MMRF5018HS

RF Power GaN Transistor

Rev. 0 — July 2022 | Data Sheet: Technical Data

This 125 W CW RF power transistor is optimized for wideband operation up to 2700 MHz and includes input matching for extended bandwidth performance. With its high gain and high ruggedness, this device is ideally suited for CW, pulse and wideband RF applications.

This part is characterized and performance is guaranteed for applications operating in the 1–2700 MHz band. There is no guarantee of performance when this part is used in applications designed outside of these frequencies.

Typical 450–2700 MHz Performance: V_{DD} = 50 Vdc, T_A = 25°C, I_{DQ} = 200 mA

Frequency (MHz)	Signal Type	P_{out} (W)	G_{ps} (dB)	η_D (%)
450–2700 (1)	CW	100 CW	12.0	40.0

Load Mismatch/Ruggedness

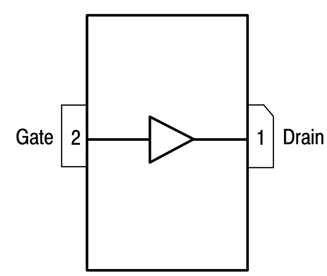
Frequency (MHz)	Signal Type	VSWR	P_{in} (W)	Test Voltage	Result
2500 (2)	Pulse (100 μsec, 20% Duty Cycle)	> 20:1 at All Phase Angles	5.0 Peak (3 dB Overdrive)	50	No Device Degradation

1. Measured in 450–2700 MHz reference circuit (page 4).
2. Measured in 2500 MHz production test fixture (page 7).

MMRF5018HS

1–2700 MHz, 125 W CW, 50 V WIDEBAND RF POWER GaN TRANSISTOR

NI–400S–2SA



(Top View)

Note: The backside of the package is the source terminal for the transistor.

Figure 1. Pin Connections

Features

- Advanced GaN on SiC, offering high power density
- Decade bandwidth performance
- Enhanced thermal resistance packaging
- Input matched for extended wideband performance
- High ruggedness: > 20:1 VSWR

Typical Applications

- Ideal for military end–use applications, including the following:
  – Narrowband and multi–octave wideband amplifiers
  – Radar
  – Jammers
  – EMC testing
- Also suitable for commercial applications, including the following:
  – Public mobile radios, including emergency service radios
  – Industrial, scientific and medical
  – Wideband laboratory amplifiers
  – Wireless cellular infrastructure

Table 1. Maximum Ratings

Rating	Symbol	Value	Unit
Drain–Source Voltage	V_{DSS}	125	Vdc
Gate–Source Voltage	V_{GS}	–8, 0	Vdc
Operating Voltage	V_{DD}	0 to +55	Vdc
Maximum Forward Gate Current, I_G @ T_C = 25°C	I_{GMAX}	18	mA
Storage Temperature Range	T_{stg}	–65 to +150	°C
Case Operating Temperature Range	T_C	–55 to +150	°C
Maximum Channel Temperature (1)	T_{CH}	350	°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	165 0.83	W W/°C

Table 2. Thermal Characteristics

Characteristic	Symbol	Value	Unit
Thermal Resistance by Infrared Measurement, Active Die Surface–to–Case Case Temperature 83°C, P_D = 109 W	$R_{\theta JC}$ (IR)	0.67 (2)	°C/W
Thermal Resistance by Finite Element Analysis, Channel–to–Case Case Temperature 90°C, P_D = 109 W	$R_{\theta CHC}$ (FEA)	1.21 (3)	°C/W
Thermal Impedance by Infrared Measurement, Active Die Surface–to–Case Case Temperature 76°C, P_D = 60 W	$Z_{\theta JC}$ (IR)	0.16 (2)	°C/W
Thermal Impedance by Finite Element Analysis, Channel–to–Case Case Temperature 76°C, P_D = 60 W	$Z_{\theta CHC}$ (FEA)	0.24 (4)	°C/W

Table 3. ESD Protection Characteristics

Test Methodology	Class
Human Body Model (per JS–001–2017)	1B, passes 500 V
Charge Device Model (per JS–002–2014)	C3, passes 1000 V

Table 4. Electrical Characteristics (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Off Characteristics					
Off–State Drain Leakage (V_{DS} = 150 Vdc, V_{GS} = –8 Vdc)	$I_{D(BR)}$	—	—	9.2	mAdc
On Characteristics					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 20.8 mAdc)	$V_{GS(th)}$	–3.9	–3.1	–2.2	Vdc
Gate Quiescent Voltage (V_{DD} = 50 Vdc, I_D = 220 mAdc, Measured in Functional Test)	$V_{GS(Q)}$	–3.2	–2.8	–2.5	Vdc
Gate–Source Leakage Current (V_{DS} = 0 Vdc, V_{GS} = –5 Vdc)	I_{GSS}	–20.8	—	—	mAdc
Dynamic Characteristics					
Reverse Transfer Capacitance (V_{DS} = 50 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = –4 Vdc)	C_{rss}	—	1.0	—	pF
Output Capacitance (V_{DS} = 50 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = –4 Vdc)	C_{oss}	—	7.7	—	pF
Input Capacitance (5) (V_{DS} = 50 Vdc, V_{GS} = –4 Vdc ± 30 mV(rms)ac @ 1 MHz)	C_{iss}	—	51.7	—	pF

1. Reliability tests were conducted at 225°C. Operation with T_{CH} at 350°C will reduce median time to failure.
2. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers.* Go to http://www.nxp.com/RF and search for AN1955.
3. $R_{\theta CHC}$ (FEA) must be used for purposes related to reliability and limitations on maximum channel temperature. MTTF may be estimated by the expression MTTF (hours) = $10^{[A + B/(T + 273)]}$, where *T* is the channel temperature in degrees Celsius, *A* = –8.44 and *B* = 7210.
4. $Z_{\theta CHC}$ (FEA) must be used for purposes related to reliability and limitations on maximum channel temperature. MTTF may be estimated by the expression MTTF (hours) = $10^{[A + B/(T + 273)]}$, where *T* is the junction temperature in degrees Celsius, *A* = –8.44 and *B* = 7210.
5. Part internally input matched.

(continued)

Table 4. Electrical Characteristics (T_A = 25°C unless otherwise noted) **(continued)**

Characteristic	Symbol	Min	Typ	Max	Unit
Functional Tests (In NXP Production Test Fixture, 50 ohm system) V_{DD} = 50 Vdc, I_{DQ} = 220 mA, P_{out} = 125 W Peak (25 W Avg.), f = 2500 MHz, 100 μsec Pulse Width, 20% Duty Cycle. **[See note on correct biasing sequence.]**					
Power Gain	G_{ps}	15.5	17.3	19.0	dB
Drain Efficiency	η_D	56.0	61.4	—	%
Input Return Loss	IRL	—	–23.5	–10	dB

Load Mismatch/Ruggedness (In NXP Production Test Fixture, 50 ohm system) I_{DQ} = 220 mA

Frequency (MHz)	Signal Type	VSWR	P_{in} (W)	Test Voltage, V_{DD}	Result
2500	Pulse (100 μsec, 20% Duty Cycle)	> 20:1 at All Phase Angles	5.0 Peak (3 dB Overdrive)	50	No Device Degradation

Table 5. Ordering Information

Device	Tape and Reel Information	Package
MMRF5018HSR5	R5 Suffix = 50 Units, 32 mm Tape Width, 13–inch Reel	NI–400S–2SA

NOTE: Correct Biasing Sequence for GaN Depletion Mode Transistors

Turning the device ON

1. Set V_{GS} to the pinch–off voltage, typically –5 V.
2. Turn on V_{DS} to nominal supply voltage (+50 V).
3. Increase V_{GS} until I_{DS} current is attained.
4. Apply RF input power to desired level.

Turning the device OFF

1. Turn RF power off.
2. Reduce V_{GS} down to the pinch–off voltage, typically –5 V.
3. Adjust drain voltage V_{DS} to 0 V. Allow adequate time for drain voltage to reduce to 0 V from external drain capacitors.
4. Turn off V_{GS}.

450–2700 MHz Wideband Reference Circuit — 2″ × 4″ (5.1 cm × 10.2 cm)

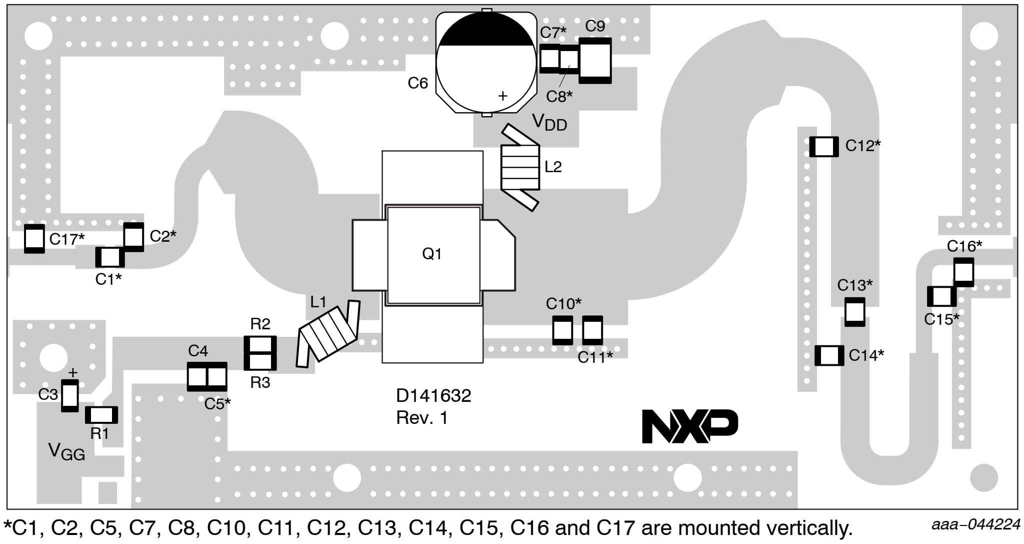


Figure 2. MMRF5018HS Wideband Reference Circuit Component Layout — 450–2700 MHz

Table 6. MMRF5018HS Wideband Reference Circuit Component Designations and Values — 450–2700 MHz

Part	Description	Part Number	Manufacturer
C1, C5, C7	33 pF Chip Capacitor	800B330JT500XT	ATC
C2, C14	0.5 pF Chip Capacitor	800B0R5BT500XT	ATC
C3	2.2 μF, 16 V Tantalum Capacitor	T491A225K016AT	Kemet
C4, C8	1000 pF Chip Capacitor	800B102JT500XT	ATC
C6	220 μF, 50 V Electrolytic Capacitor	EMVY500ADA221MJA0G	United Chemi-Con
C9	2.2 μF Chip Capacitor	HMK432B7225KM–T	Taiyo Yuden
C10	0.8 pF Chip Capacitor	800B0R8BT500XT	ATC
C11	0.6 pF Chip Capacitor	800B0R6BT500XT	ATC
C12	0.4 pF Chip Capacitor	800B0R4BT500XT	ATC
C13	27 pF Chip Capacitor	800B270JT500XT	ATC
C15, C16	0.3 pF Chip Capacitor	800B0R3BT500XT	ATC
C17	0.2 pF Chip Capacitor	800B0R2BT500XT	ATC
L1, L2	5 Turn, #20 AWG, ID = 0.125″ Inductor, Hand Wound	Copper Wire	—
Q1	RF Power GaN Transistor	MMRF5018HS	NXP
R1	0 Ω, 1/4 W Chip Resistor	CRCW12060000Z0EA	Vishay
R2, R3	10 Ω, 1/4 W Chip Resistor	CRCW120610R0FKEA	Vishay
PCB	Rogers RO4350B, 0.030″, ε_r = 3.66, 1 oz. Copper	D141632	MTL

Typical Characteristics — 450–2700 MHz Wideband Reference Circuit

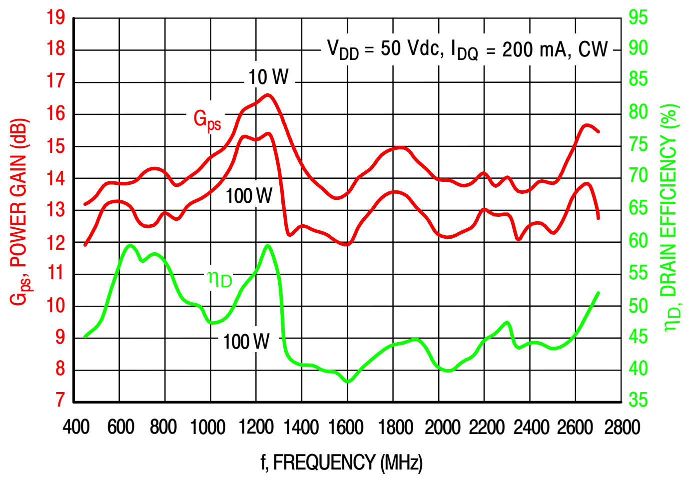


Figure 3. 450–2700 MHz Wideband Circuit Performance

Typical Characteristics — Optimized Narrowband Performance

Narrowband Performance and Impedance Information (T_C = 25°C)

The measured input and output impedances are presented to the input of the device at the package reference plane. Measurements are performed in NXP narrowband fixture tuned at 500, 1000, 1500, 2000 and 2500 MHz.

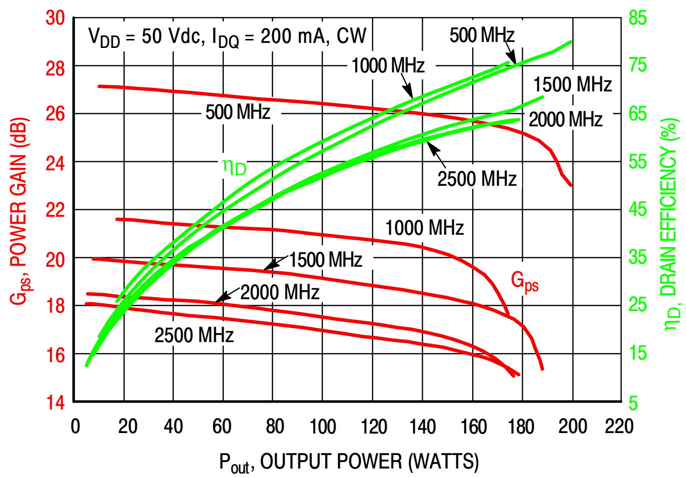


Figure 4. Power Gain and Drain Efficiency versus CW Output Power

f (MHz)	Z_{source} (Ω)	Z_{load} (Ω)
500	0.8 + j1.8	5.7 + j2.9
1000	1.2 – j1.5	6.0 + j2.0
1500	0.9 – j3.9	3.9 + j2.0
2000	1.1 – j6.1	4.7 + j0.6
2500	5.6 – j6.9	3.8 + j0.0

Z_{source} = Test circuit impedance as measured from gate to ground.

Z_{load} = Test circuit impedance as measured from drain to ground.

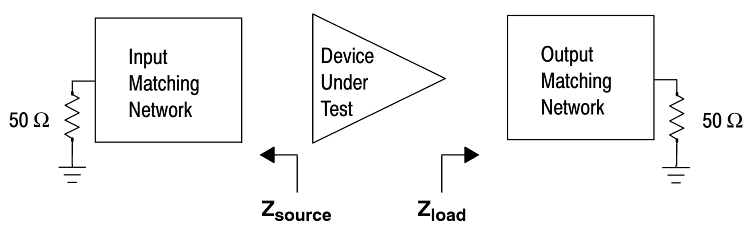


Figure 5. Narrowband Fixtures: Series Equivalent Source and Load Impedances

2500 MHz Production Test Fixture — 4″ × 5″ (10.2 cm × 12.7 cm)

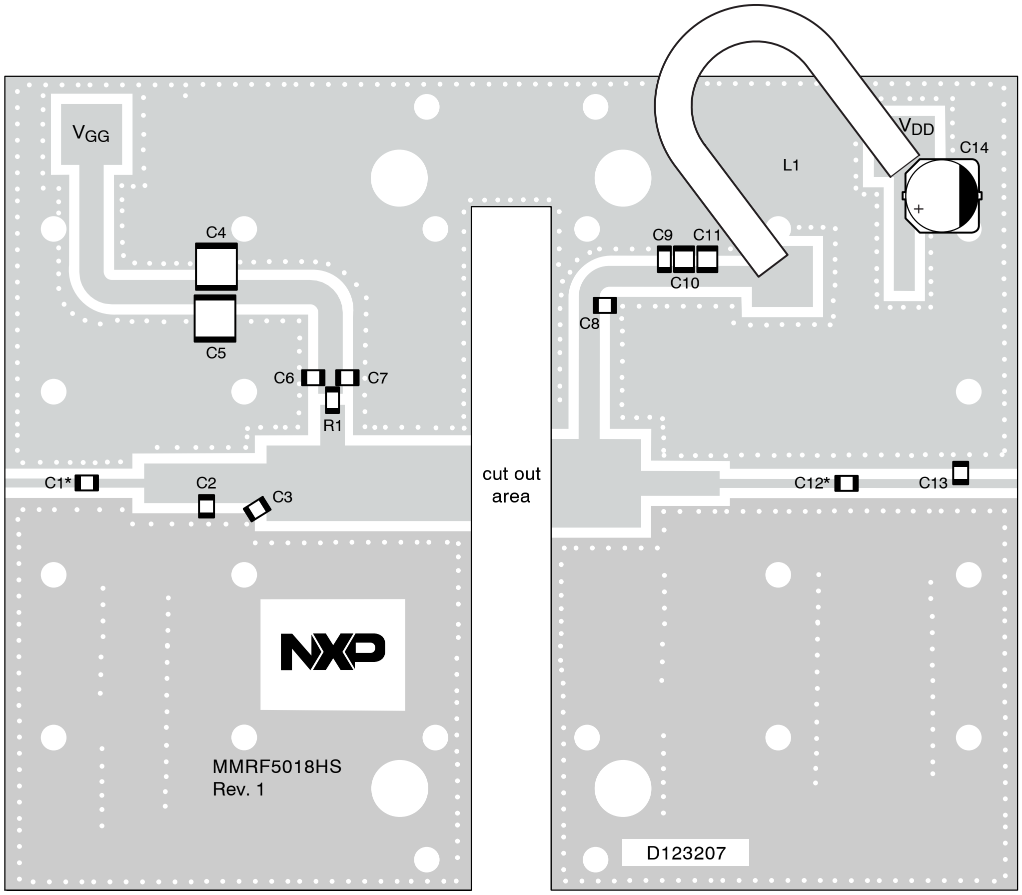


Figure 6. MMRF5018HS Production Test Fixture Component Layout — 2500 MHz

Table 7. MMRF5018HS Production Test Fixture Component Designations and Values — 2500 MHz

Part	Description	Part Number	Manufacturer
C1, C6, C7	15 pF Chip Capacitor	GQM2195C2E150FB12D	Murata
C2, C3	0.8 pF Chip Capacitor	GQM2195C2ER80BB12D	Murata
C4, C5	10 μF Chip Capacitor	C5750X7S2A106M	TDK
C8, C12	15 pF Chip Capacitor	800B150JT500XT	ATC
C9	0.01 μF Chip Capacitor	GRM55N5C2A103JZ01L	Murata
C10	0.1 μF Chip Capacitor	GRM319R72A104KA01D	Murata
C11	1 μF Chip Capacitor	GRM31CR72A105KA01L	Murata
C13	0.6 pF Chip Capacitor	GQM2195C2ER60BB12D	Murata
C14	220 μF, 100 V Electrolytic Capacitor	EEV–FK2A221M	Panasonic
L1	#16 AWG, Magnetic Wire, Length = 3″	8074	Belden
R1	12 Ω, 1/4 W Chip Resistor	CRCW120612R0FKEA	Vishay
PCB	Rogers RO4350B, 0.0230″, ε_r = 3.66, 1 oz. Copper	D123207	MTL

Typical Characteristics — 2500 MHz, T_C = 25°C, Production Test Fixture

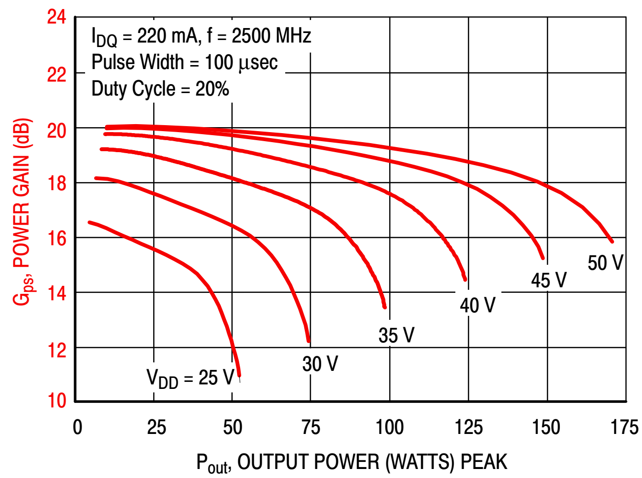


Figure 7. Power Gain versus Output Power and Drain–Source Voltage (1)

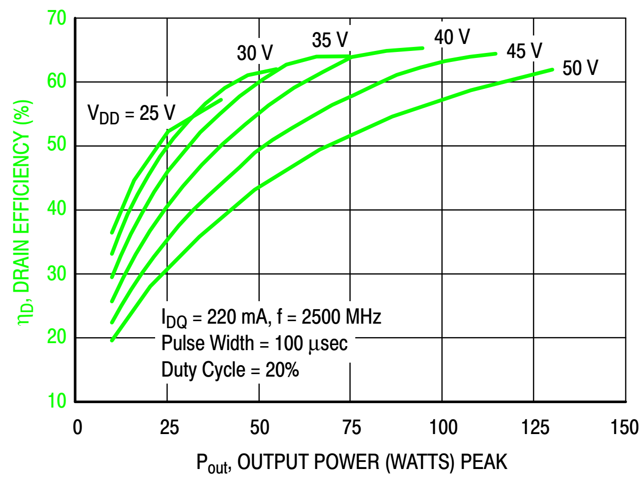


Figure 8. Drain Efficiency versus Output Power and Drain–Source Voltage (1)

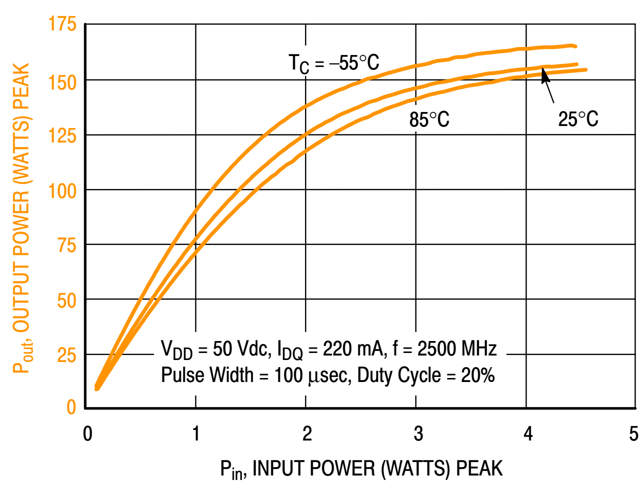


Figure 9. Output Power versus Input Power over Temperature (1)

1. Circuit tuned for maximum power.

Typical Characteristics — 2500 MHz, T_C = 25°C, Production Test Fixture

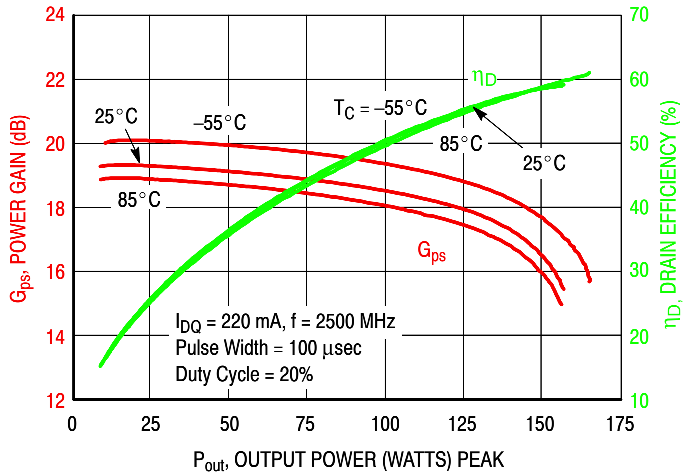
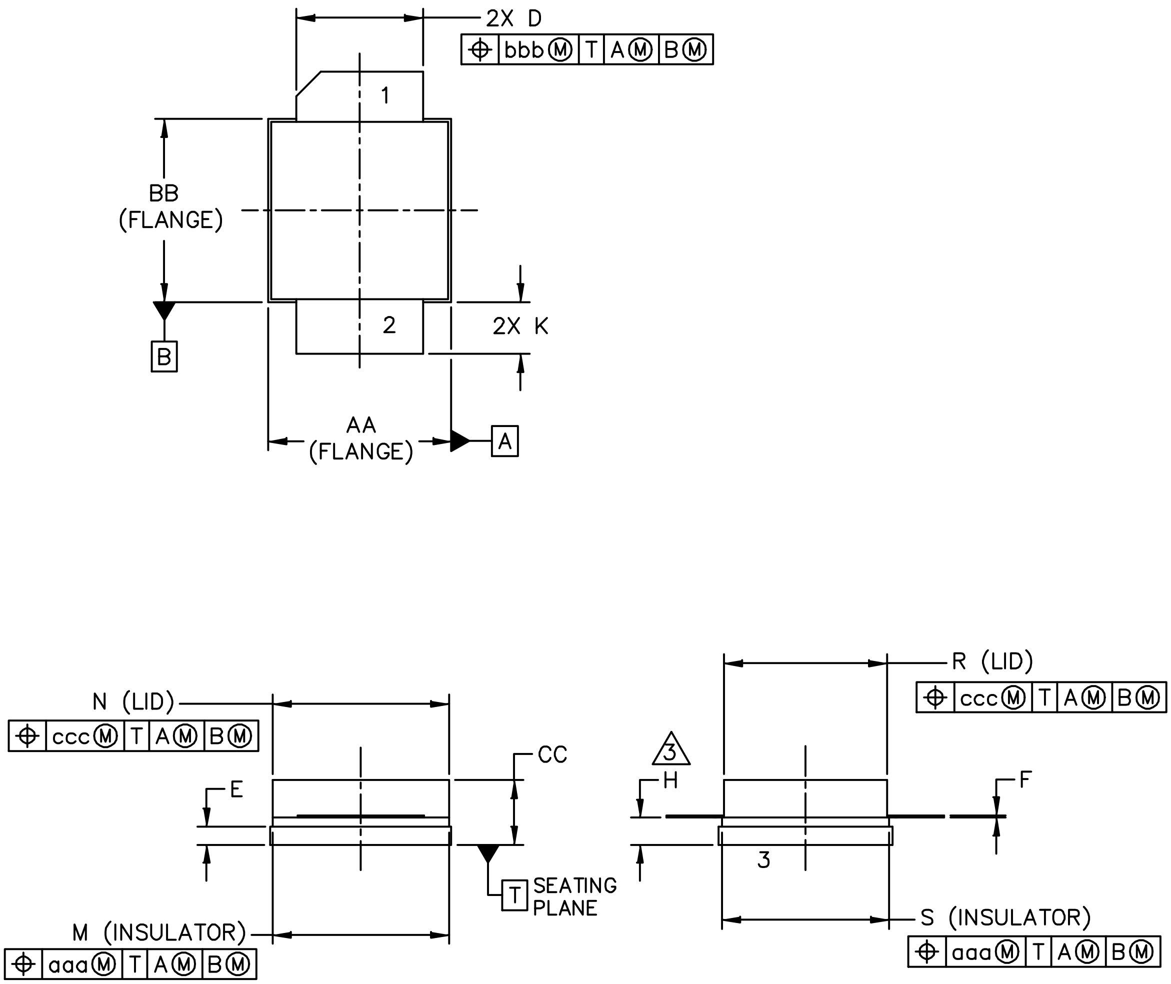


Figure 10. Power Gain and Drain Efficiency versus Output Power over Temperature (1)

1. Circuit tuned for maximum power.

Package Information



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	STANDARD: NON-JEDEC	
	SOT1828-3	05 MAR 2018

NOTES:

1. CONTROLLING DIMENSION: INCH
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M–1994.
3. (△) DIMENSION H IS MEASURED .030 INCH (0.762 MM) AWAY FROM THE FLANGE TO CLEAR THE EPOXY FLOW OUT REGION PARALLEL TO DATUM B.
4. INPUT & OUTPUT LEADS (PIN 1 & 2) MAY HAVE SMALL FEATURES SUCH AS SQUARE HOLES OR NOTCHES FOR MANUFACTURING CONVENIENCE.

	INCH		MILLIMETER			INCH		MILLIMETER	
BB	MIN	MAX	MIN	MAX	DIM	MIN	MAX	MIN	MAX
AA	.395	.405	10.03	10.29	aaa	.005		0.13	
DIM	.382	.388	9.70	9.86	bbb	.010		0.25	
CC	.125	.163	3.18	4.14	ccc	.015		0.38	
D	.275	.285	6.98	7.24					
E	.031	.041	0.79	1.04					
F	.004	.006	0.10	0.15					
H	.057	.067	1.45	1.70					
K	.0995	.1295	2.53	3.29					
M	.395	.405	10.03	10.29					
N	.385	.395	9.78	10.03					
R	.355	.365	9.02	9.27					
S	.365	.375	9.27	9.53					

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Product Documentation, Software and Tools

Refer to the following resources to aid your design process.

Application Notes

- AN1908: Solder Reflow Attach Method for High Power RF Devices in Air Cavity Packages
- AN1955: Thermal Measurement Methodology of RF Power Amplifiers

Engineering Bulletins

- EB212: Using Data Sheet Impedances for RF LDMOS Devices

Software

- .s2p File

Development Tools

- Printed Circuit Boards

Revision History

The following table summarizes revisions to this document.

Revision	Date	Description
0	July 2022	• Initial release of data sheet