GaN Amplifier 28 V, 5 W
20 - 1500 MHz

MACOM PURE CARBIDE

MAPC-A1003
Rev. V1

Features

- *MACOM PURE CARBIDE*® Amplifier Series
- Suitable for Linear & Saturated Applications
- CW & Pulsed Operation
- 50 Ω Input & Output Matched
- 28 V Operation
- 100% RF Tested
- RoHS* Compliant

4 mm QFN

Applications

Military Radio Communications, RADAR, Avionics, Digital Cellular Infrastructure, RF Energy, and Test Instrumentation

Description

The MAPC-A1003 is a GaN on Silicon Carbide HEMT D-mode amplifier suitable for 20 - 1500 MHz frequency operation. The device supports both CW and pulsed operation with minimum output power levels of 5 W (37 dBm(in a 4 mm plastic package.

Typical Performance:

Measured in sample board under CW operation:
V_{DS} = 28 V, I_{DQ} = 50 mA, T_C = 25°C, P_{OUT} = 37 dBm

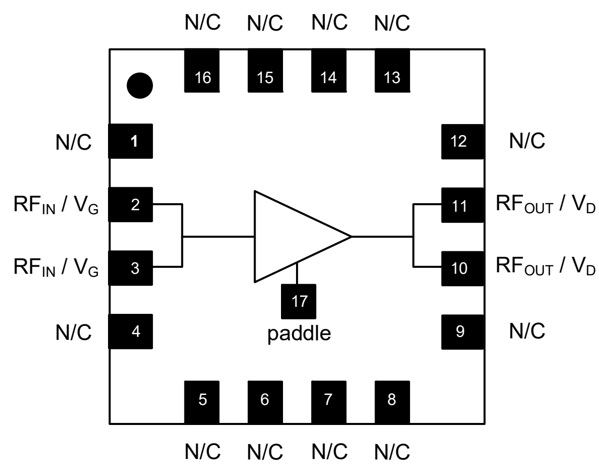
Frequency (GHz)	Gain (dB)	η_D (%)	IRL (dB)
20	19.3	49.2	-9
100	18.4	51.1	-11.5
400	17.4	49.6	-9.8
700	16.1	42.7	-9.3
1000	15.9	41.2	-14
1300	14.3	40.9	-7.5
1500	12	40.1	-3.8

Ordering Information[1]

Part Number	Package
MAPC-A1003-AQ000	Bulk Quantity
MAPC-A1003-AQTR1	Tape & Reel
MAPC-A1003-AQSB1	Sample Board

1. Reference Application Note M513 for reel size information.

Functional Schematic



Pin Configuration[2]

Pin #	Pin Name	Function
1	N/C	No Connection
2, 3	RF_{IN} / V_G	RF Input / Gate Voltage
4 - 9	N/C	No Connection
10, 11	RF_{OUT} / V_D	RF Output / Drain Voltage
12 - 16	N/C	No Connection
17	Paddle[3]	Ground

2. MACOM recommends connecting unused package pins to ground.
3. The exposed pad centered on the package bottom must be connected to RF, DC and thermal ground.

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

DC-0037301

RF Electrical Characteristics: T_C = 25°C, V_{DS} = 28 V, I_{DQ} = 50 mA
Note: Performance in MACOM Evaluation Test Fixture, 50 Ω system

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Small Signal Gain	CW, 1000 MHz	G_{SS}	-	17.1	-	dB
Power Gain	CW, 1000 MHz	G_{SAT}	-	14.1	-	dB
Saturated Drain Efficiency	CW, 1000 MHz	h_{SAT}	-	52.7	-	%
Saturated Output Power	CW, 1000 MHz	P_{SAT}	-	39.7	-	dBm
Gain Variation (-40°C to +85°C)	CW, 1000 MHz	ΔG_{SAT}	-	.0122	-	dB/°C
Power Variation (-40°C to +85°C)	CW, 1000 MHz	ΔP_{SAT}	-	.006	-	dBm/°C
Power Gain	CW, 1000 MHz, P_{OUT} = 37 dBm	G_P	-	15.9	-	dB
Drain Efficiency	CW, 1000 MHz, P_{OUT} = 37 dBm	h	-	41.2	-	%
Input Return Loss	CW, 1000 MHz, P_{OUT} = 37 dBm	IRL	-	-14	-	dB
Ruggedness: Output Mismatch	All phase angles	Y	VSWR = 10:1, No Damage			

RF Electrical Specifications: T_A = 25°C, V_{DS} = 28 V, I_{DQ} = 50 mA
Note: Performance in MACOM Production Test Fixture, 50 Ω system

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Power Gain	CW, 1000 MHz, P_{OUT} = 37 dBm	G_P	14.5	15.9	-	dB
Saturated Drain Efficiency	CW, 1000 MHz, P_{OUT} = 37 dBm	h_P	32	40	-	%

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} = 120 V	I_{DLK}	-	-	2.16	mA
Gate-Source Leakage Current	V_{GS} = -8 V, V_{DS} = 0 V	I_{GLK}	-	-	2.16	mA
Gate Threshold Voltage	V_{DS} = 28 V, I_D = 2.16 mA	V_T	-	-2.9	-	V
Gate Quiescent Voltage	V_{DS} = 28 V, I_D = 50 mA	V_{GSQ}	-	-2.65	-	V
Maximum Drain Current	V_{DS} = 7 V, pulse width 300 µs	$I_{D, MAX}$	-	1.26	-	A

Absolute Maximum Ratings[4,5,6,7,8]

Parameter	Absolute Maximum
Drain Source Voltage, V_{DS}	120 V
Gate Source Voltage, V_{GS}	-10 to 2 V
Gate Current, I_G	2.16 mA
Storage Temperature Range	-65°C to +150°C
Case Operating Temperature Range	-40°C to +85°C
Channel Operating Temperature Range, T_{CH}	-40°C to +225°C

4. Exceeding any one or combination of these limits may cause permanent damage to this device.
5. MACOM does not recommend sustained operation above maximum operating conditions.
6. Operating at drain source voltage V_{DS} < 28 V will ensure MTTF > 1 x 10^6 hours.
7. Operating at nominal conditions with T_{CH} ≤ 225°C will ensure MTTF > 1 x 10^6 hours.
8. 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* = TBD, *B* = TBD, and *C* = TBD.

Thermal Characteristics

Parameter	Test Conditions	Symbol	Typical	Units
Thermal Resistance using Finite Element Analysis	V_{DS} = 28 V, T_C = 85°C, T_{CH} = 225°C	R_q(FEA)	10.7	°C/W
Thermal Resistance using Infrared Measurement of Die Surface Temperature	V_{DS} = 28 V, T_C = 85°C, T_{CH} = 225°C	R_q(IR)	7.53	°C/W

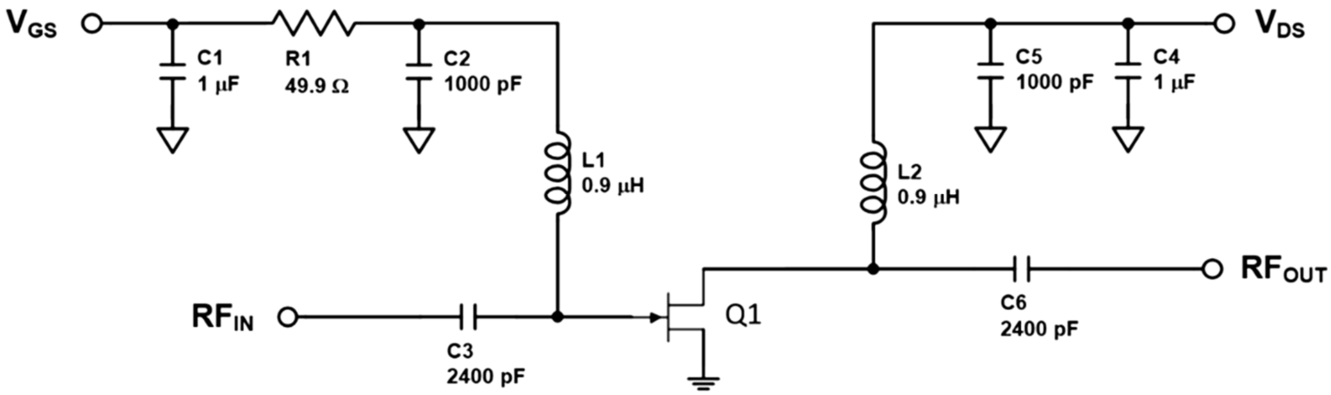
Handling Procedures

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 devices.

Evaluation Test Fixture and Recommended Tuning Solution 20 - 1500 MHz



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

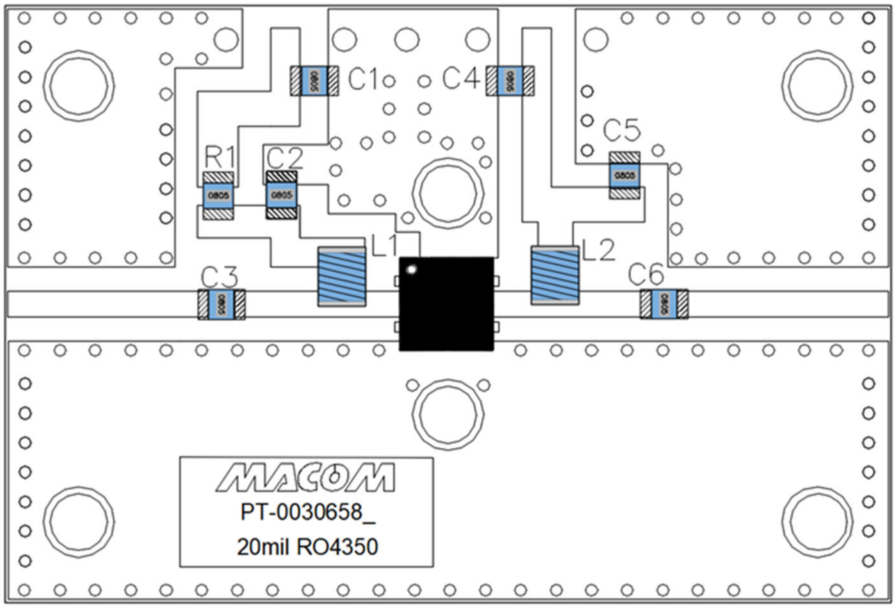
Turning the device ON

1. Set V_{GS} to pinch-off (V_P).
2. Turn on V_{DS} to nominal voltage (28 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}.

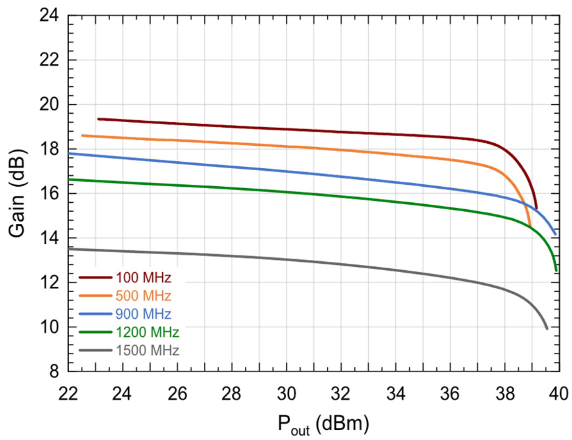
Evaluation Test Fixture and Recommended Tuning Solution 20 - 1500 MHz



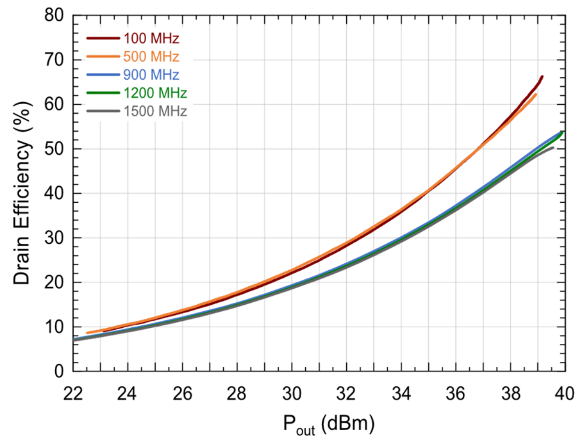
Reference Designator	Value	Tolerance	Manufacturer	Part Number
C1, C4	1 µF	+/- 10 %	Murata	GRM21BC72A105KE01L
C2, C5	1000 pF	+/- 10 %	Murata	GRM219R72A102JA01D
C3, C6	2400 pF	+/- 15 %	Knowles	C08BL242X-5UN-X0T
L1, L2	0.9 µH	+/- 10 %	CoilCraft	1008AF-901XJLC
R1	49.9 Ω	+/- 1 %	Panasonic	ERJ-6ENF49R9V
Q1	MACOM GaN Power Amplifier			MAPC-A1003
PCB	RO4350, 20 mil, 0.5 oz. Cu, Au Finish			

Typical Performance Curves as Measured in the Evaluation Test Fixture: CW, V_{DS} = 28 V, I_{DQ} = 50 mA, T_C = 25°C

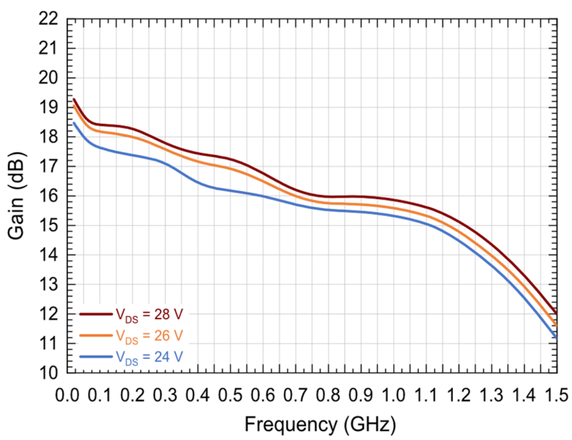
Gain vs. Output Power over Frequency



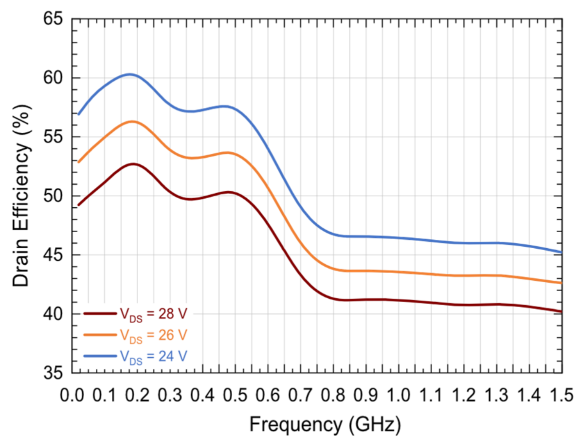
Drain Efficiency vs. Output Power over Frequency



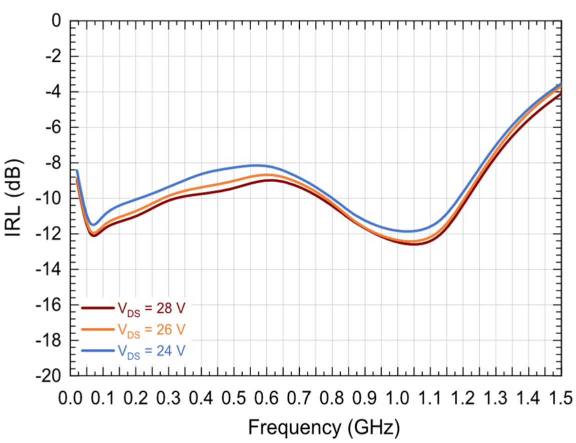
Gain vs. Frequency over V_{DS} @ P_{OUT} = 37 dBm



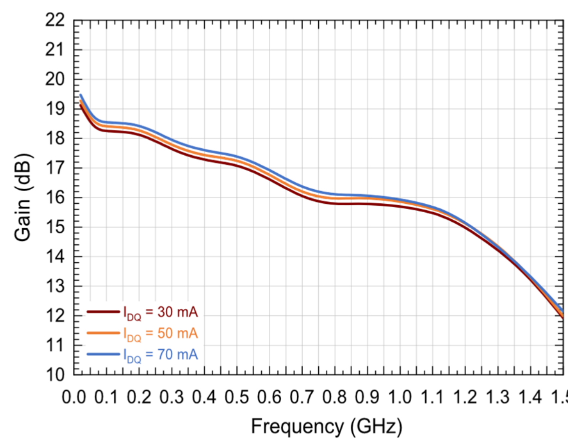
Drain Efficiency vs. Frequency over V_{DS} @ P_{OUT} = 37 dBm



IRL vs. Frequency over V_{DS} @ P_{OUT} = 37 dBm

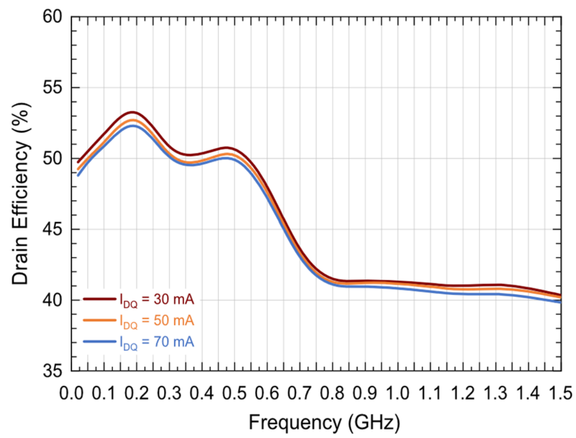


Gain vs. Frequency over I_{DQ} @ P_{OUT} = 37 dBm

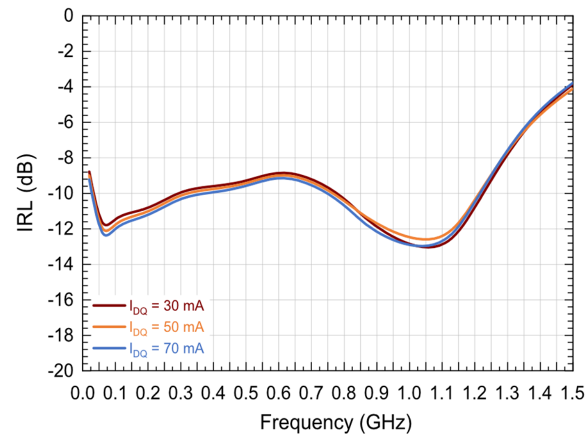


Typical Performance Curves as Measured in the Evaluation Test Fixture: CW, V_{DS} = 28 V, I_{DQ} = 50 mA, T_C = 25°C

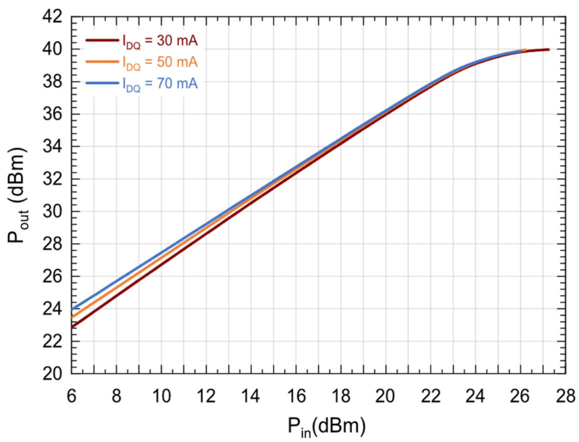
Drain Efficiency vs. Frequency over I_{DQ} @ P_{OUT} = 37 dBm



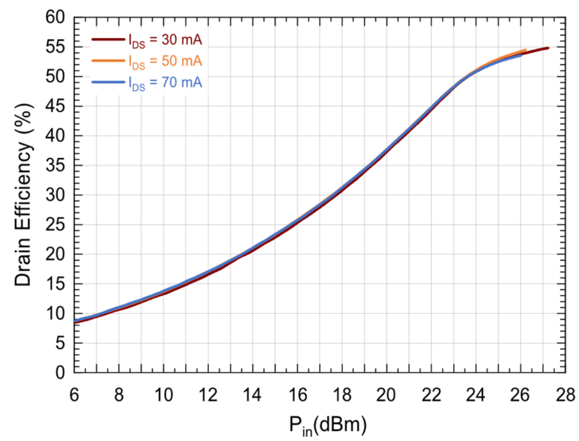
IRL vs. Frequency over I_{DQ} @ P_{OUT} = 37 dBm



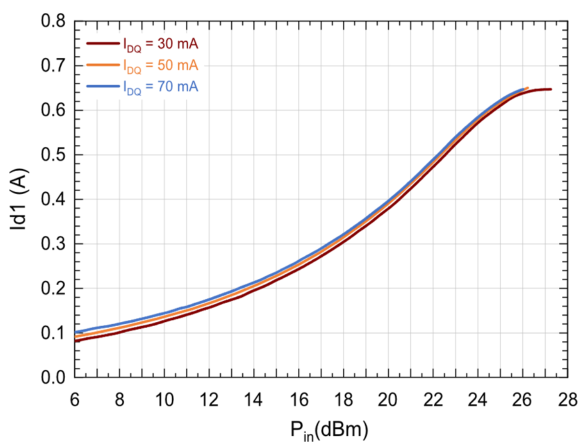
Output Power vs. Input Power over I_{DQ} @ 1000 MHz



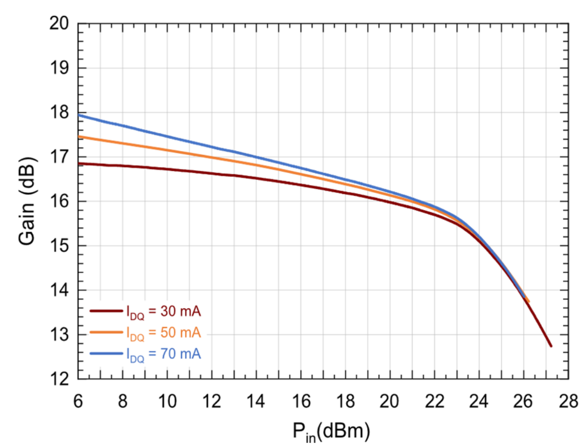
Drain Efficiency vs. Input Power over I_{DQ} @ 1000 MHz



I_{DS} vs. Input Power over I_{DQ} @ 1000 MHz

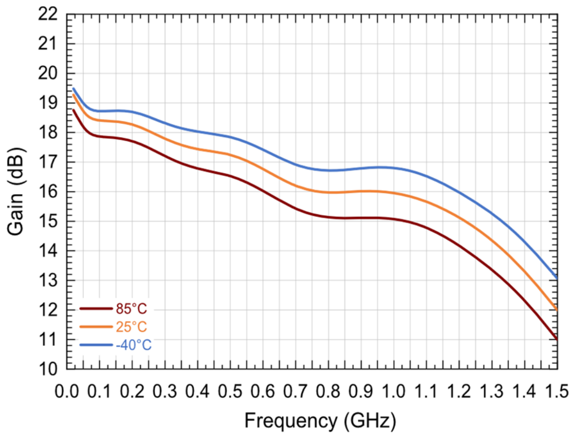


Gain vs. Input Power over I_{DQ} @ 1000 MHz

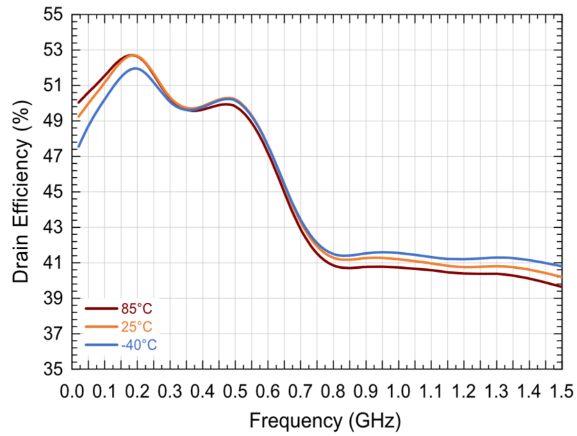


Typical Performance Curves as Measured in the Evaluation Test Fixture: CW, V_{DS} = 28 V, I_{DQ} = 50 mA, T_C = 25°C

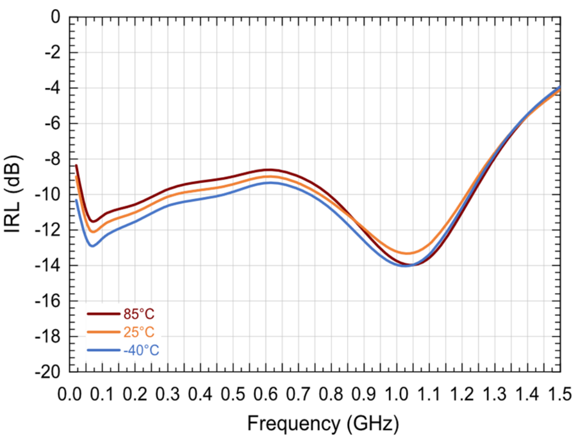
Gain vs. Frequency over Temperature @ P_{OUT} = 37 dBm



Drain Efficiency vs. Frequency over Temperature @ P_{OUT} = 37 dBm

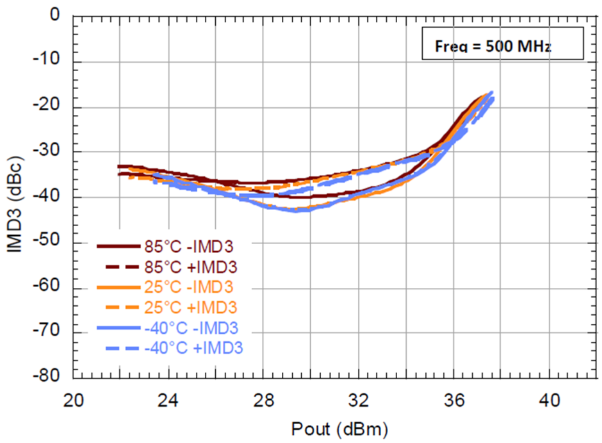


IRL vs. Frequency over Temperature @ P_{OUT} = 37 dBm

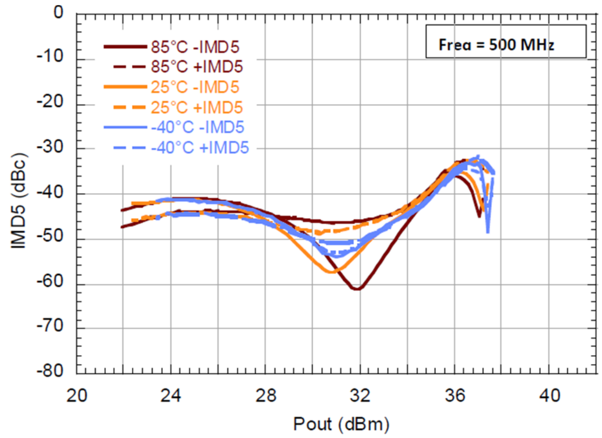


Typical Performance Curves as Measured in the Evaluation Test Fixture: CW, Two Tone, DF = 2 MHz, VDS = 28 V, IDQ = 50 mA, TC = 25°C

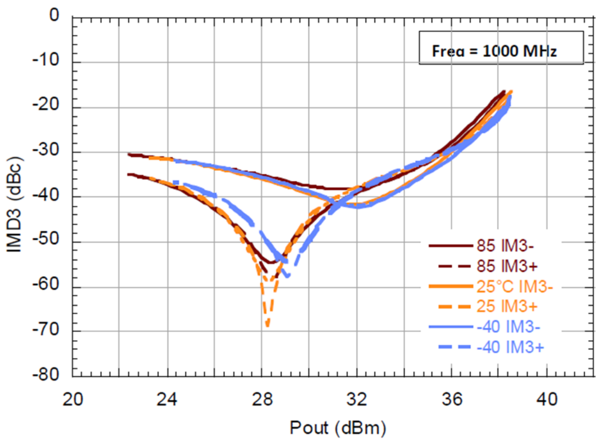
IMD3 vs. Output Power @ S.C.L over Temperature



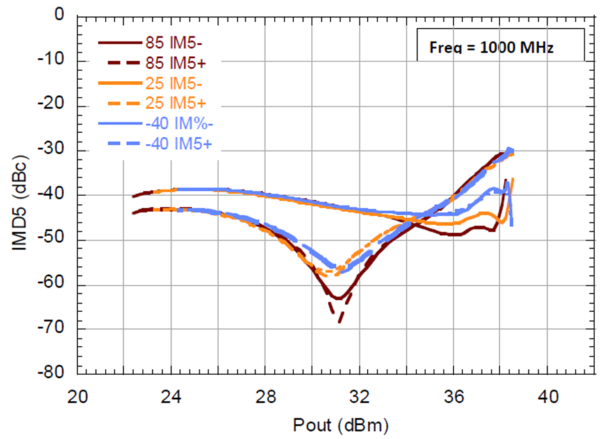
IMD5 vs. Output Power @ S.C.L over Temperature



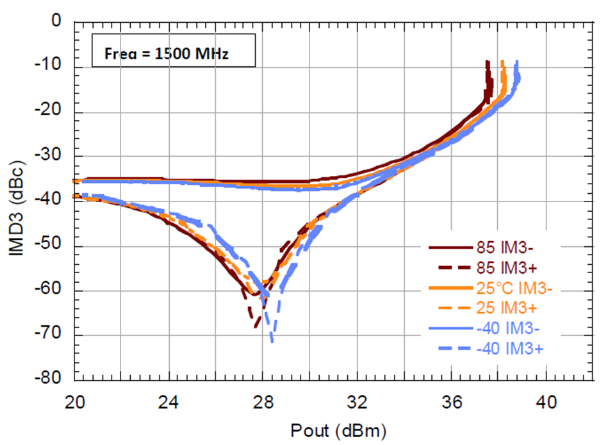
IMD3 vs. Output Power @ S.C.L over Temperature



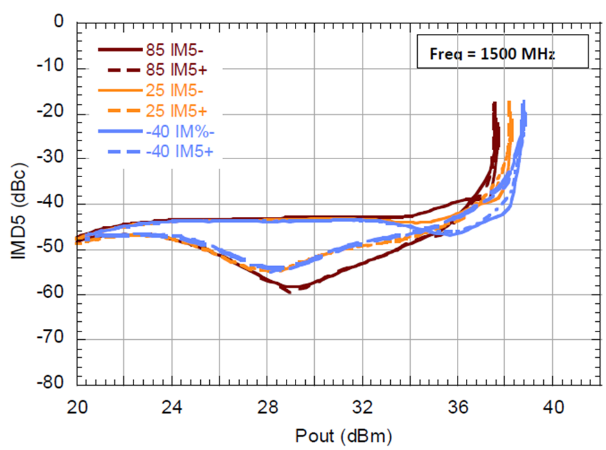
IMD5 vs. Output Power @ S.C.L over Temperature



IMD3 vs. Output Power @ S.C.L over Temperature

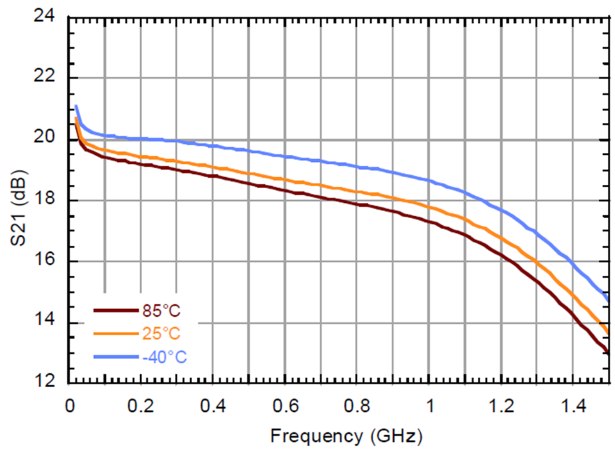


IMD5 vs. Output Power @ S.C.L over Temperature

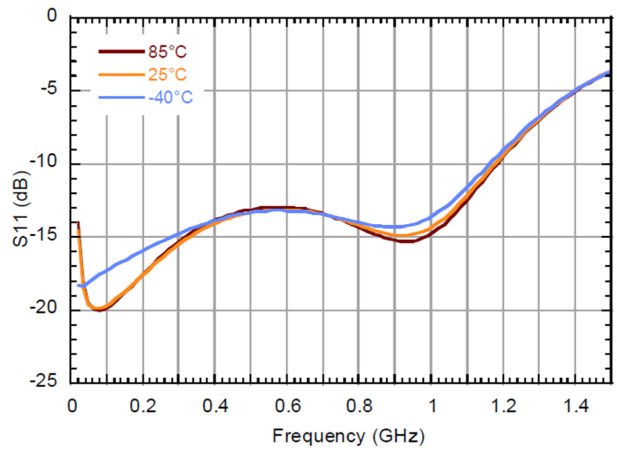


Typical Performance Curves as Measured in the Evaluation Test Fixture: CW, V_{DS} = 28 V, I_{DQ} = 50 mA, T_C = 25°C

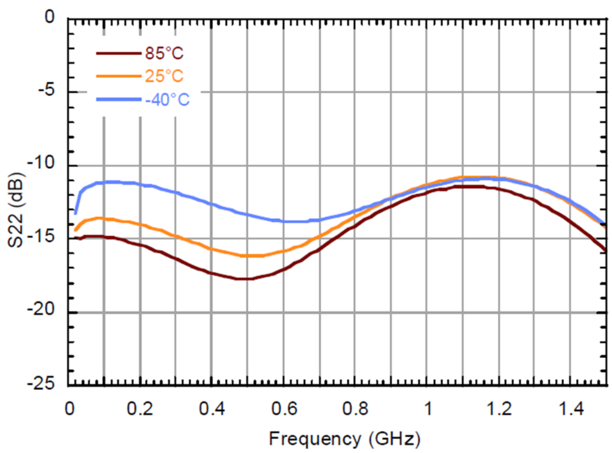
S21 vs. Frequency and Temperature



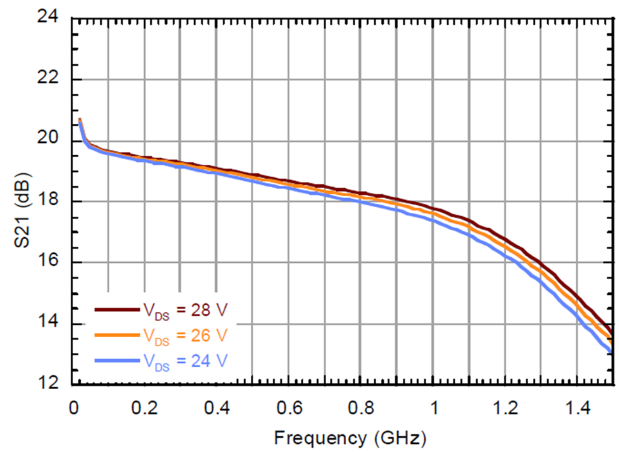
S11 vs. Frequency and Temperature



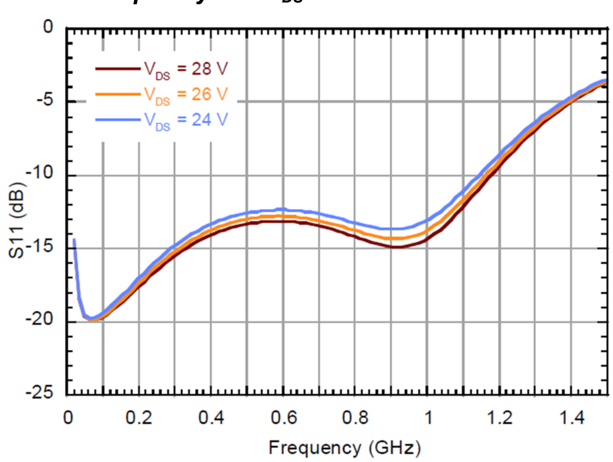
S22 vs. Frequency and Temperature



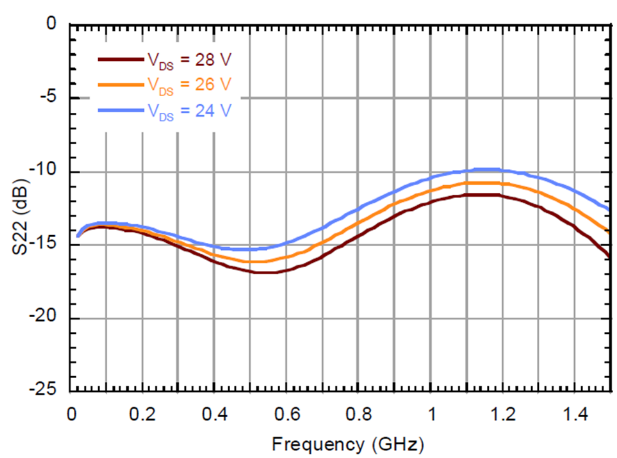
S21 vs. Frequency and V_{DS}



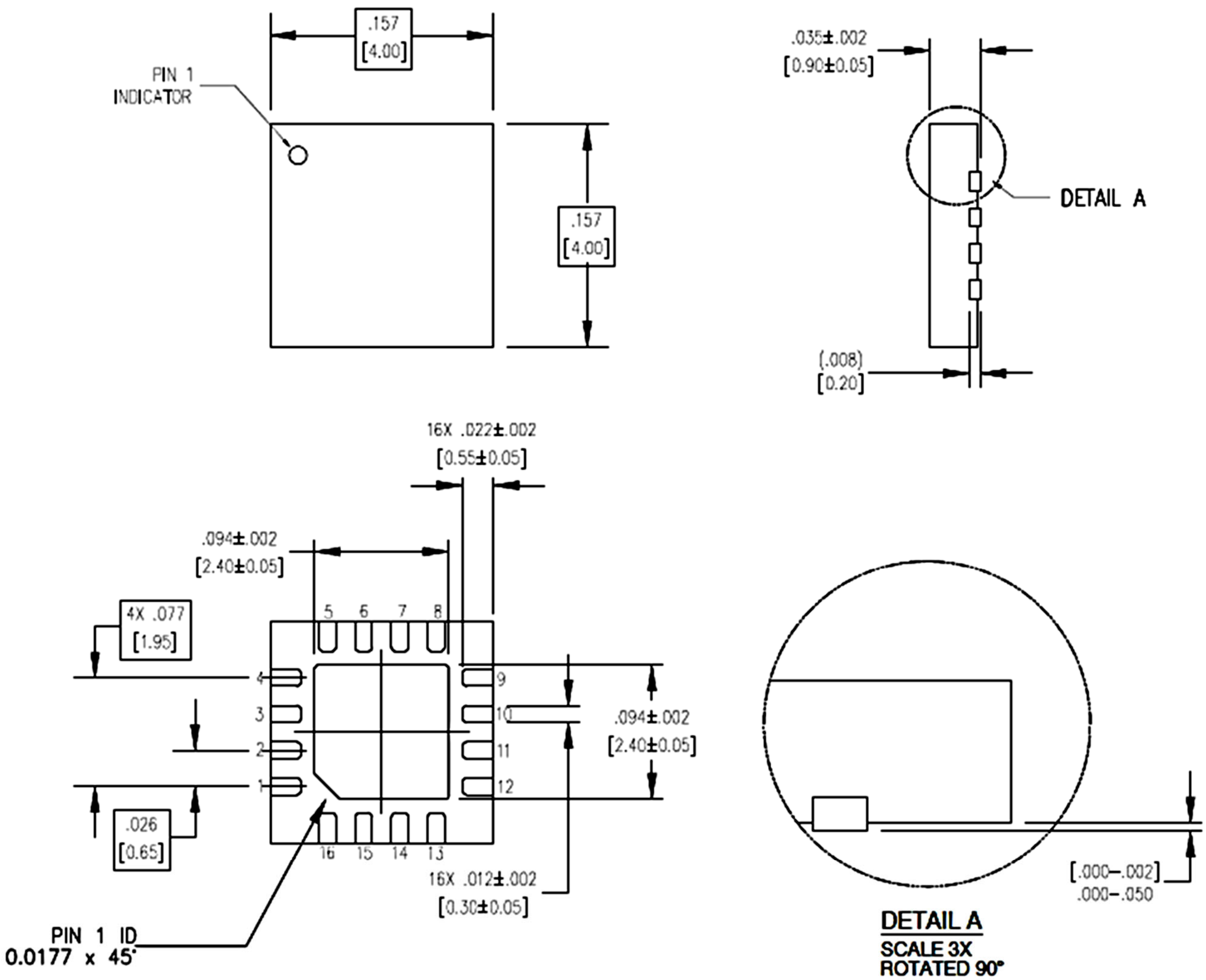
S11 vs. Frequency and V_{DS}



S22 vs. Frequency and V_{DS}



Lead-Free 6 mm 16-Lead QFN



NOTES:

1. ALL DIMENSIONS SHOWN AS in[mm]. CONTROLLING DIMENSIONS ARE IN in. CONVERTED mm DIMENSIONS ARE NOT NECESSARILY EXACT.
2. EXPOSED LEADS: NiPdAu