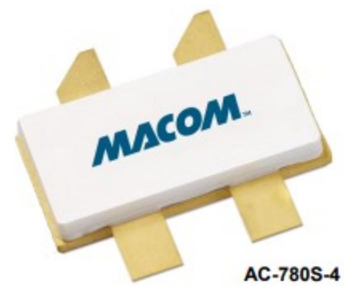
MAGB-103438-170S0S

GaN Amplifier 50 V, 17 W AVG
3.4 - 3.8 GHz

Rev. V1



Features

- Optimized for Cellular Base Station Applications
- Designed for Digital Predistortion Error Correction Systems
- Optimized for Doherty Applications
- High Terminal Impedances for Broadband Performance
- 50 V Operation
- 100% RF Tested
- RoHS* Compliant

Description

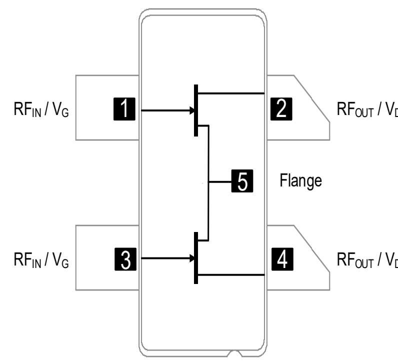
The MAGB-103438-170S0S is a symmetrical GaN HEMT D-mode amplifier pair designed for Doherty base station applications with 17 W average power and optimized for 3.4 - 3.8 GHz modulated signal operation. This device supports pulsed, and linear operation at V_{DS} = 50 V with peak output power levels up to 170 W (52.3 dBm) in an air cavity ceramic package.

Typical Doherty Performance:

- WCDMA 3GPP TM1 64 DPCH 9.9 dB PAR @ 0.01% CCDF, V_{DS} = 46 V, I_{DQCAR} = 180 mA,

Frequency (GHz)	G_P (dB)	η_D (%)	Output PAR (dB)	ACPR (dBc)	IRL (dB)
3.4	12.25	37	9.5	-30	-12
3.5	12.75	40	9.0	-35	-12
3.6	12.25	40	8.9	-37	-12

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_{IN} / V_G	RF Input / Gate (Peaking)
4	RF_{OUT} / V_D	RF Output / Drain (Peaking)
5	Flange[1]	Ground / Source

1. The flange 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

Part Number	Package
MAGB-103438-170S0S	Bulk Quantity
MAGB-103438-170STS	Tape and Reel
MAGB-1D3438-170S0S	Symmetric Doherty Sample Board

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

DC-0018988

RF Electrical Characteristics: T_C = 25°C, V_{DS} = 46 V, I_{DQCAR} = 180 mA, V_{GSPK} = -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], 3.5 GHz	G_{SS}	-	12.5	-	dB
Saturated Output Power	Pulsed[2], 3.5 GHz	P_{SAT}	-	52.2	-	dBm
Drain Efficiency at Saturation	Pulsed[2], 3.5 GHz	η_{SAT}	-	59	-	%
AM/PM	Pulsed[2], 3.5 GHz, P_{OUT} = 42.2 dBm	Φ	-	7.0	-	°
Modulated Peak Power	WCDMA[3], 3.5 GHz	P2.5dB[4]	-	50.4	-	dBm
VBW Resonance Point	IMD 3rd Order Inflection Point	VBW_{RES}	-	350	-	MHz
Gain Flatness in 100 MHz	WCDMA[3], P_{OUT} = 42.2 dBm	G_F	-	0.5	-	dB
Gain Variation (-25°C to +105°C)	WCDMA[3], 3.5 GHz, P_{OUT} = 42.2 dBm	ΔG	-	0.019	-	dB/°C
Power Variation (-25°C to +105°C)	Pulsed[2], 3.5 GHz	ΔP2.5dB[4]	-	0.80	-	dB
Power Gain	WCDMA[3], 3.5 GHz, P_{OUT} = 42.2 dBm	G_P	-	12.8	-	dB
Drain Efficiency	WCDMA[3], 3.5 GHz, P_{OUT} = 42.2 dBm	η	-	40.0	-	%
Output PAR @ 0.01% CCDF	WCDMA[3], 3.5 GHz, P_{OUT} = 42.2 dBm	PAR	-	9.0	-	dB
Adjacent Channel Power	WCDMA[3], 3.5 GHz, P_{OUT} = 42.2 dBm	ACP	-	-35	-	dB
Input Return Loss	WCDMA[3], 3.5 GHz, P_{OUT} = 42.2 dBm	IRL	-	-13	-	dB
Ruggedness: Output Mismatch	All phase angles	Ψ	VSWR = 10:1, No Device Damage			

RF Electrical Specifications: T_A = 25°C, V_{DS} = 46 V, I_{DQCAR} = 180 mA, V_{GSPK} = -4 V
Note: Performance in MACOM Doherty Production Test Fixture, 50 Ω System.

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Power Gain	WCDMA[3], 3.65 GHz, P_{OUT} = 42.2 dBm	G_P	11.3	12.7	-	dB
Drain Efficiency	WCDMA[3], 3.65 GHz, P_{OUT} = 42.2 dBm	η	32	35	-	%
Output PAR @ 0.01% CCDF	WCDMA[3], 3.65 GHz, P_{OUT} = 42.2 dBm	PAR	8.8	9.2	-	dB
Adjacent Channel Power Ratio	WCDMA[3], 3.65 GHz, P_{OUT} = 42.2 dBm	ACPR	-	-30	-25	dBc
Input Return Loss	WCDMA[3], 3.65 GHz, P_{OUT} = 42.2 dBm	IRL	-	-13	-7	dB

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

DC Electrical Characteristics: T_A = 25°C Per Side of Symmetrical Device

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Drain-Source Leakage Current	V_{GS} = -8 V, V_{DS} = 130 V	I_{DLK}	-	-	10.8	mA
Gate-Source Leakage Current	V_{GS} = -8 V, V_{DS} = 0 V	I_{GLK}	-	-	10.8	mA
Gate Threshold Voltage	V_{DS} = 46 V, I_D = 10.8 mA	V_T	-2.6	-2.0	-1.6	V
Gate Quiescent Voltage	V_{DS} = 46 V, I_D = 180 mA	V_{GSQ}	-2.4	-1.9	-1.4	V
On Resistance	V_{DS} = 2 V, I_D = 180 mA	R_{ON}	-	0.44	-	Ω
Maximum Drain Current	V_{DS} = 7 V pulsed, pulse width 300 μs	$I_{D,MAX}$	-	6.3	-	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 3.0 V
Gate Current, I_G	10.8 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 +250°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 > 1 x 10^7 hours.
8. Operating at nominal conditions with T_{CH} ≤ 225°C will ensure MTTF > 1 x 10^7 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* = 3.686, *B* = -35.00, and *C* = 25,416.

Thermal Characteristics[10]

Parameter	Test Conditions	Symbol	Typical	Units
Thermal Resistance using Finite Element Analysis	V_{DS} = 50 V, P_D = 46 W, T_C = 120°C, T_{CH} = 225°C	R_θ (FEA)	1.90	°C/W
Thermal Resistance using Infrared Measurement of Die Surface Temperature	V_{DS} = 50 V, P_D = 46 W, T_C = 120°C, T_{CH} = 225°C	R_θ (IR)	1.58	°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 HBM Class 1B, CDM Class C3 devices.

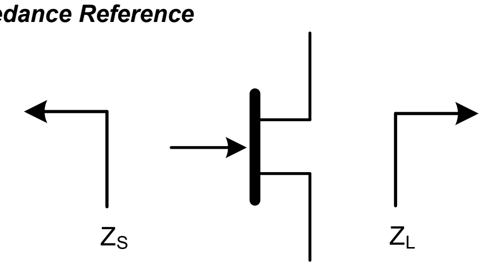
Pulsed[11] Load-Pull Performance

Reference Plane at Device Leads

Frequency (GHz)	Z_{SOURCE} (Ω)	Carrier / Peak Amplifier: Max Output Power					
		V_{DS} = 50 V, I_{DQ} = 180 mA, T_C = 25°C, P2.5 dB					
		Z_{LOAD}[12] (Ω)	Gain (dB)	P_{OUT} (dBm)	P_{OUT} (W)	η_D (%)	AM/PM (°)
3.4	6.0 - j22.0	11.25 - j7.5	15.2	49.3	85.1	54.3	1.0
3.6	15.5 - j30.0	13.4 - j6.5	14.8	49.27	84.5	55.4	-1.0
3.8	41.0 - j21.0	14.5 - j3.4	14.2	49.1	81.3	55.0	-3.6

Frequency (GHz)	Z_{SOURCE} (Ω)	Carrier / Peak Amplifier: Max Drain Efficiency					
		V_{DS} = 50 V, I_{DQ} = 180 mA, T_C = 25°C, P2.5dB					
		Z_{LOAD}[13] (Ω)	Gain (dB)	P_{OUT} (dBm)	P_{OUT} (W)	η_D (%)	AM/PM (°)
3.4	6.0 - j23.0	7.36 - j7.5	16.2	48.6	72.5	59.5	-1.8
3.6	17.5 - j32.0	10.0 - j13.5	16.0	48.3	67.6	61	-0.2
3.8	41.0 - j21.5	14.5 - j13.1	15.3	48.0	63.1	60.8	-3.6

Impedance Reference

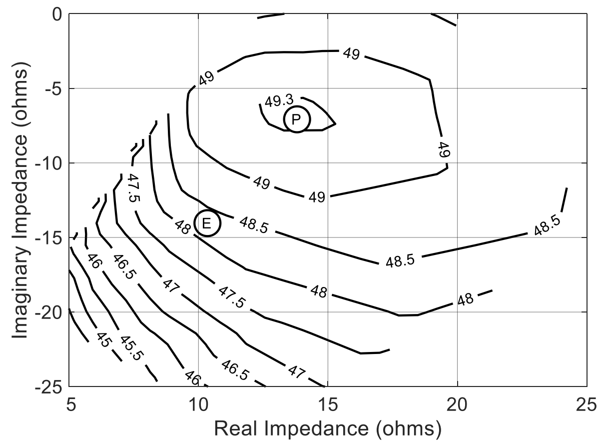


Z_{SOURCE} = Measured impedance presented to the input of the device at package reference plane.
Z_{LOAD} = Measured impedance presented to the output of the device at package reference plane.

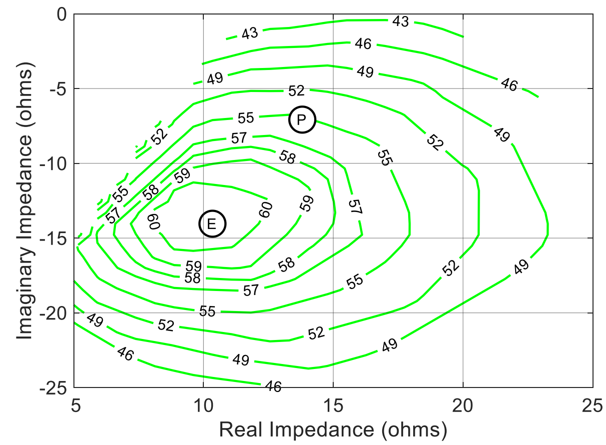
11. Pulse details: 100 μs pulse width, 1 ms period, 10% Duty Cycle.
12. Load Impedance for optimum output power.
13. Load Impedance for optimum efficiency.

Pulsed[11] Load-Pull Performance: Carrier / Peak Amplifier 3.5 GHz

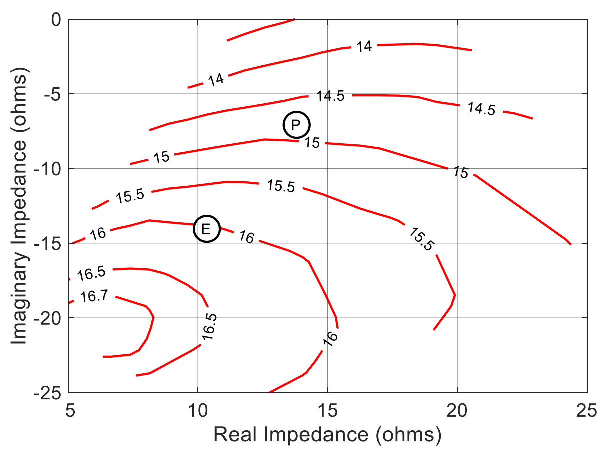
P2.5dB Loadpull Output Power Contours (dBm)



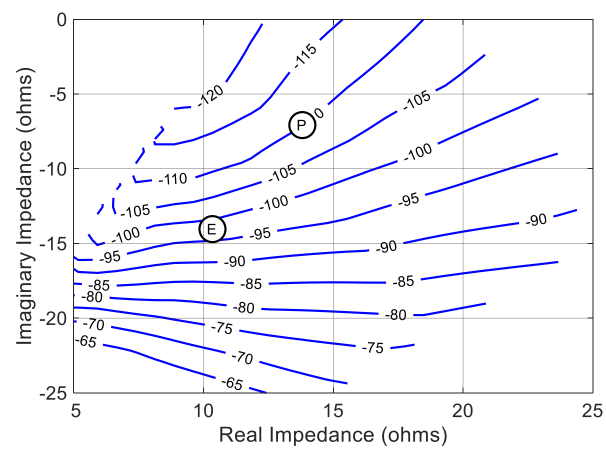
P2.5dB Loadpull Drain Efficiency Contours (%)



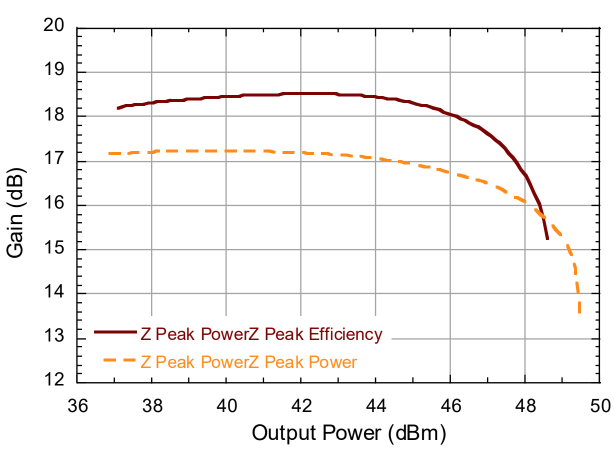
P2.5dB Loadpull Gain Contours (dB)



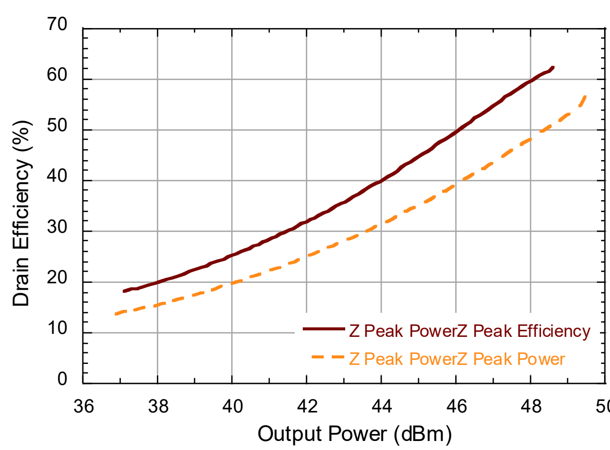
P2.5dB Loadpull AM/PM Contours (°)



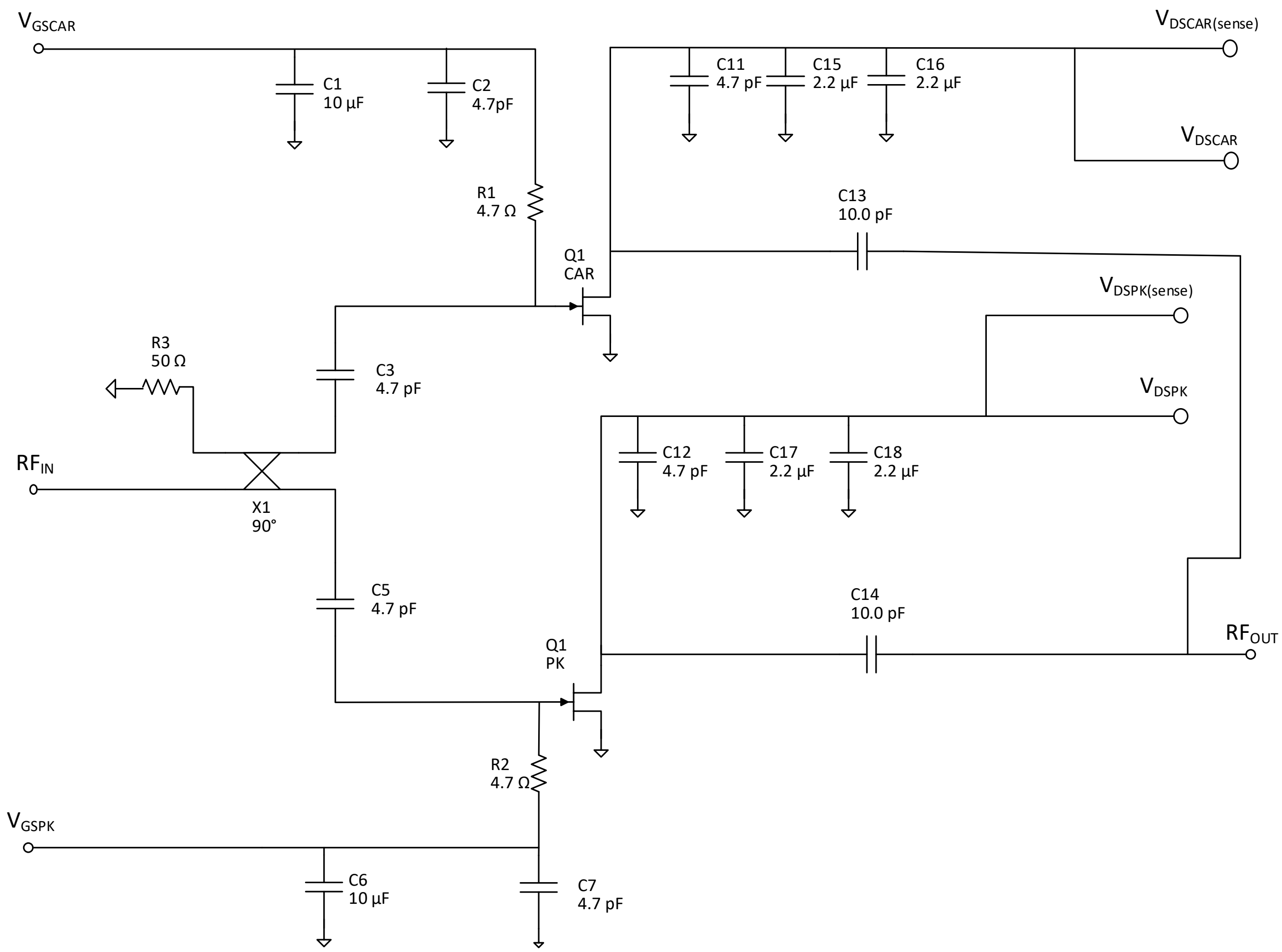
Gain vs. Output Power



Drain Efficiency vs. Output Power



Evaluation Test Fixture and Recommended Tuning Solution 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.

Bias Sequencing

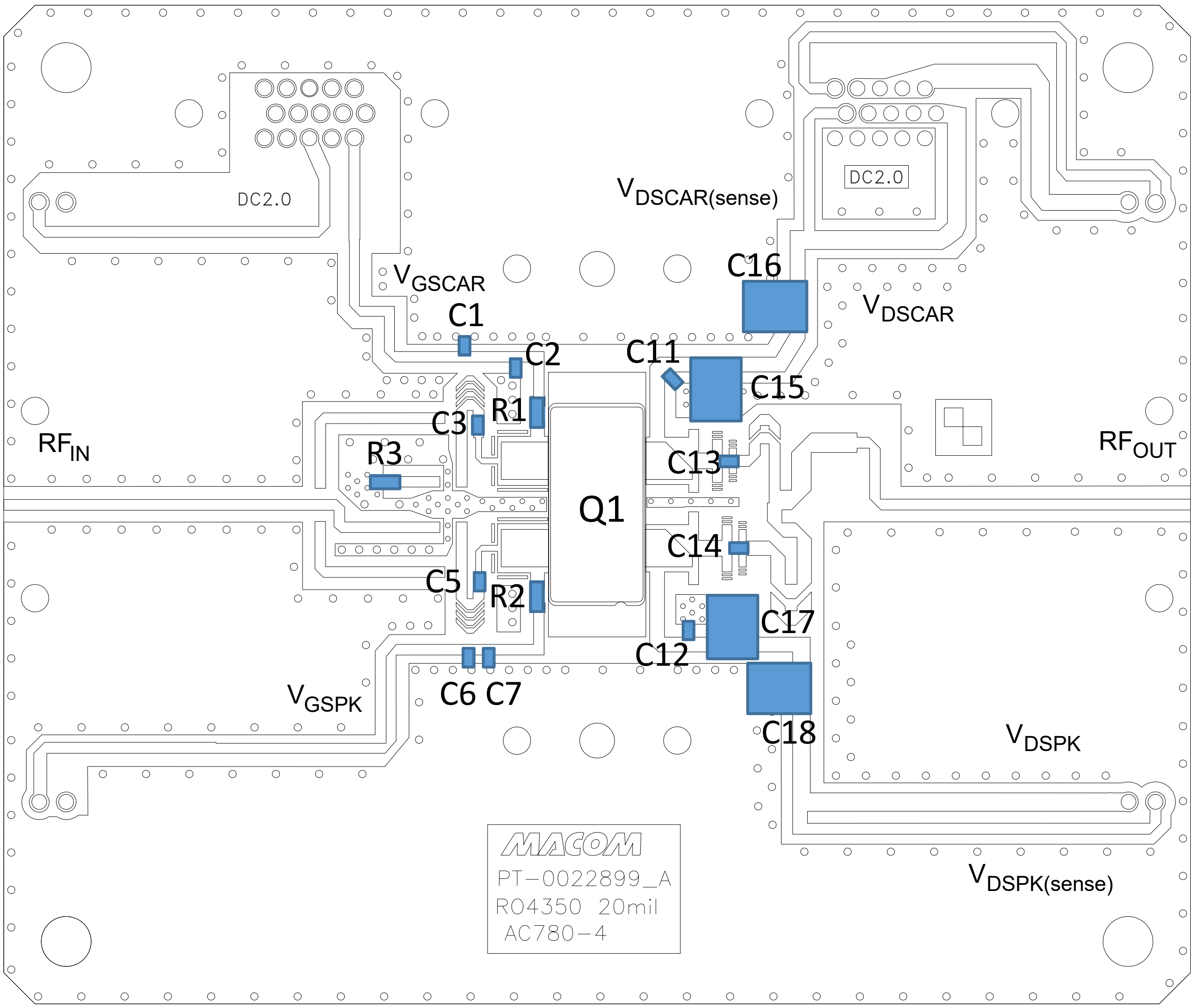
Turning the device ON

1. Set both V_{GSCAR} and V_{GSPK} to the pinch-off (V_P).
2. Turn on V_{DS} to nominal voltage (46 V).
3. Increase V_{GSPK} until I_{DSQPK} current is reached. Record the V_{GSQPK} voltage.
4. Offset the V_{GSQPK} by -1.9 V, typically -3.65 V.
5. Increase V_{GSCAR} until I_{DSQCAR} current is reached.
6. Apply RF power to desired level.

Turning the device OFF

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

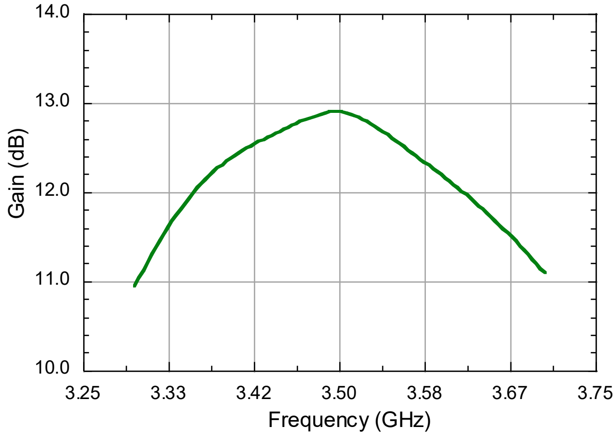
Evaluation Test Fixture and Recommended Tuning Solution 3.4 - 3.6 GHz



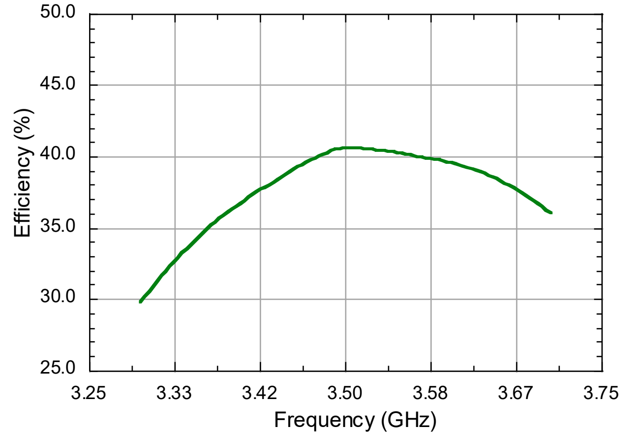
Reference Designator	Value	Tolerance	Vendor	Part Number
C1, C6	10 µF	+/- 10%	Murata	GRM21BZ71C106KE15L
C2, C3, C5, C7, C11, C12	4.7 pF	+/- 0.1 pF	Murata	GQM2195C2E4R7BB12
C15-C18	2.2 µF	+/- 10%	Murata	KRM55TR72E225MH01L
C13, C14	10 pF	+/- 5%	Murata	GQM2195C2E100JB12
R3	50 Ω	+/- 1%	Anaren	C8A50Z4B (8W)
R1, R2	4.7 Ω	+/- 5%	Panasonic	ERJ-8RQF4R7V
Q1	*MACOM*			MAGB-103438-170S0S
X1	Anaren 3dB Splitter			X3C35F1-03S
PCB	RO4350, 20 mil Laminate, SnPb Finish			

Typical Performance as Measured in the 3.4 - 3.6 GHz Evaluation Test Fixture: WCMDA 3GPP TM1 64 DPCH 9.9 dB PAR @ 0.01% CCDF V_{DS} = 46 V, I_{DQCAR} = 180 mA, V_{GSPK} = -4.0 V, T_C = 25°C

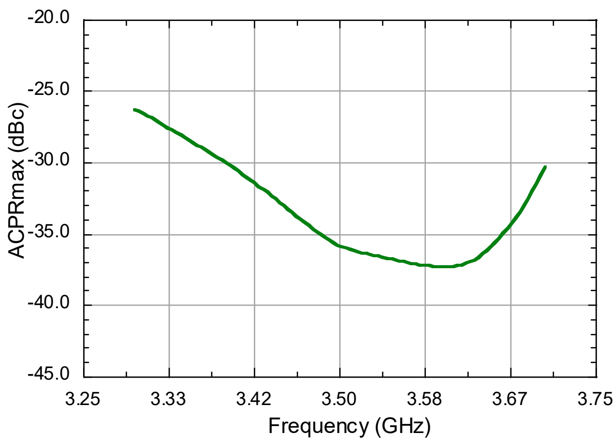
Gain vs. Frequency at P_{OUT} = 42.2 dBm



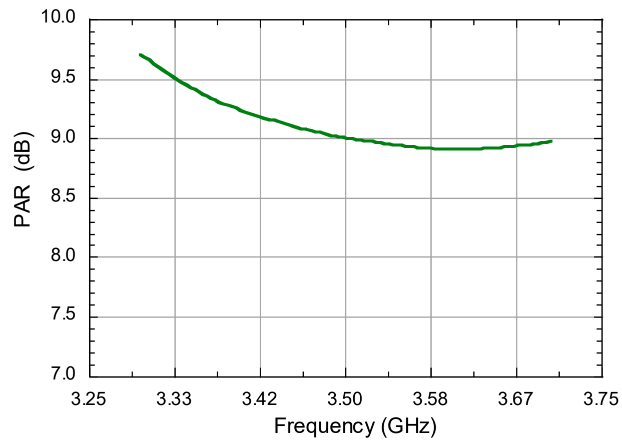
Efficiency vs. Frequency at P_{OUT} = 42.2 dBm



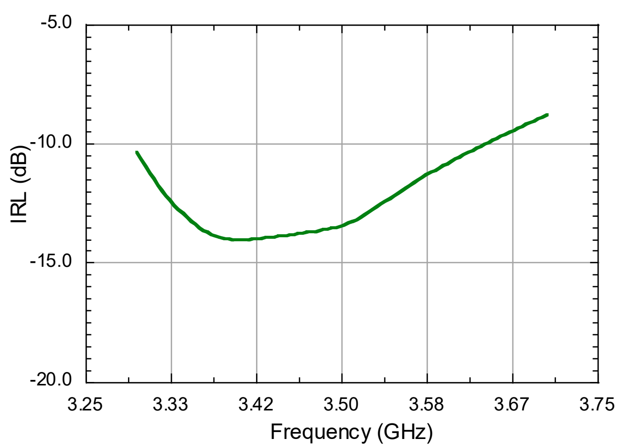
ACPR (Max ±5 MHz) vs. Frequency at P_{OUT} = 42.2 dBm



PAR vs. Frequency at P_{OUT} = 42.2 dBm

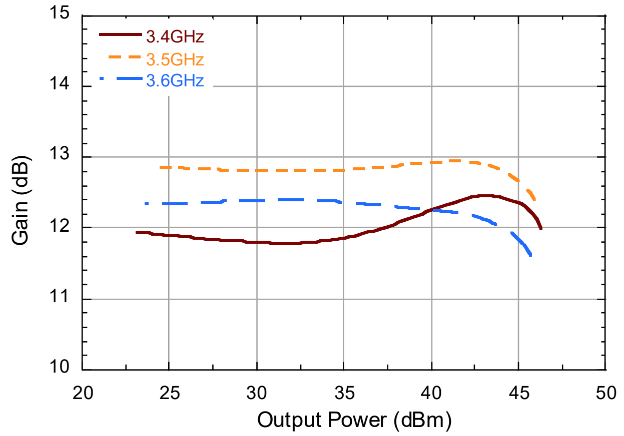


Input Return Loss vs. Frequency at P_{OUT} = 42.2 dBm

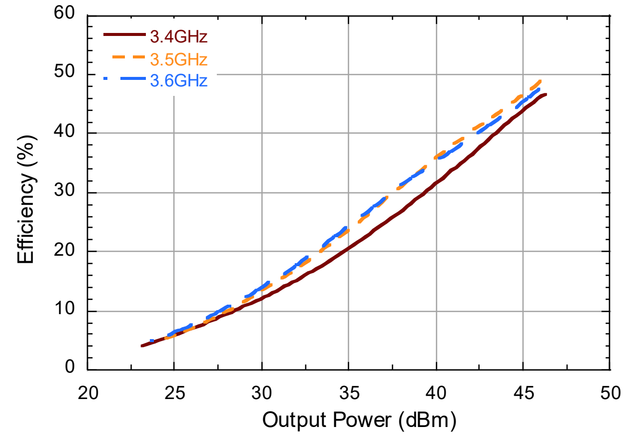


Typical Performance as Measured in the 3.4 - 3.6 GHz Evaluation Test Fixture: WCMDA 3GPP TM1 64 DPCH 9.9 dB PAR @ 0.01% CCDF V_{DS} = 46 V, I_{DQCAR} = 180 mA, V_{GSPK} = -4.0 V, T_C = 25°C

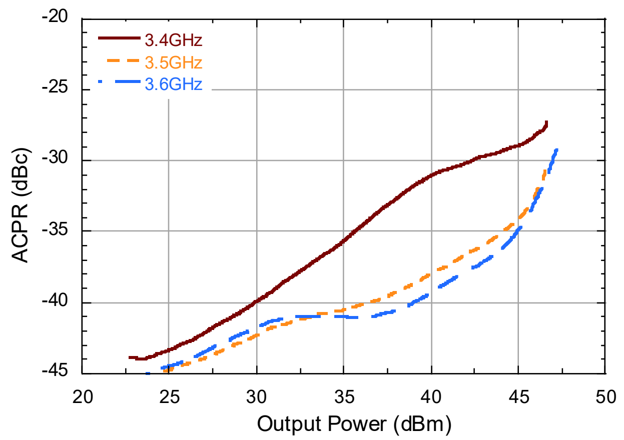
Gain vs. Output Power



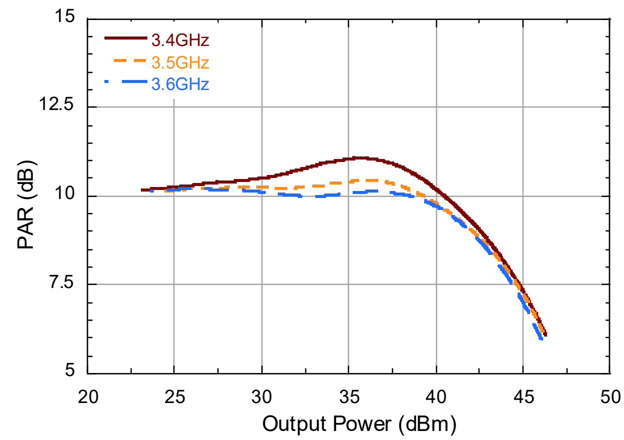
Efficiency vs. Output Power



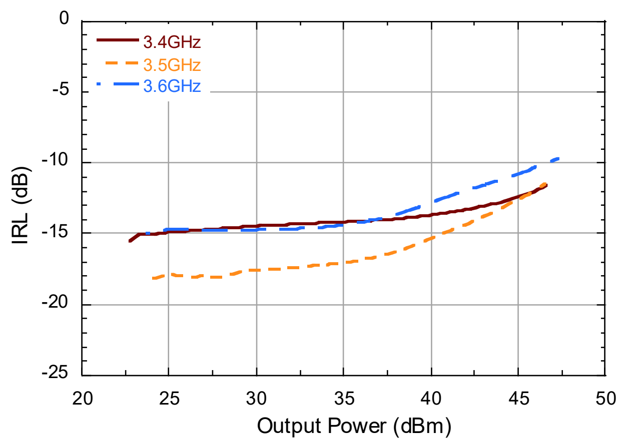
ACPR (Max ±5 MHz) vs. Output Power



PAR vs. Output Power

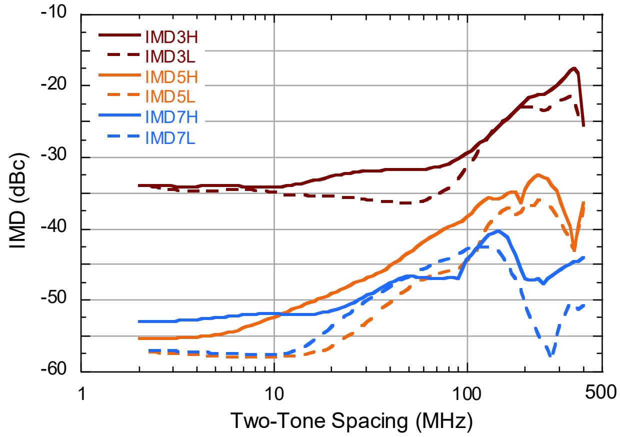


Input Return Loss vs. Output Power

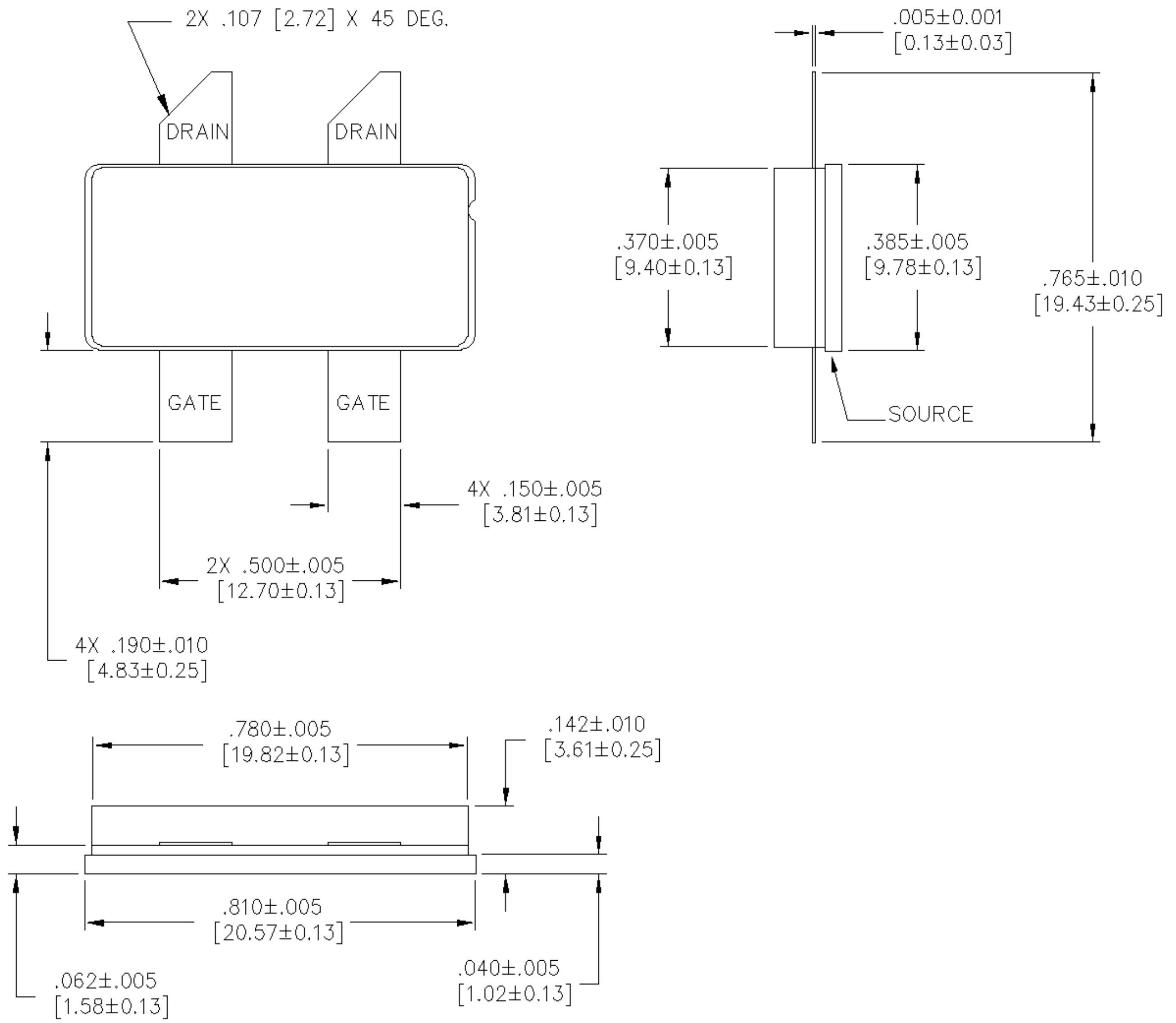


Typical Performance as Measured in the 3.4 - 3.6 GHz Evaluation Test Fixture: 2-Tone Video Bandwidth Performance V_{DS} = 46 V, I_{DQCAR} = 180 mA, V_{GSPK} = -4.0 V, P_{OUT} = 42.2 dBm Avg

IMD vs. Tone Spacing (MHz) at 3.5 GHz



AC-780S-4 Package Dimensions†



NOTES:
1. ALL DIMENSIONS SHOWN AS in[mm]. CONTROLLING DIMENSIONS ARE IN in AND CONVERTED mm DIMENSIONS ARE NOT NECESSARILY EXACT.
2. LEAD FINISH: AU
   FLANGE FINISH: AU
3. LID SEAL EPOXY MAY FLOW OUT A MAXIMUM OF .018 [0.46] FROM EDGE OF LID
4. LID MAY BE MIS-ALIGNED UP TO .008 [0.20] FROM PACKAGE IN ANY DIRECTION

† Meets JEDEC moisture sensitivity level 3 requirements.