GaN Amplifier 12.5 W, 28 V
20 – 1000 MHz

MACOM PURE CARBIDE

MAPC-A1006
Rev. V1

Features

- *MACOM PURE CARBIDE®* Amplifier Series
- Suitable for Linear & Saturated Applications
- CW & Pulsed Operation
- 50 Ω Input Matched
- 260°C Reflow Compatible
- 28 V Operation
- 100% RF Tested
- RoHS* Compliant

5 x 6 mm DFN

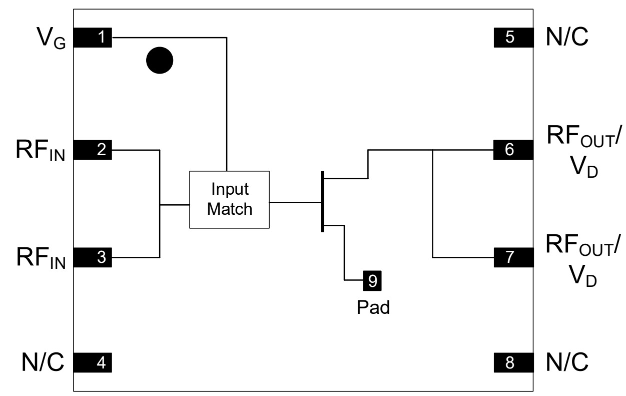
Applications

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

Description

The MAPC-A1006 is a GaN on Silicon Carbide HEMT amplifier suitable for 20 - 1000 MHz frequency operation. The device supports both CW and pulsed operation with minimum output power levels of 12.5 W (41 dBm) in a 5 x 6 mm plastic package.

Functional Schematic



Typical Circuit Performance:

V_{DS} = 28 V, I_{DQ} = 180 mA, T_C = 25°C. Measured in sample board circuit under CW operation. Data presented below is at constant P_{OUT} = 41 dBm.

Frequency (MHz)	G_P (dB)	η_D	IRL (dB)
20	10.4	77.3	-23.1
100	10.7	79.8	-17.3
400	13.1	67.1	-14.7
700	14.6	52	-14
1000	14.1	68	-9.3

Pin Configuration

Pin #	Pin Name	Function
1	V_G	Gate
2, 3	RF_{IN}	RF Input
4, 5, 8	N/C	No Connection
6, 7	RF_{OUT} / V_D	RF Output / Drain
9	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-A1006-AD000	Bulk Quantity
MAPC-A1006-ADTR1	Tape and Reel
MAPC-A1106-ADSB1	Sample Board

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

RF Electrical Characteristics: T_C = 25°C, V_{DS} = 28 V, I_{DQ} = 180 mA
Note: Performance in MACOM Evaluation Test Fixture, 50 Ω system

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Small Signal Gain	CW, 900 MHz	G_{SS}	-	17.4	-	dB
Power Gain	CW, 900 MHz	G_{SAT}	-	10.1	-	dB
Saturated Drain Efficiency	CW, 900 MHz	η_{SAT}	-	74	-	%
Saturated Output Power	CW, 900 MHz	P_{SAT}	-	43	-	dBm
Gain Variation (-40°C to +85°C)	CW, 900 MHz, P_{OUT} = 41 dBm	ΔG	-	0.014	-	dB/°C
Power Variation (-40°C to +85°C)	CW, 900 MHz, P_{OUT} = 41 dBm	ΔP	-	0.007	-	dBm/°C
Power Gain	CW, 900 MHz, P_{OUT} = 41 dBm	G_P	-	16	-	dB
Drain Efficiency	CW, 900 MHz, P_{OUT} = 41 dBm	η	-	58.5	-	%
Input Return Loss	CW, 900 MHz, P_{OUT} = 41 dBm	IRL	-	-9.4	-	dB
Ruggedness: Output Mismatch	All phase angles	Ψ	VSWR = 15:1, No Damage			

RF Electrical Specifications: T_A = 25°C, V_{DS} = 28 V, I_{DQ} = 180 mA
Note: Performance in MACOM Production Test Fixture, 50 Ω system

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Units
Power Gain	CW, 900 MHz, P_{OUT} = 41 dBm	G_P	12.5	14.5	-	dB
Saturated Drain Efficiency	CW, 900 MHz, P_{OUT} = 41 dBm	η_P	61	69	-	%

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}	-	-	7.2	mA
Gate-Source Leakage Current	V_{GS} = -8 V, V_{DS} = 0 V	I_{GLK}	-	-	7.2	mA
Gate Threshold Voltage	V_{DS} = 28 V, I_D = 7.2 mA	V_T	-	-2.9	-	V
Gate Quiescent Voltage	V_{DS} = 28 V, I_D = 180 mA	V_{GSQ}	-	-2.65	-	V

Absolute Maximum Ratings[2,3,4,5,6]

Parameter	Absolute Maximum
Drain Source Voltage, V_{DS}	120 V
Gate Source Voltage, V_{GS}	-10 to 2 V
Gate Current, I_G	7.2 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

2. Exceeding any one or combination of these limits may cause permanent damage to this device.
3. MACOM does not recommend sustained operation above maximum operating conditions.
4. Operating at drain source voltage V_{DS} < 28 V will ensure MTTF > 1×10^6 hours.
5. Operating at nominal conditions with $T_{CH} \leq 225°C$ will ensure MTTF > 1×10^6 hours.
6. 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[7]

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_θ(FEA)	3.51	°C/W
Thermal Resistance using Infrared Measurement of Die Surface Temperature	V_{DS} = 28 V T_C = 85°C,T_{CH} = 225°C	R_θ(IR)	2.81	°C/W

7. Case temperature measured using thermocouple embedded in heat-sink. Contact local applications support team for more details on this measurement.

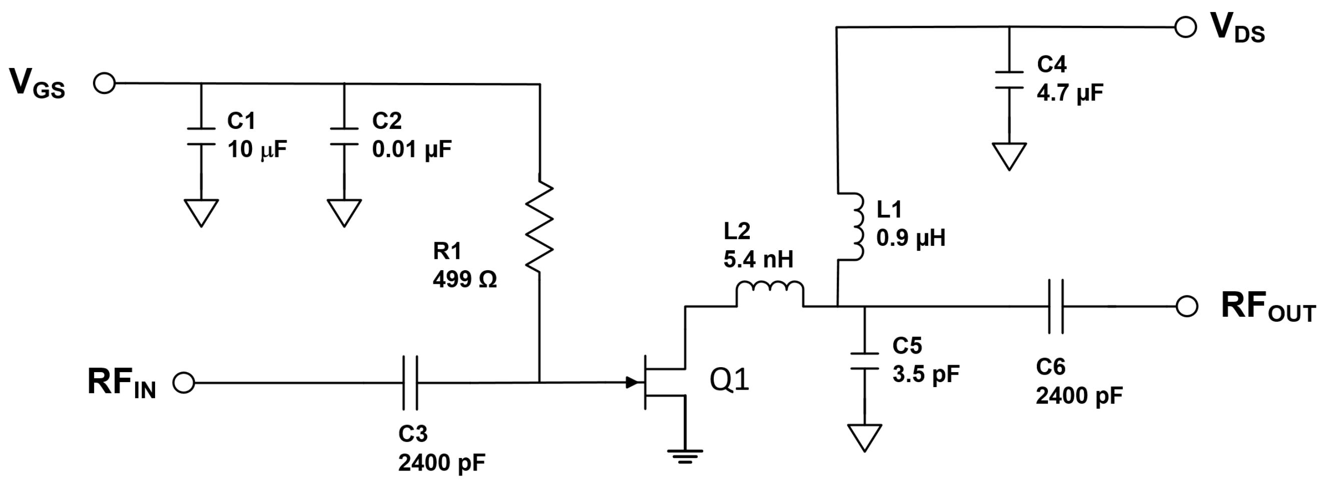
Handling Procedures

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 and CDM Class C3 devices.

Evaluation Test Fixture and Recommended Tuning Solution 20 - 1000 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

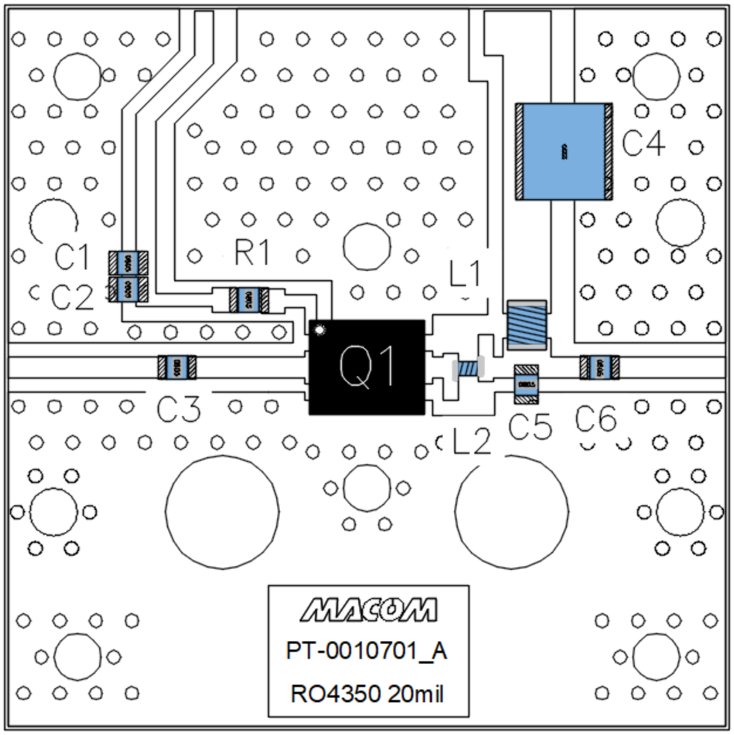
Turning the device ON

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 - 1000 MHz



Reference Designator	Value	Tolerance	Manufacturer	Part Number
C1	10 µF	+/- 10 %	Murata	GRM21BC71E106KE11L
C2	0.01 µF	+/- 10 %	Murata	GRM219R72A103KA01D
C3, C6	2400 pF	+/- 15 %	Knowles	C08BL242X-5UN-X0T
C4	4.7 µF	+/- 10 %	TDK	C575X7R2A475K230KA
C5	3.5 pF	+/- 0.1 pF	Murata	GQM2195G2E3R5CB12D
L1	0.9 µH	+/- 10 %	CoilCraft	1008AF-901XJLC
L2	5.4 nH	+/- 5 %	CoilCraft	0906-5JLC
R1	499 Ω	+/- 0.5 %	Panasonic	ERA-6AED4990V
Q1	MACOM GaN Power Amplifier			MAPC-A1006
PCB	RO4350, 20 mil, 0.5 oz. Cu, Au Finish			

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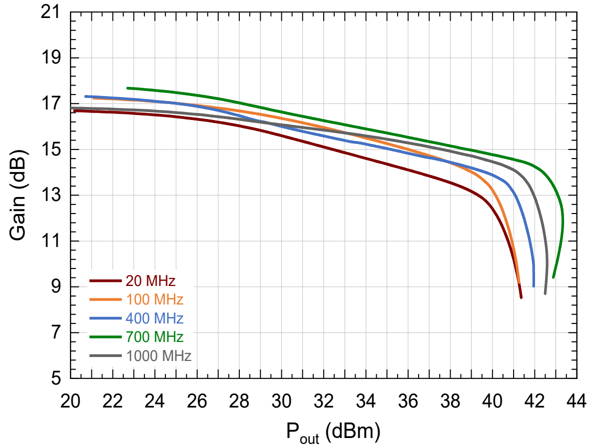
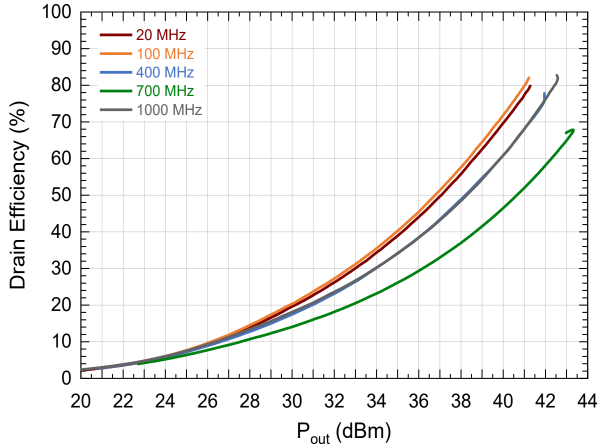
For Engineering Evaluation Only - This data does not Modify MACOM's Datasheet Limits.

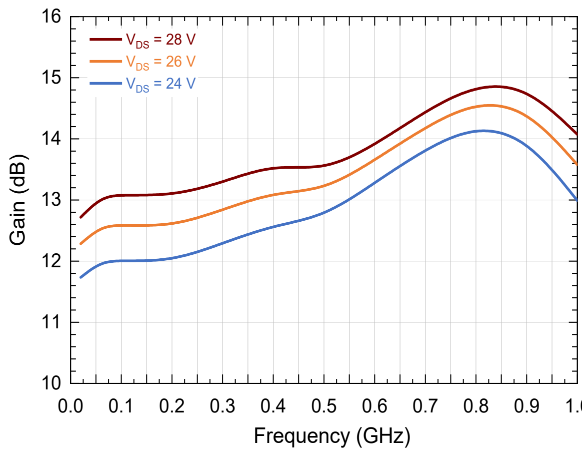
Gain vs. Output Power and Frequency



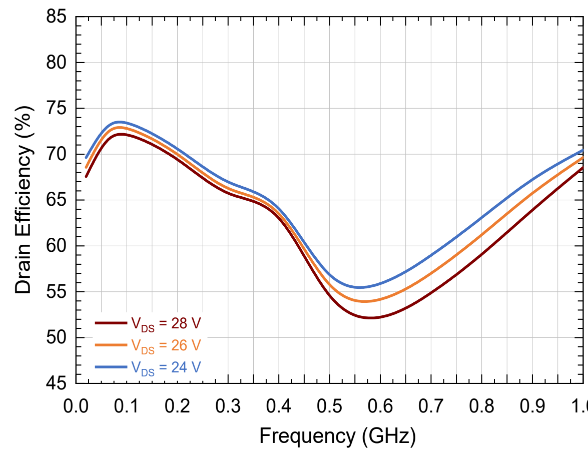
Drain Efficiency vs. Output Power and Frequency



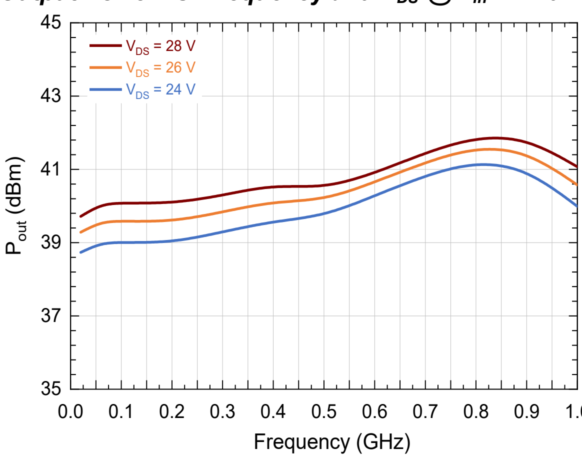
Gain vs. Frequency and V_{DS} @ P_{in} = 27 dBm



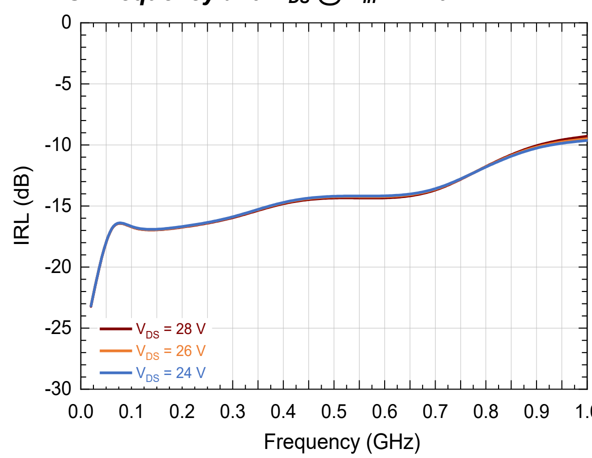
Drain Efficiency vs. Frequency and V_{DS} @ P_{in} = 27



Output Power vs. Frequency and V_{DS} @ P_{in} = 27 dBm



IRL vs. Frequency and V_{DS} @ P_{in} = 27 dBm



Typical Performance Curves as Measured in the Evaluation Test Fixture:
CW, V_{DS} = 28 V, I_{DQ} = 180 mA, T_C = 25°C (Unless Otherwise Noted)
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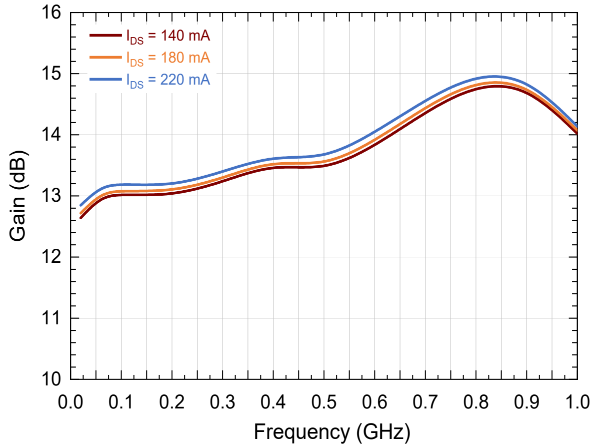
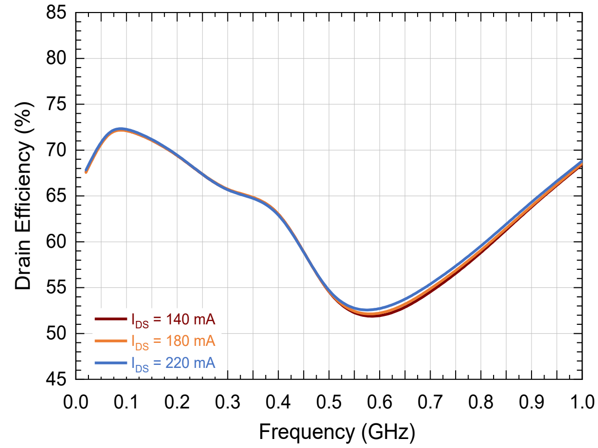
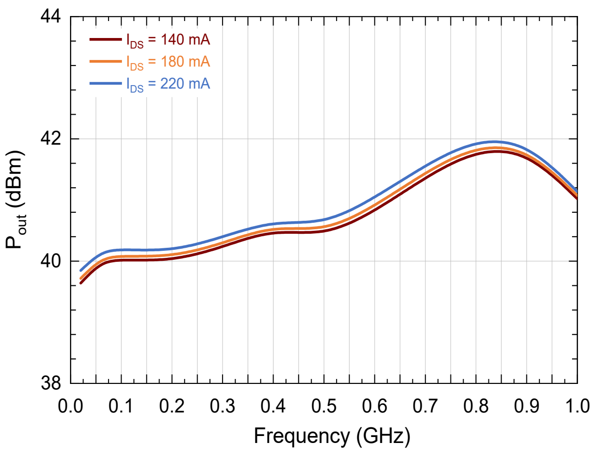
Gain vs. Frequency and I_{DQ} @ P_{in} = 27 dBm



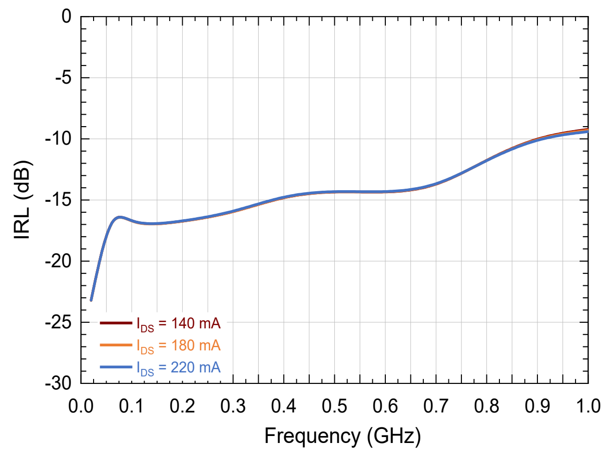
Drain Efficiency vs. Frequency and I_{DQ} @ P_{in} = 27 dBm



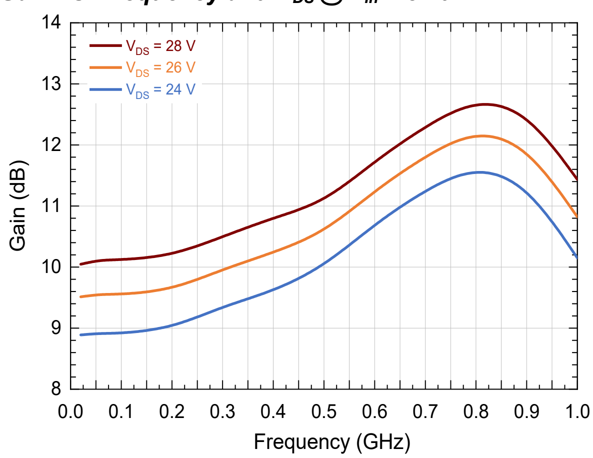
Output Power vs. Frequency and I_{DQ} @ P_{in} = 27 dBm



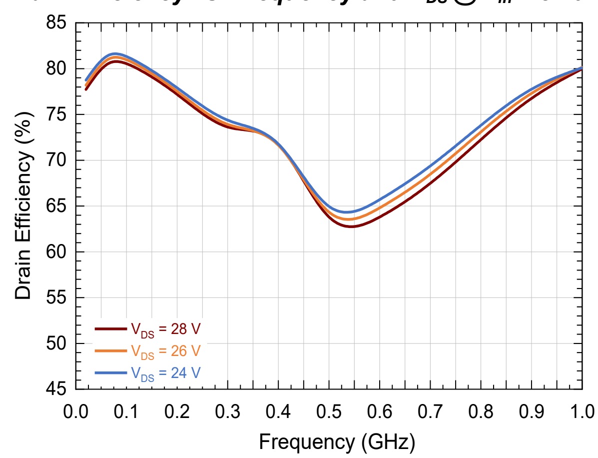
IRL vs. Frequency and I_{DQ} @ P_{in} = 27 dBm



Gain vs. Frequency and V_{DS} @ P_{in} = 31 dBm



Drain Efficiency vs. Frequency and V_{DS} @ P_{in} = 31 dBm



Typical Performance Curves as Measured in the Evaluation Test Fixture:
CW, V_{DS} = 28 V, I_{DQ} = 180 mA, T_C = 25°C (Unless Otherwise Noted)
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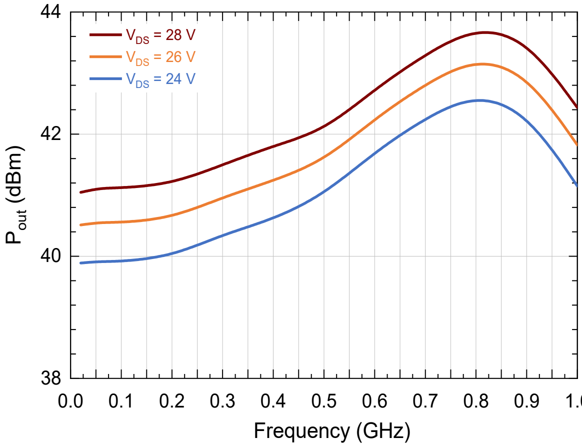
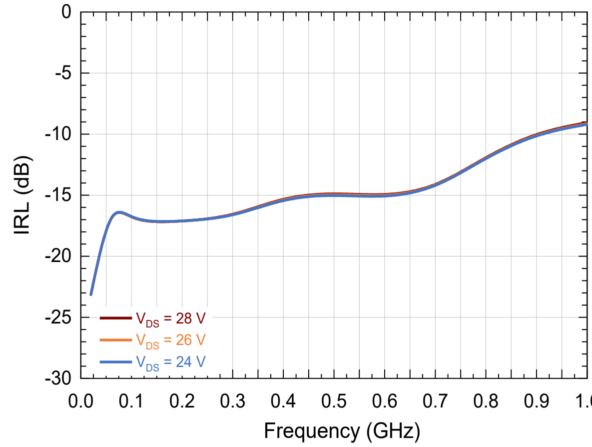
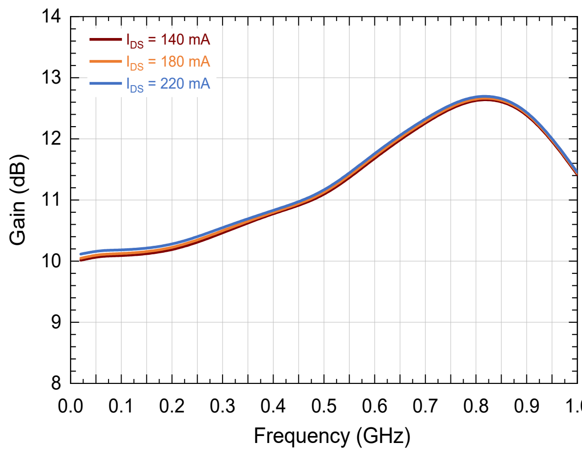
Output Power vs. Frequency and V_{DS} @ P_{in} = 31 dBm



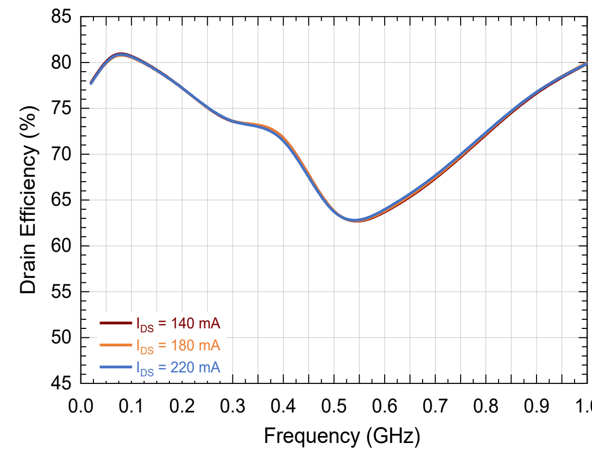
Drain Efficiency vs. Frequency and V_{DS} @ P_{in} = 31 dBm



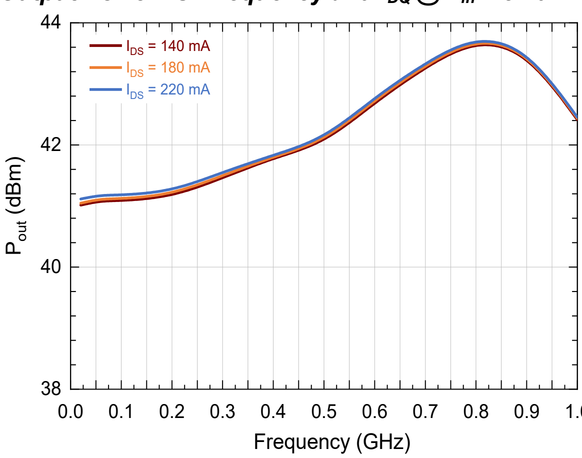
Gain vs. Frequency and V_{DS} @ P_{in} = 31 dBm



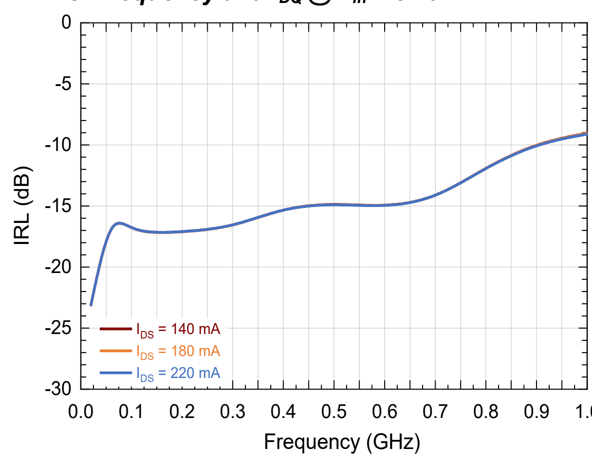
Drain Efficiency vs. Frequency and V_{DS} @ P_{in} = 31 dBm



Output Power vs. Frequency and I_{DQ} @ P_{in} = 31 dBm



IRL vs. Frequency and I_{DQ} @ P_{in} = 31 dBm



Typical Performance Curves as Measured in the Evaluation Test Fixture:

CW, V_{DS} = 28 V, I_{DQ} = 180 mA, T_C = 25°C (Unless Otherwise Noted)
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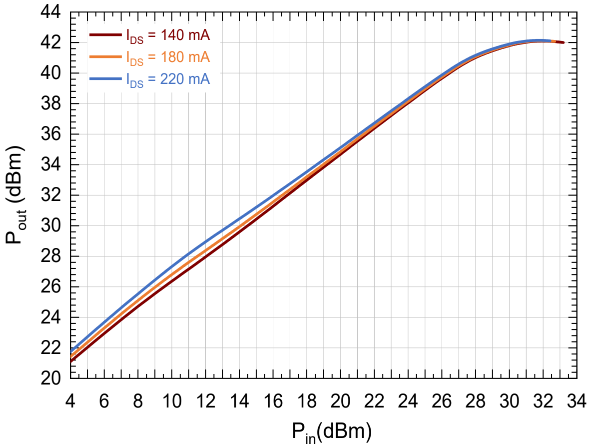
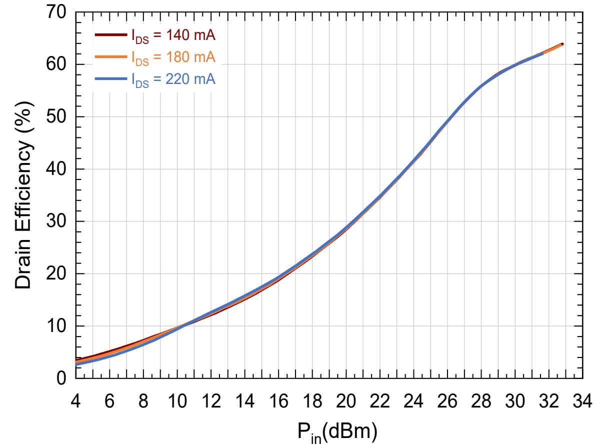
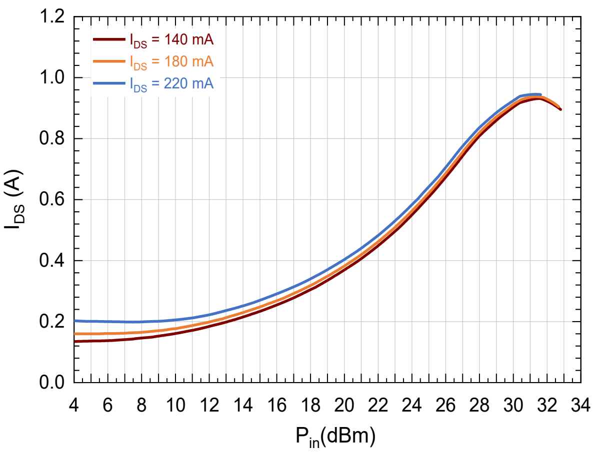
Output Power vs. I_{DQ} and Input Power



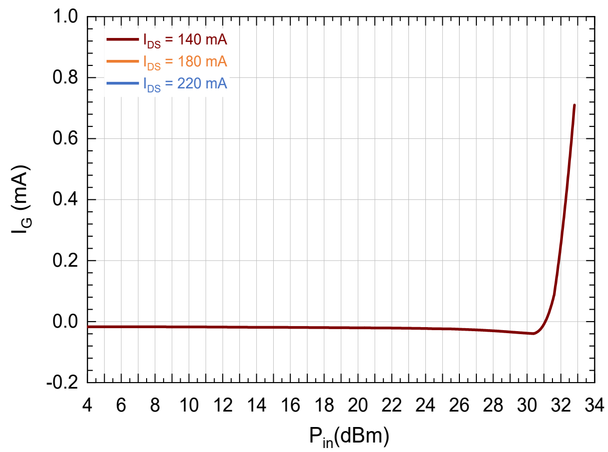
Drain Efficiency vs. I_{DQ} and Input Power



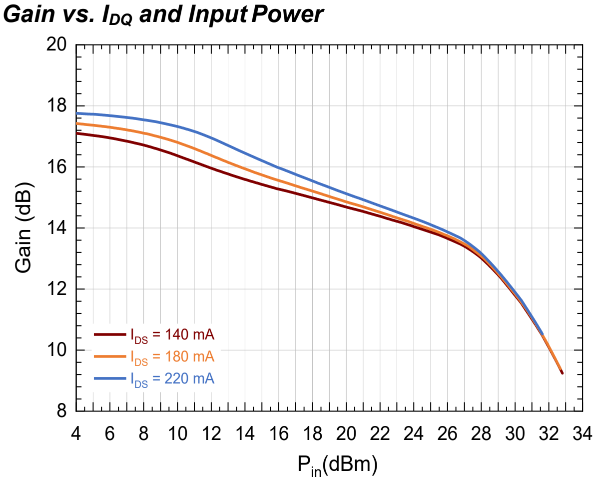
I_{DS} vs. I_{DQ} and Input Power



I_G vs. I_{DQ} and Input Power



Gain vs. I_{DQ} and Input Power



Typical Performance Curves as Measured in the Evaluation Test Fixture:

CW, V_{DS} = 28 V, I_{DQ} = 180 mA, T_C = 25°C (Unless Otherwise Noted)
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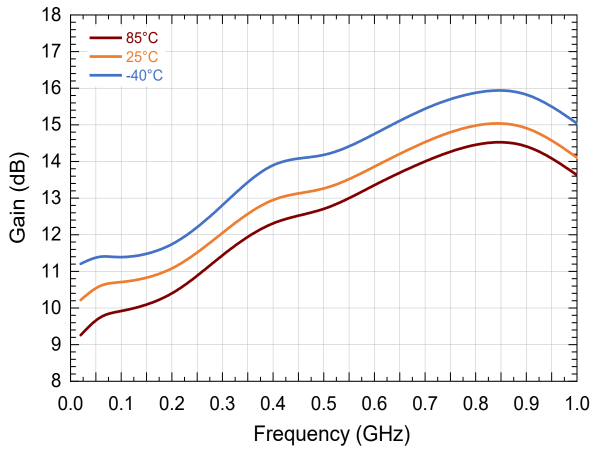
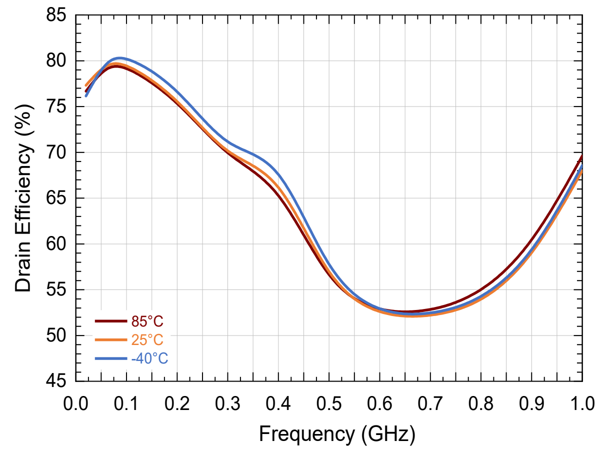
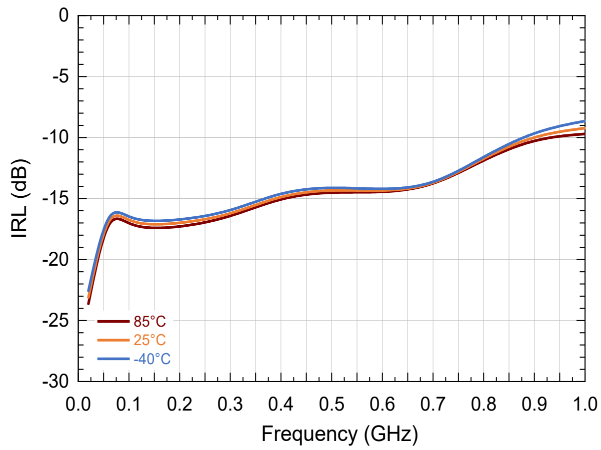
Gain vs. Output Power and Temperature @ P_{OUT} = 41 dBm



Drain Efficiency vs. Output Power and Temperature @ P_{OUT} = 41 dBm

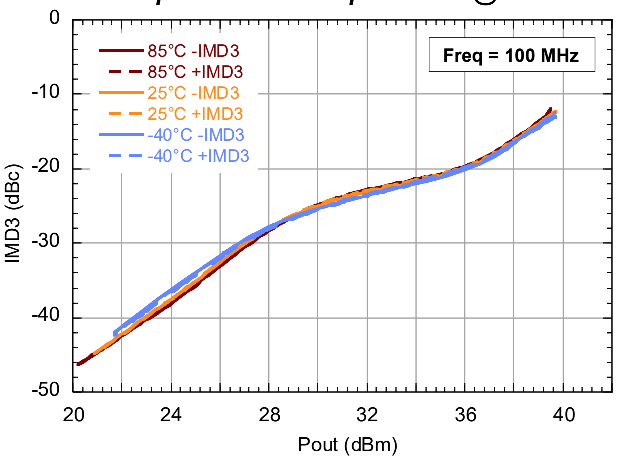


IRL vs. Output Power and Temperature at P_{OUT} = 41 dBm

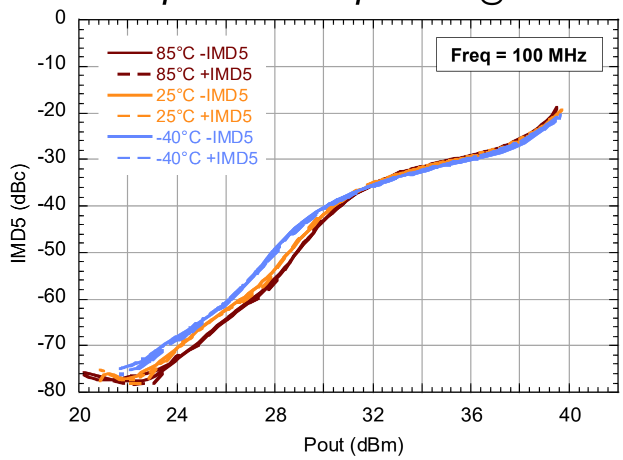


Typical Performance Curves as Measured in the Evaluation Test Fixture:
CW, Two Tone, ΔF = 5 MHz, V_{DS} = 28 V, I_{DQ} = 180 mA, T_C = 25°C (Unless Otherwise Noted)
For Engineering Evaluation Only - This data does not Modify MACOM’s Datasheet Limits.

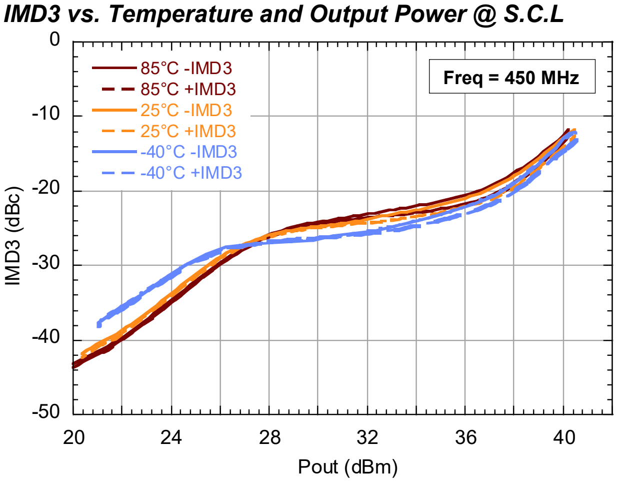
IMD3 vs. Temperature and Output Power @ S.C.L



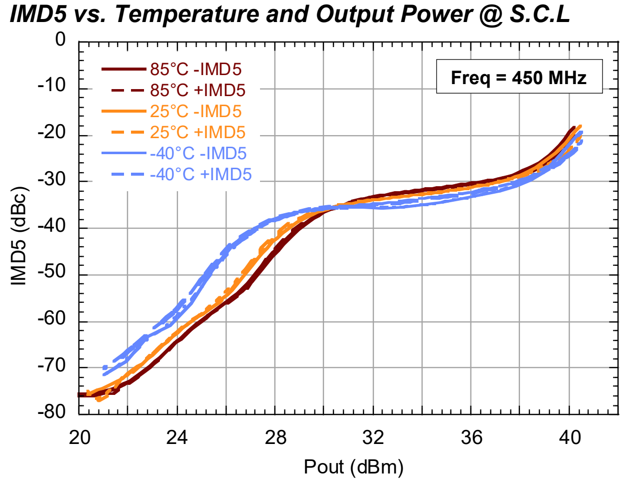
IMD5 vs. Temperature and Output Power @ S.C.L



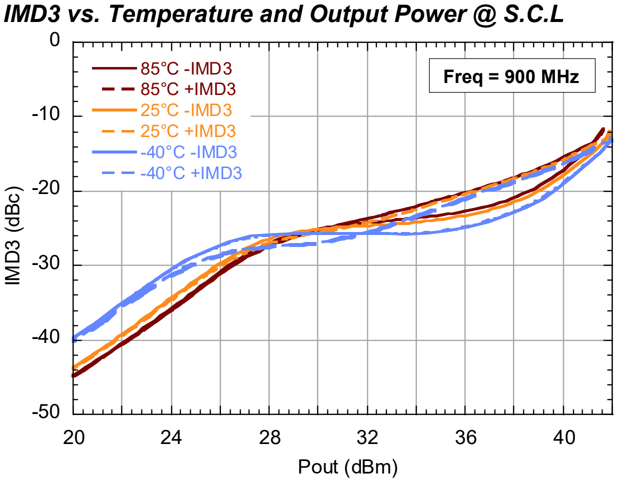
IMD3 vs. Temperature and Output Power @ S.C.L



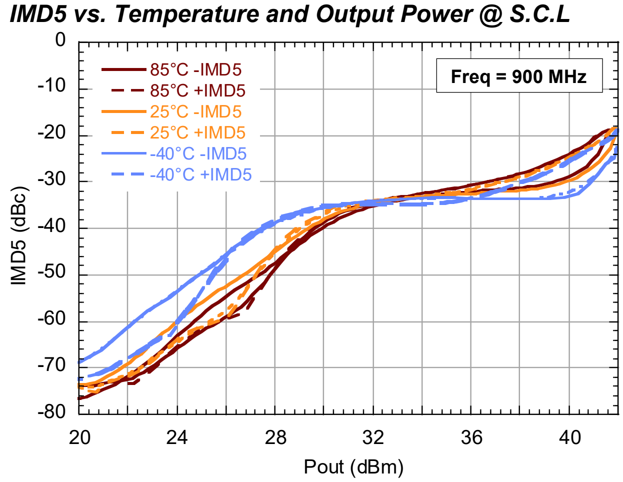
IMD5 vs. Temperature and Output Power @ S.C.L



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



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



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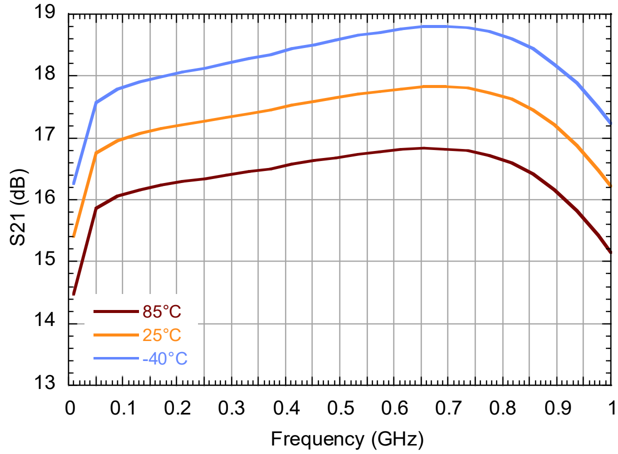
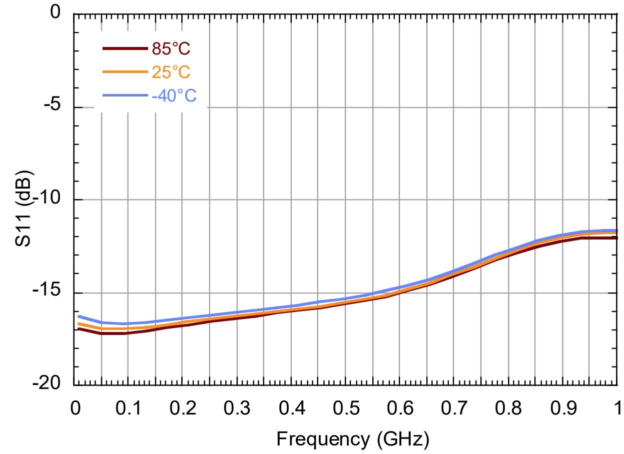
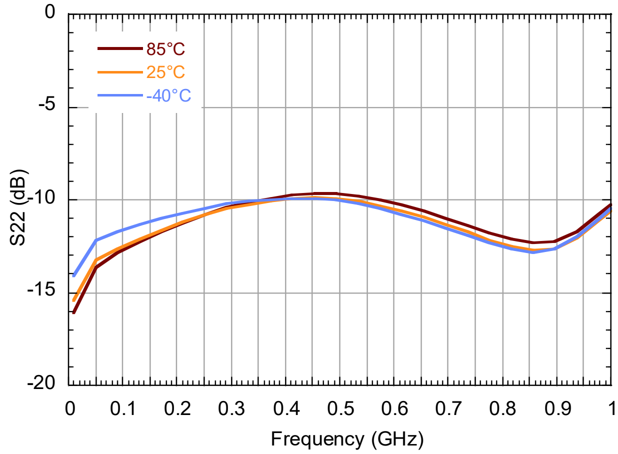
S21 vs. Frequency and Temperature



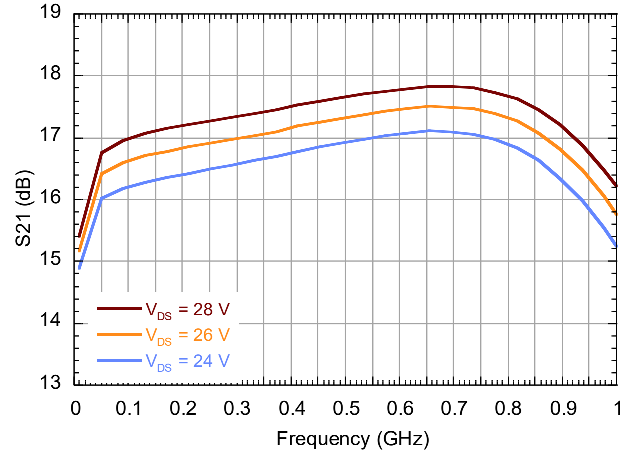
S11 vs. Frequency and Temperature



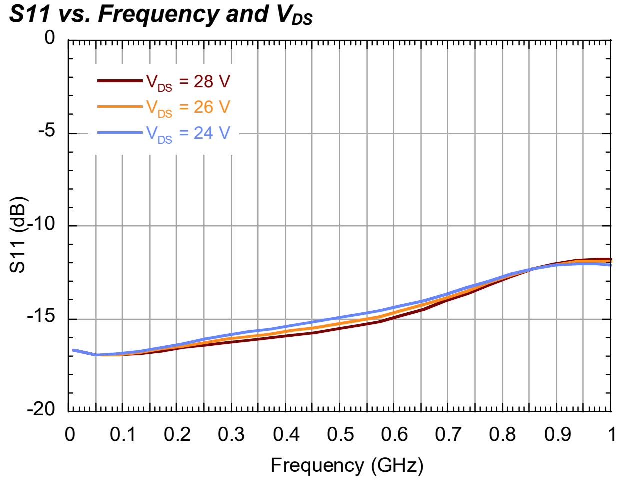
S22 vs. Frequency and Temperature



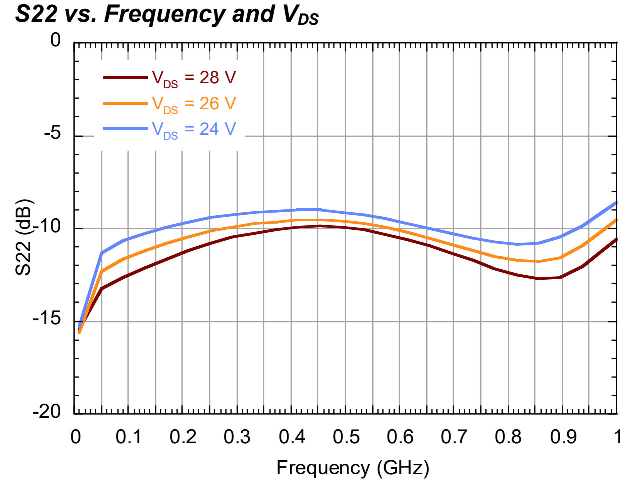
S21 vs. Frequency and V_{DS}



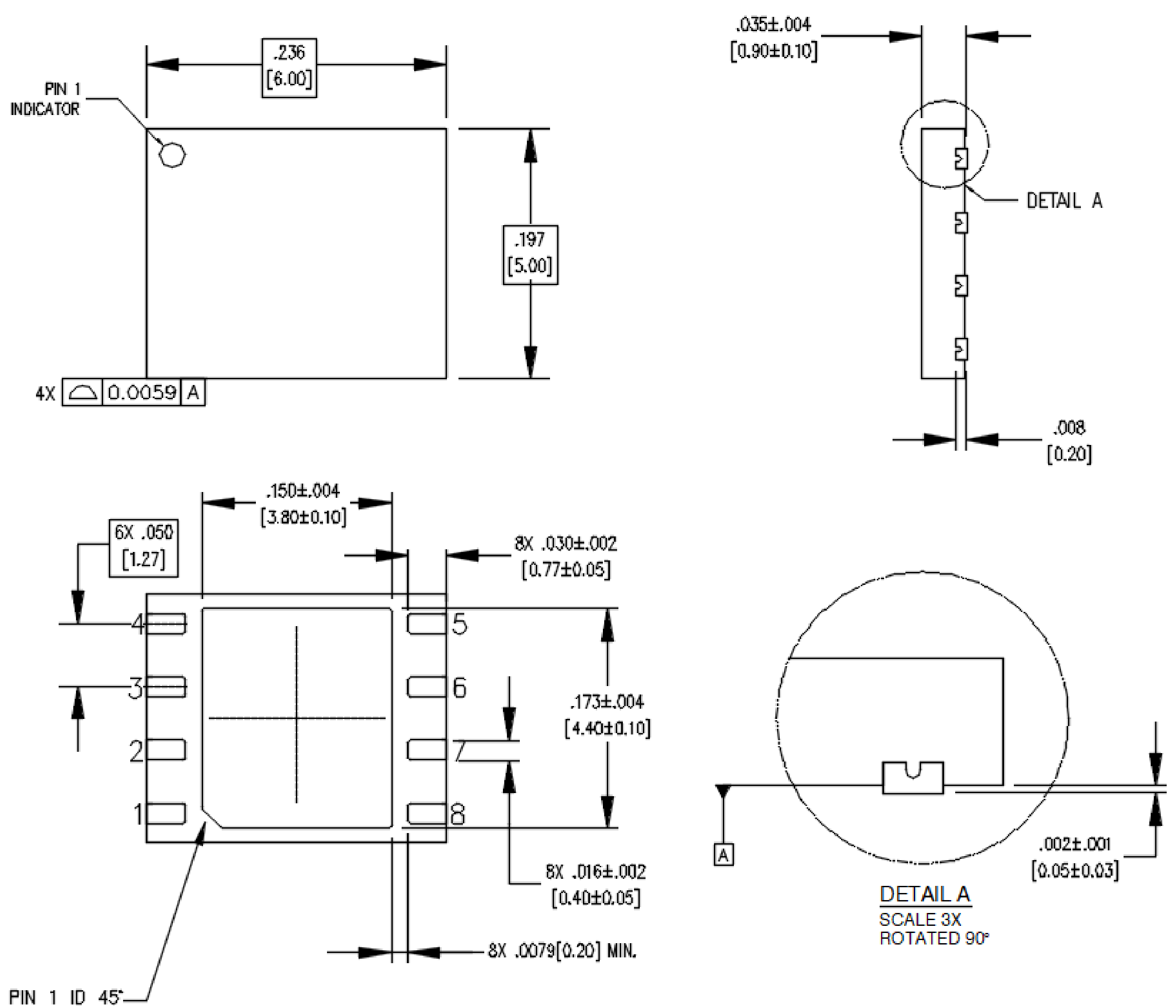
S11 vs. Frequency and V_{DS}



S22 vs. Frequency and V_{DS}



Package Dimensions



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