



# RF Power GaN Transistor

This 125 W RF power GaN transistor is capable of broadband operation from 30 to 2200 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 broadband RF applications.

This part is characterized and performance is guaranteed for applications operating in the 30 to 2200 MHz band. There is no guarantee of performance when this part is used in applications designed outside of these frequencies.

**Typical Performance:**  $V_{DD} = 50 \text{ Vdc}$ ,  $T_A = 25^\circ\text{C}$

Frequency (MHz)	Signal Type	$P_{out}$ (W)	$G_{ps}$ (dB)	$\eta_D$ (%)
30–940 (1,2)	CW	90	16.0	45.0
520 (1)	CW	125	18.0	59.1
940 (1)	CW	80	18.4	44.0
2200	Pulse (100 $\mu\text{sec}$ , 20% Duty Cycle)	200	17.0	57.0

### Load Mismatch/Ruggedness

Frequency (MHz)	Signal Type	VSWR	$P_{in}$ (W)	Test Voltage	Result
520 (1)	Pulse (100 $\mu\text{sec}$ , 20% Duty Cycle)	> 10:1 at All Phase Angles	3.4 (3 dB Overdrive)	50	No Device Degradation

1. Measured in 30–940 MHz wideband reference circuit (page 4).
2. The values shown are the minimum measured efficiency performance numbers across the indicated frequency range.

### Features

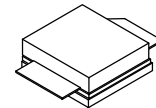
- Advanced GaN on SiC, offering high power density
- Decade bandwidth performance
- Input matched for extended wideband performance
- High ruggedness: > 10:1 VSWR

### Typical Applications

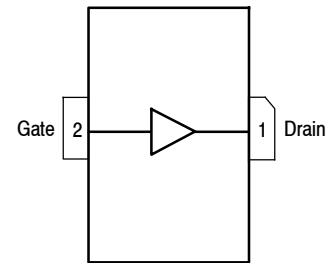
- Ideal for military end-use applications, including the following:
  - Narrowband and multi-octave wideband amplifiers
  - Radar
  - Jammers
  - EMC testing
- Also suitable for commercial applications, including the following:
  - Public mobile radios, including emergency service radios
  - Industrial,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

**MMRF5017HS**

**30–2200 MHz, 125 W CW, 50 V  
 WIDEBAND  
 RF POWER GaN TRANSISTOR**



**NI-400S-2S**



(Top View)

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

**Figure 1. Pin Connections**



**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 @ $T_C = 25^\circ\text{C}$	$I_{GMAX}$	24	mA
Storage Temperature Range	$T_{stg}$	-65 to +150	$^\circ\text{C}$
Case Operating Temperature Range	$T_C$	-55 to +150	$^\circ\text{C}$
Operating Junction Temperature Range	$T_J$	-55 to +225	$^\circ\text{C}$
Absolute Maximum Channel Temperature (1)	$T_{MAX}$	350	$^\circ\text{C}$
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above $25^\circ\text{C}$	$P_D$	154 0.77	W W/ $^\circ\text{C}$

**Table 2. Thermal Characteristics**

Characteristic (2)	Symbol	Value	Unit
Thermal Resistance by Infrared Measurement, Active Die Surface-to-Case CW: Case Temperature $81^\circ\text{C}$ , 80 W CW, 50 Vdc, $I_{DQ} = 200$ mA, 940 MHz	$R_{\theta JC}$ (IR)	1.3 (3)	$^\circ\text{C}/\text{W}$
Thermal Resistance by Finite Element Analysis, Channel-to-Case Case Temperature $90^\circ\text{C}$ , $P_D = 96$ W	$R_{\theta CHC}$ (FEA)	1.77 (4)	$^\circ\text{C}/\text{W}$

**Table 3. ESD Protection Characteristics**

Test Methodology	Class
Human Body Model (per JS-001-2017)	2, passes 2500 V
Charge Device Model (per JS-002-2014)	II, passes 200 V

**Table 4. Electrical Characteristics** ( $T_A = 25^\circ\text{C}$  unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
<b>Off Characteristics</b>					
Drain-Source Breakdown Voltage ( $V_{GS} = -8$ Vdc, $I_D = 20$ mAdc)	$V_{(BR)DSS}$	150	—	—	Vdc
<b>On Characteristics</b>					
Gate Threshold Voltage ( $V_{DS} = 10$ Vdc, $I_D = 20$ mAdc)	$V_{GS(th)}$	-3.8	-3.0	-2.3	Vdc
Gate Quiescent Voltage ( $V_{DD} = 48$ Vdc, $I_D = 200$ mAdc, Measured in Functional Test)	$V_{GS(Q)}$	-3.6	-3.1	-2.3	Vdc
Gate-Source Leakage Current ( $V_{DS} = 0$ Vdc, $V_{GS} = -5$ Vdc)	$I_{GSS}$	-7.5	—	—	mAdc

**Table 5. Ordering Information**

Device	Tape and Reel Information	Package
MMRF5017HSR5	R5 Suffix = 50 Units, 32 mm Tape Width, 13-inch Reel	NI-400S-2S

- Reliability tests were conducted at  $225^\circ\text{C}$ . Operation with  $T_{MAX}$  at  $350^\circ\text{C}$  will reduce median time to failure.
- Characterized in 30–940 MHz reference circuit at 940 MHz and 80 W CW output power.
- Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers*. Go to <http://www.nxp.com/RF> and search for AN1955.
- $R_{\theta CHC}$  (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,  $A = -10.3$  and  $B = 8260$ .

## **NOTE: Correct Biasing Sequence for GaN Depletion Mode Transistors**

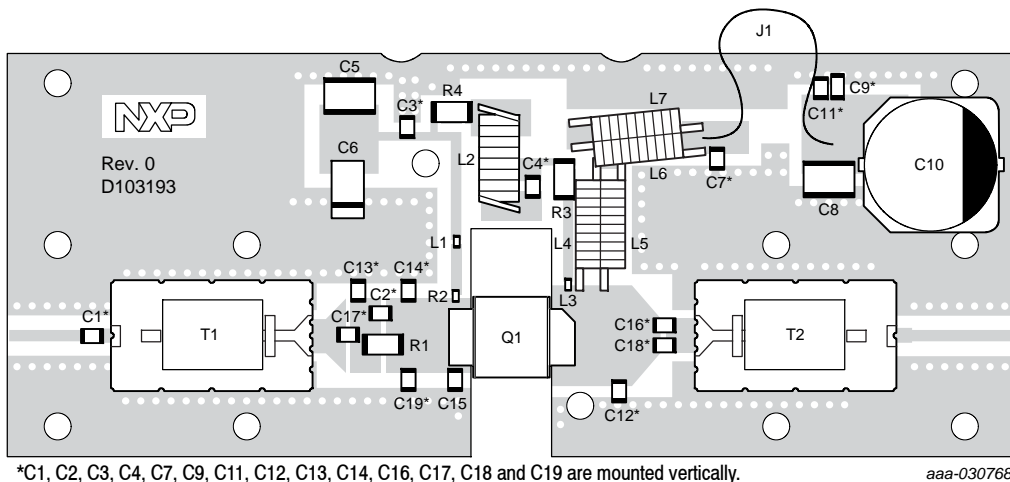
### **Turning the device ON**

1. Set  $V_{GS}$  to  $-5\text{ V}$
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  $-5\text{ V}$
3. Reduce  $V_{DS}$  down to 0 V (Adequate time must be allowed for  $V_{DS}$  to reduce to 0 V to prevent severe damage to device.)
4. Turn off  $V_{GS}$

### 30–940 MHz WIDEBAND REFERENCE CIRCUIT — 2.0" × 5.0" (5.1 cm × 12.7 cm)

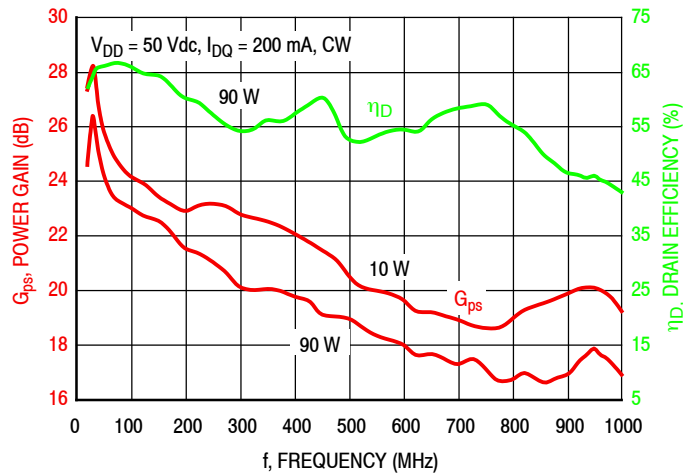


**Figure 2. MMRF5017HS Wideband Reference Circuit Component Layout — 30–940 MHz**

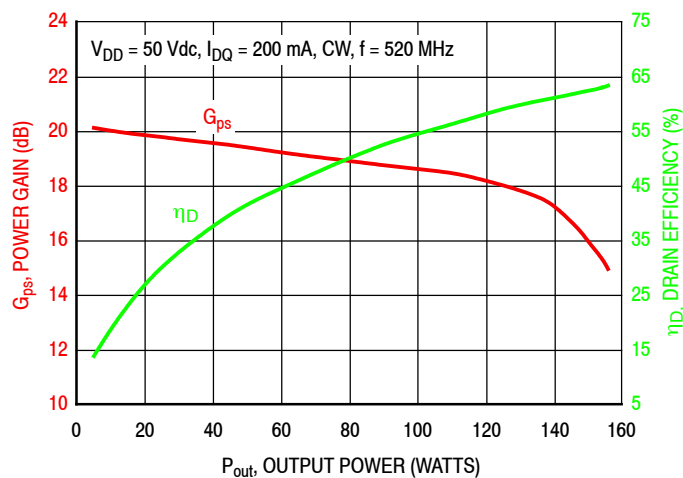
**Table 6. MMRF5017HS Wideband Reference Circuit Component Designations and Values — 30–940 MHz**

Part	Description	Part Number	Manufacturer
C1	1500 pF Chip Capacitor	ATC700B152JT50XT	ATC
C2	100 pF Chip Capacitor	ATC800B101JT500XT	ATC
C3, C7	39 pF Chip Capacitor	ATC800B390JT500XT	ATC
C4	680 pF Chip Capacitor	ATC800B681JT50XT	ATC
C5, C8	2.2 $\mu$ F Chip Capacitor	C3225X7R2A225KT	TDK
C6	22 $\mu$ F, 25 V Tantalum Capacitor	TPSD226M025R0200	AVX
C9	0.1 $\mu$ F Chip Capacitor	C1206C104K1RACTU	Kemet
C10	220 $\mu$ F, 100 V Electrolytic Capacitor	EEV-FK2A221M	Panasonic-ECG
C11	220 pF Chip Capacitor	ATC100B221JT200XT	ATC
C12	2.2 pF Chip Capacitor	ATC800B2R2BT500XT	ATC
C13, C14, C19	5.6 pF Chip Capacitor	ATC800B5R6CT500XT	ATC
C15	10 pF Chip Capacitor	ATC800B100JT500XT	ATC
C16, C18	470 pF Chip Capacitor	ATC800B471JT200XT	ATC
C17	330 pF Chip Capacitor	ATC800B331JT200XT	ATC
J1	#16 AWG, Magnetic Wire, Length = 2.5"	8074	Belden
L1	270 nH Inductor	0603AF-271XJRU	Coilcraft
L2	422 nH inductor	132-18SMJL	Coilcraft
L3	240 nH Inductor	0603AF-241XJRU	Coilcraft
L4, L5, L6, L7	1.3 $\mu$ H Inductor	4310LC-132KE	Coilcraft
Q1	RF Power GaN Transistor	MMRF5017HS	NXP
R1	51 $\Omega$ , 1/2 W Chip Resistor	CRCW201051R0JNEF	Vishay
R2	10 $\Omega$ , 1/4 W Chip Resistor	CRCW080510R0FKEA	Vishay
R3, R4	100 $\Omega$ , 4 W Chip Resistor	CW12010T0100GBK	ATC
T1, T2	High Power Transformer, 30–1000 MHz, 50 $\Omega$ to 12.5 $\Omega$	XMT0310B5012	Anaren
PCB	Shengyi S1000-2, 0.031", $\epsilon_r = 4.8$	D103193	MTL

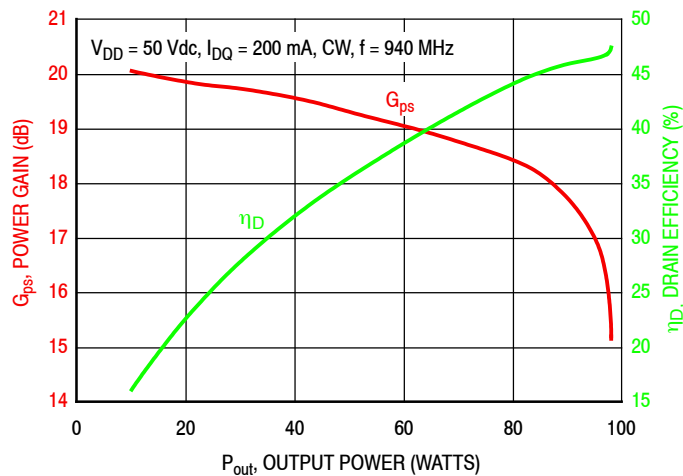
## TYPICAL CHARACTERISTICS — 30–940 MHz WIDEBAND REFERENCE CIRCUIT



**Figure 3. Power Gain and Drain Efficiency versus Output Power and Frequency**



**Figure 4. Power Gain and Drain Efficiency versus CW Output Power – 520 MHz**



**Figure 5. Power Gain and Drain Efficiency versus CW Output Power – 940 MHz**

### 30–940 MHz WIDEBAND REFERENCE CIRCUIT

f MHz	Z <sub>source</sub> Ω	Z <sub>load</sub> Ω
20	39.0 + j23.1	11.3 – j5.0
30	59.6 – j3.7	11.0 – j3.1
50	28.3 – j28.7	11.1 – j1.8
70	15.5 – j22.2	11.2 – j1.3
90	11.1 – j17.3	11.3 – j1.1
136	7.9 – j11.3	10.7 – j1.4
174	7.0 – j8.9	10.0 – j0.3
360	6.2 – j5.0	11.9 – j0.2
440	6.0 – j4.6	11.9 – j0.0
520	5.5 – j4.7	12.3 – j0.1
760	2.5 – j4.0	14.4 – j1.2
850	1.7 – j2.9	16.2 – j3.5
940	1.1 – j1.8	15.9 – j7.9
1000	1.0 – j1.1	13.2 – j10.6

Z<sub>source</sub> = Test circuit impedance as measured from gate to ground.

Z<sub>load</sub> = Test circuit impedance as measured from drain to ground.

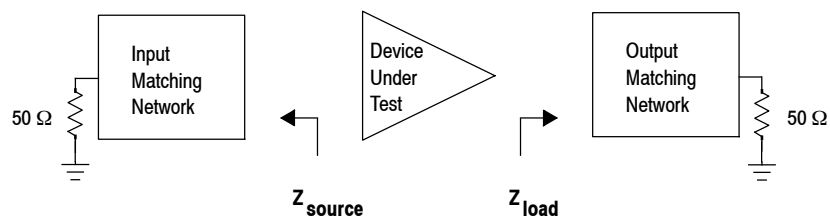
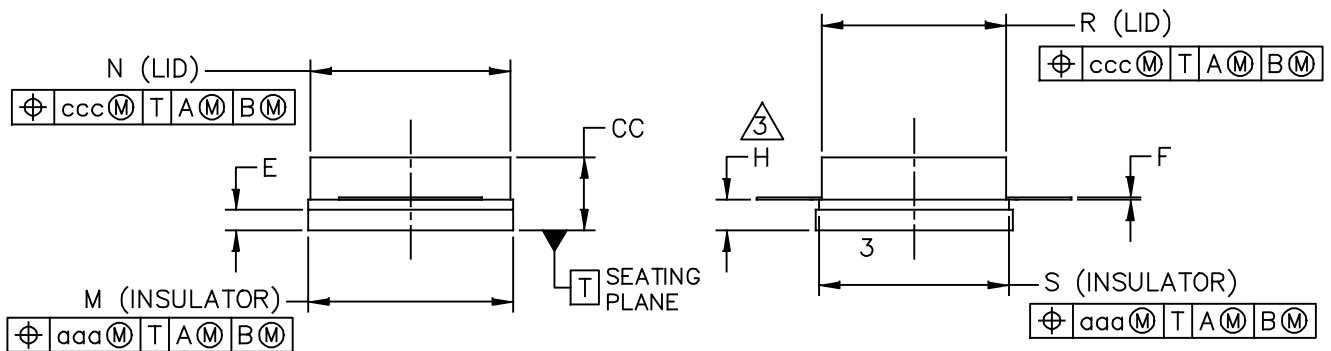
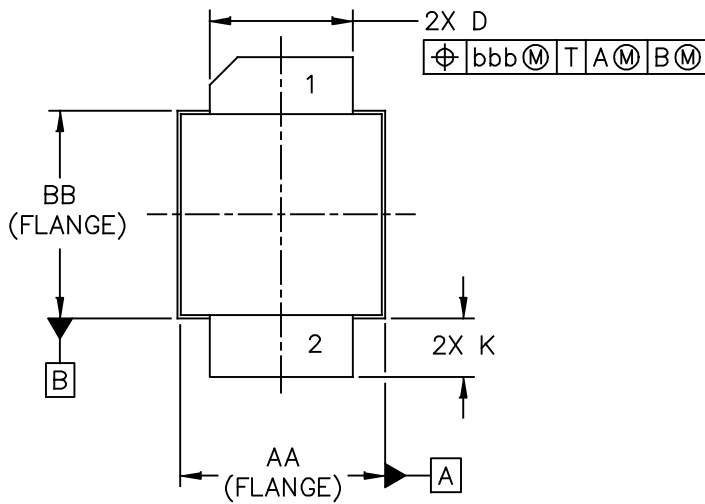


Figure 6. Wideband Series Equivalent Source and Load Impedance — 30–940 MHz

## PACKAGE DIMENSIONS



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TITLE:  <div style="text-align: center; font-size: 1.2em;">NI-400S-2S</div>	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 60%;">DOCUMENT NO: 98ASA10732D</td> <td style="width: 40%;">REV: C</td> </tr> <tr> <td colspan="2">STANDARD: NON-JEDEC</td> </tr> <tr> <td>SOT1828-1</td> <td style="text-align: right;">13 JAN 2016</td> </tr> </table>		DOCUMENT NO: 98ASA10732D	REV: C	STANDARD: NON-JEDEC		SOT1828-1	13 JAN 2016
DOCUMENT NO: 98ASA10732D	REV: C							
STANDARD: NON-JEDEC								
SOT1828-1	13 JAN 2016							

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.

DIM	INCH		MILLIMETER		DIM	INCH		MILLIMETER	
	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX
AA	.395	.405	10.03	10.29	aaa	.005			0.13
BB	.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	.035	.045	0.89	1.14					
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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					STANDARD: NON-JEDEC				
					SOT1828-1			13 JAN 2016	



## PRODUCT DOCUMENTATION 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

### Development Tools

- Printed Circuit Boards

### To Download Resources Specific to a Given Part Number:

1. Go to <http://www.nxp.com/RF>
2. Search by part number
3. Click part number link
4. Choose the desired resource from the drop down menu

## REVISION HISTORY

The following table summarizes revisions to this document.

Revision	Date	Description
0	June 2018	• Initial release of data sheet

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