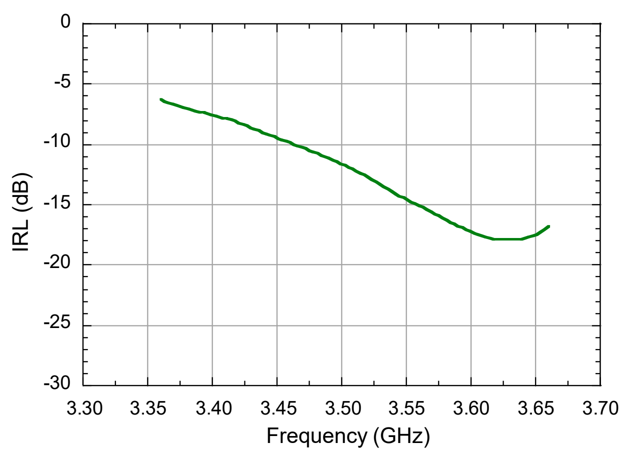
ACPR vs. Frequency at P_{OUT} = 36 dBm



PAR (CCDF @ 0.01%) vs. Frequency at P_{OUT} = 36 dBm

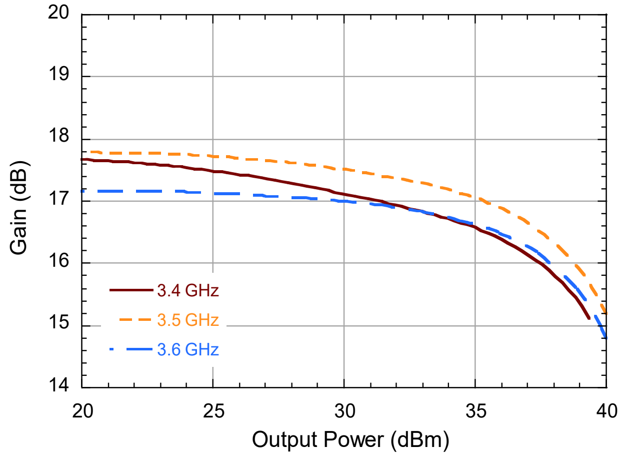


Input Return Loss vs. Frequency at P_{out} = 36 dBm

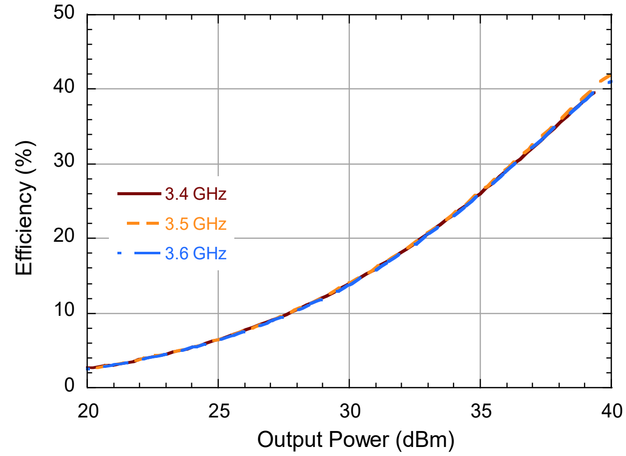


Typical Performance as Measured in the 3.4 - 3.6 GHz Evaluation Test Board: WCMDA 3GPP TM1 64 DPCH, 9.9 dB PAR @ 0.01% CCDF Performance V_{DS} = 50 V, I_{DQ} = 75 mA at T_C = 25ºC

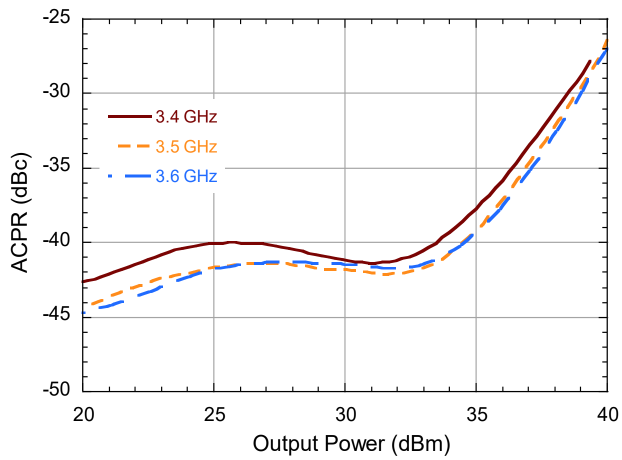
Gain vs. Output Power



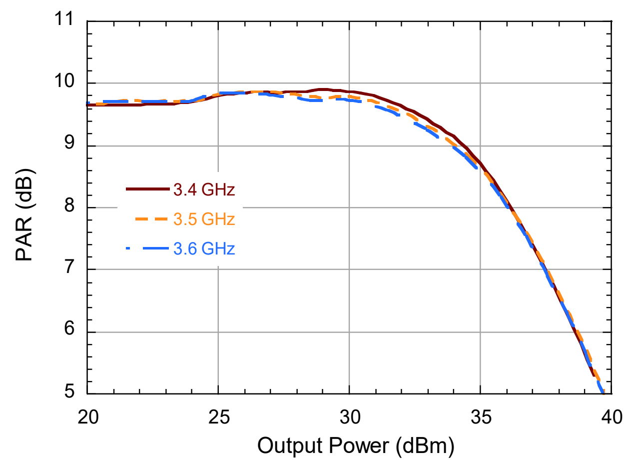
Efficiency vs. Output Power



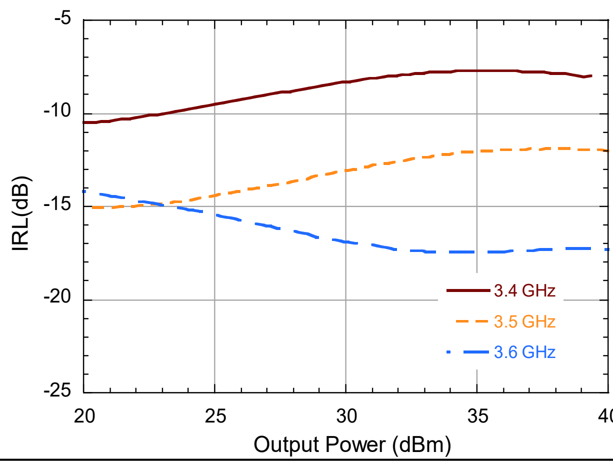
ACPR vs. Output Power



PAR (CCDF @ 0.01%) vs. Output Power

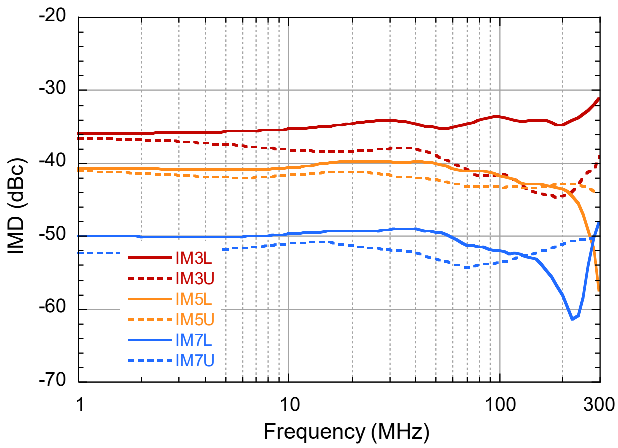


Input Return Loss vs. Output Power

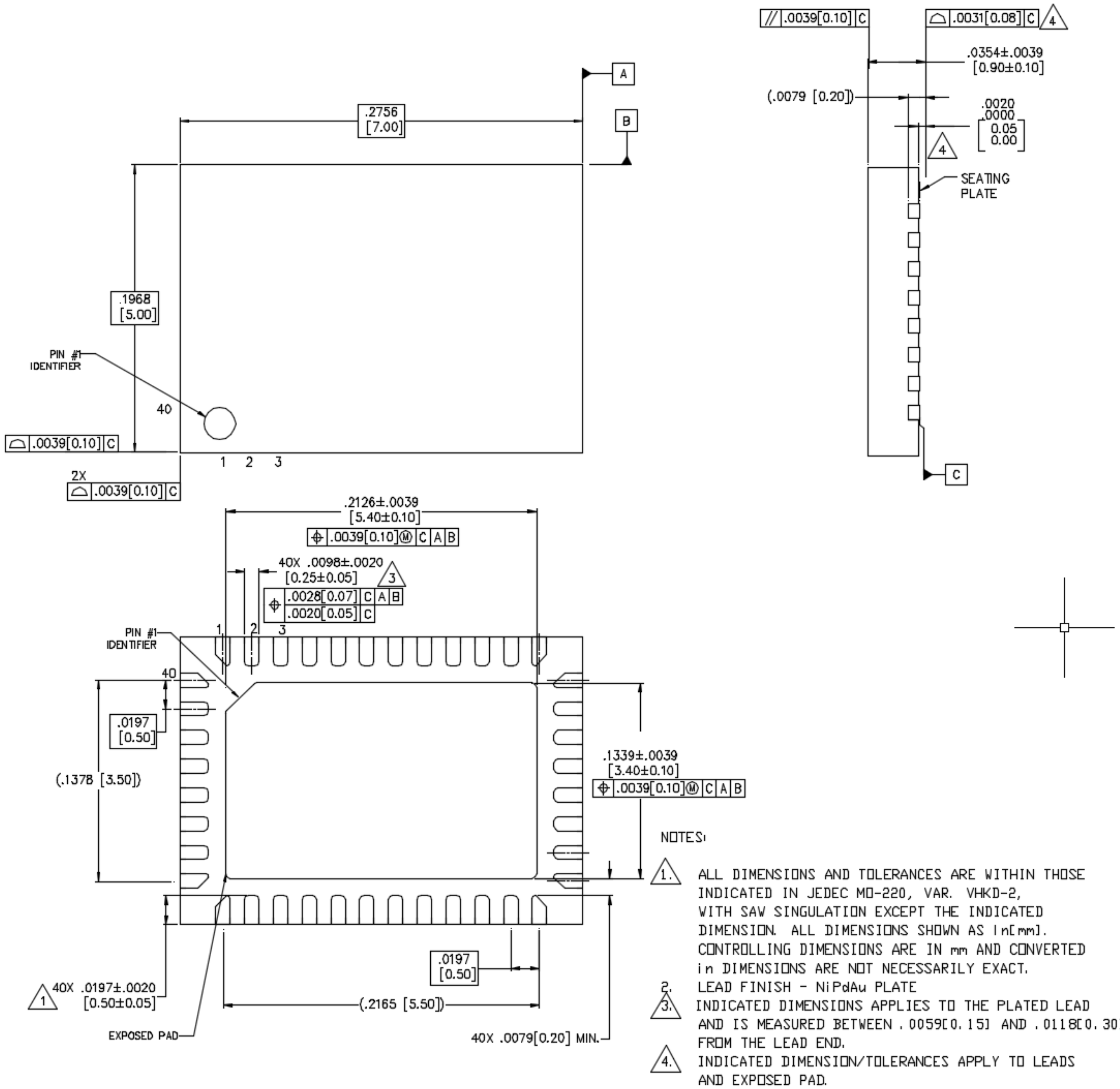


Typical Performance as Measured in the 3.4 - 3.6 GHz Evaluation Test Board: 2-Tone Video Bandwidth Performance
V_{DS} = 50 V, I_{DQ} = 75 mA at T_C = 25ºC

IMD vs. Tone Spacing (MHz) at 3.5 GHz



Outline: 5 x 7 mm QFN Plastic Package†



† Meets JEDEC moisture sensitivity level 3 requirements.