NXP Semiconductors
Technical Data

Document Number: MRF101AN
Rev. 0, 11/2018

RF Power LDMOS Transistors

High Ruggedness N-Channel Enhancement-Mode Lateral MOSFETs

MRF101AN
MRF101BN

1.8–250 MHz, 100 W CW, 50 V WIDEBAND RF POWER LDMOS TRANSISTORS

These devices are designed for use in VHF/UHF communications, VHF TV broadcast and aerospace applications as well as industrial, scientific and medical applications. The devices are exceptionally rugged and exhibit high performance up to 250 MHz.

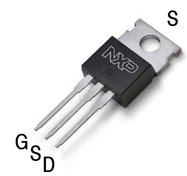
Typical Performance: V_{DD} = 50 Vdc

Frequency (MHz)	Signal Type	P_{out} (W)	G_{ps} (dB)	η_D (%)
13.56	CW	130 CW	27.1	79.6
27	CW	130 CW	24.0	81.5
40.68 (1)	CW	120 CW	23.8	81.5
50	CW	115 CW	23.0	79.5
81.36	CW	130 CW	23.2	80.8
87.5–108	CW	110 CW	21.3	77.1
136–174 (2,3)	CW	104 CW	21.2	76.5
230 (4)	Pulse (100 μsec, 20% Duty Cycle)	115 Peak	21.1	76.7

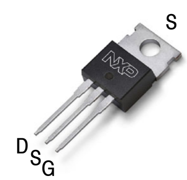
Load Mismatch/Ruggedness

Frequency (MHz)	Signal Type	VSWR	P_{in} (W)	Test Voltage	Result
40.68	CW	> 65:1 at all Phase Angles	0.64 Peak (3 dB Overdrive)	50	No Device Degradation
230	Pulse (100 μsec, 20% Duty Cycle)	> 65:1 at all Phase Angles	1.8 Peak (3 dB Overdrive)	50	No Device Degradation

1. Measured in 40.68 MHz reference circuit (page 5).
2. Measured in 136–174 MHz VHF broadband reference circuit (page 9).
3. The values shown are the center band performance numbers across the indicated frequency range.
4. Measured in 230 MHz fixture (page 13).



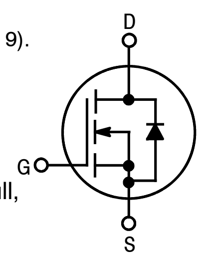
TO-220-3L
MRF101AN



TO-220-3L
MRF101BN

Backside

Note: Exposed backside of the package and tab also serves as a source terminal for the transistor.



Features

- Mirror pinout versions (A and B) to simplify use in a push-pull, two-up configuration
- Characterized from 30 to 50 V
- Suitable for linear application
- Integrated ESD protection with greater negative gate-source voltage range for improved Class C operation
- Included in NXP product longevity program with assured supply for a minimum of 15 years after launch

Typical Applications

- Industrial, scientific, medical (ISM)
  – Laser generation
  – Plasma etching
  – Particle accelerators
  – MRI and other medical applications
  – Industrial heating, welding and drying systems
- Radio and VHF TV broadcast
- HF and VHF communications
- Switch mode power supplies

Table 1. Maximum Ratings

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	–0.5, +133	Vdc
Gate-Source Voltage	V_{GS}	–6.0, +10	Vdc
Operating Voltage	V_{DD}	50	Vdc
Storage Temperature Range	T_{stg}	–65 to +150	°C
Case Operating Temperature Range	T_C	–40 to +150	°C
Operating Junction Temperature Range (1,2)	T_J	–40 to +175	°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	182 0.91	W W/°C

Table 2. Thermal Characteristics

Characteristic	Symbol	Value (2,3)	Unit
Thermal Resistance, Junction to Case CW: Case Temperature 77°C, 150 W CW, 50 Vdc, I_{DQ} = 100 mA, 40.68 MHz	$R_{\theta JC}$	1.1	°C/W
Thermal Impedance, Junction to Case Pulse: Case Temperature 73°C, 113 W Peak, 100 μsec Pulse Width, 20% Duty Cycle, 50 Vdc, I_{DQ} = 100 mA, 230 MHz	$Z_{\theta JC}$	0.37	°C/W

Table 3. ESD Protection Characteristics

Test Methodology	Class
Human Body Model (per JS-001-2017)	1B, passes 1000 V
Charge Device Model (per JS-002-2014)	C3, passes 1200 V

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

Characteristic	Symbol	Min	Typ	Max	Unit
Off Characteristics					
Gate-Source Leakage Current (V_{GS} = 5 Vdc, V_{DS} = 0 Vdc)	I_{GSS}	—	—	1	μAdc
Drain-Source Breakdown Voltage (V_{GS} = 0 Vdc, I_D = 50 mAdc)	$V_{(BR)DSS}$	133	—	—	Vdc
Zero Gate Voltage Drain Leakage Current (V_{DS} = 100 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	10	μAdc
On Characteristics					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 290 μAdc)	$V_{GS(th)}$	1.7	2.2	2.7	Vdc
Gate Quiescent Voltage (V_{DS} = 50 Vdc, I_D = 100 mAdc)	$V_{GS(Q)}$	—	2.5	—	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 1 Adc)	$V_{DS(on)}$	—	0.45	—	Vdc
Forward Transconductance (V_{DS} = 10 Vdc, I_D = 8.8 Adc)	g_{fs}	—	7.1	—	S

1. Continuous use at maximum temperature will affect MTTF.
2. MTTF calculator available at http://www.nxp.com/RF/calculators.
3. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers.* Go to http://www.nxp.com/RF and search for AN1955.

(continued)

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

Characteristic	Symbol	Min	Typ	Max	Unit
Dynamic Characteristics					
Reverse Transfer Capacitance (V_{DS} = 50 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{rss}	—	0.96	—	pF
Output Capacitance (V_{DS} = 50 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{oss}	—	43.4	—	pF
Input Capacitance (V_{DS} = 50 Vdc, V_{GS} = 0 Vdc ± 30 mV(rms)ac @ 1 MHz)	C_{iss}	—	149	—	pF
Typical Performance — 230 MHz (In NXP 230 MHz Fixture, 50 ohm system) V_{DD} = 50 Vdc, I_{DQ} = 100 mA, P_{in} = 0.9 W, f = 230 MHz, 100 μsec Pulse Width, 20% Duty Cycle					
Common-Source Amplifier Output Power	P_{out}	—	115	—	W
Power Gain	G_{ps}	—	21.1	—	dB
Drain Efficiency	η_D	—	76.7	—	%

Table 5. Load Mismatch/Ruggedness (In NXP 230 MHz Fixture, 50 ohm system) I_{DQ} = 100 mA

Frequency (MHz)	Signal Type	VSWR	P_{in} (W)	Test Voltage, V_{DD}	Result
230	Pulse (100 μsec, 20% Duty Cycle)	> 65:1 at all Phase Angles	1.8 Peak (3 dB Overdrive)	50	No Device Degradation

Table 6. Ordering Information

Device	Shipping Information	Package
MRF101AN	MPQ = 250 devices (50 devices per tube, 5 tubes per box)	TO-220-3L (Pin 1: Gate, Pin 2: Source, Pin 3: Drain)
MRF101BN		TO-220-3L (Pin 1: Drain, Pin 2: Source, Pin 3: Gate)

TYPICAL CHARACTERISTICS

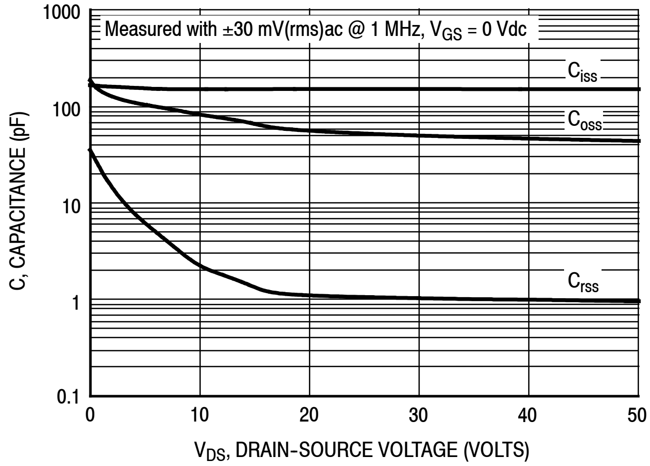


Figure 1. Capacitance versus Drain-Source Voltage

40.68 MHz COMPACT REFERENCE CIRCUIT (MRF101AN) — 0.7″ × 2.0″ (1.8 cm × 5.0 cm)

Table 7. 40.68 MHz Performance (In NXP Reference Circuit, 50 ohm system)
V_{DD} = 50 Vdc, I_{DQ} = 100 mA, P_{in} = 0.50 W, CW

Frequency (MHz)	P_{out} (W)	G_{ps} (dB)	η_D (%)
40.68	120	23.8	81.5

40.68 MHz COMPACT REFERENCE CIRCUIT (MRF101AN) — 0.7″ × 2.0″ (1.8 cm × 5.0 cm)

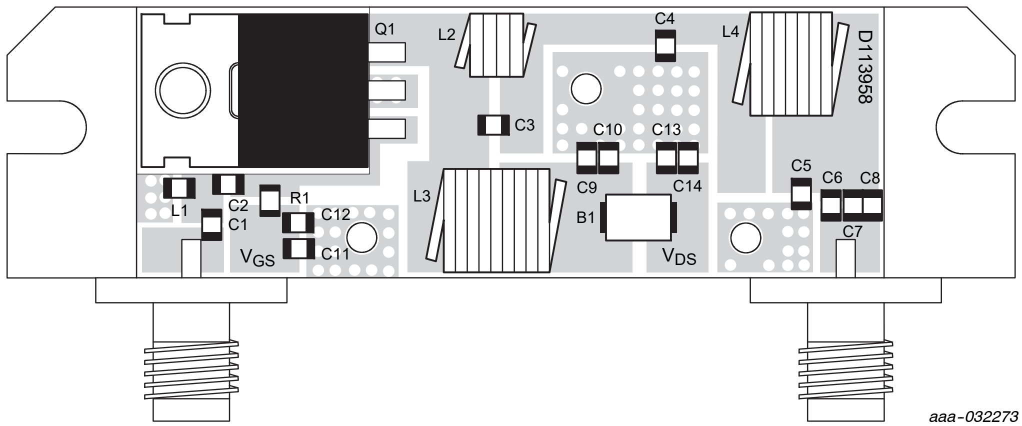


Figure 2. MRF101AN Compact Reference Circuit Component Layout and Assembly Example — 40.68 MHz

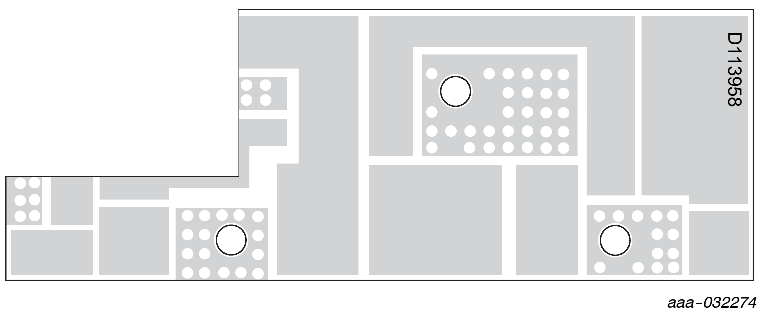


Figure 3. MRF101AN Compact Reference Circuit Board

Table 8. MRF101AN Compact Reference Circuit Component Designations and Values — 40.68 MHz

Part	Description	Part Number	Manufacturer
B1	Short RF Bead	2743019447	Fair-Rite
C1, C5	82 pF Chip Capacitor	GQM2195C2E820GB12D	Murata
C2, C4	200 pF Chip Capacitor	GQM2195C2A201GB12D	Murata
C3	33 pF Chip Capacitor	GQM2195C2E330GB12D	Murata
C6, C7, C8, C9, C10	1000 pF Chip Capacitor	GRM2165C2A102JA01D	Murata
C11	1 μF Chip Capacitor	GJ821BR71H105KA12L	Murata
C12, C13	10 nF Chip Capacitor	GRM21BR72A103KA01B	Murata
C14	1 μF Chip Capacitor	C3216X7R2A105K160AA	TDK
L1	150 nH Chip Inductor	0805WL151JT	ATC
L2	17.5 nH, 4 Turn Inductor	GA3095-ACL	Coilcraft
L3	160 nH Square Air Core Inductor	2222SQ-161JEC	Coilcraft
L4	110 nH Square Air Core Inductor	2222SQ-111JEB	Coilcraft
Q1	RF Power LDMOS Transistor	MRF101AN	NXP
R1	75 Ω, 1/4 W Chip Resistor	SG73P2ATTD75R0F	KOA Speer
PCB	FR4 0.09″, ε_r = 4.8, 2 oz. Copper	D113958	MTL

TYPICAL CHARACTERISTICS — 40.68 MHz
COMPACT REFERENCE CIRCUIT (MRF101AN)

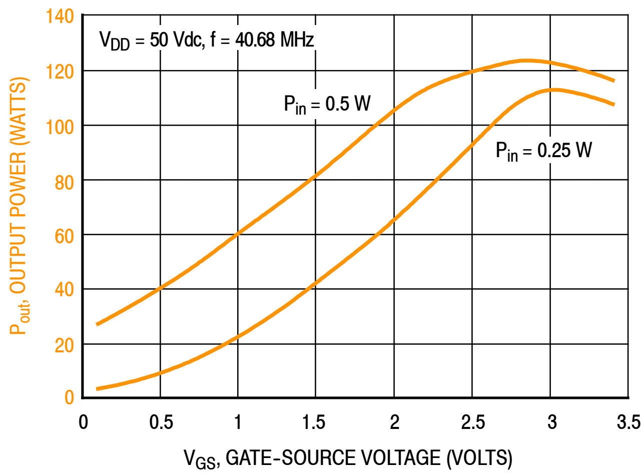
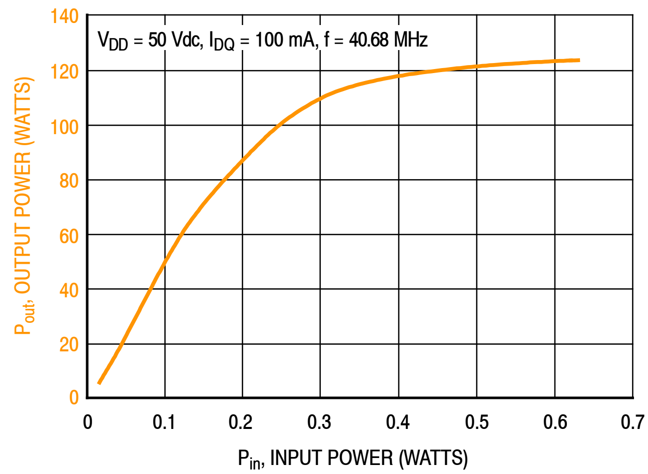


Figure 4. CW Output Power versus Gate-Source Voltage at a Constant Input Power



f (MHz)	P1dB (W)	P3dB (W)
40.68	101	121

Figure 5. CW Output Power versus Input Power

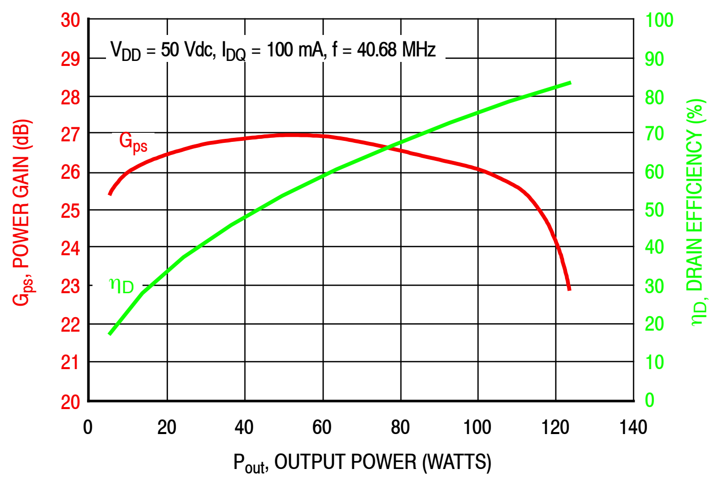


Figure 6. Power Gain and Drain Efficiency versus CW Output Power

40.68 MHz COMPACT REFERENCE CIRCUIT (MRF101AN)

f MHz	Z_{source} Ω	Z_{load} Ω
40.68	24.0 + j12.6	14.2 – j2.5

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

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

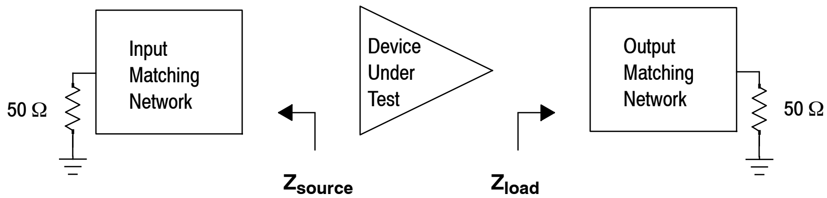


Figure 7. Series Equivalent Source and Load Impedance — 40.68 MHz

136–174 MHz COMPACT VHF BROADBAND REFERENCE CIRCUIT (MRF101AN) — 0.7″× 2.0″ (1.8 cm × 5.0 cm)

Table 9. 136–174 MHz VHF Broadband Performance (In NXP Reference Circuit, 50 ohm system)
V_{DD} = 50 Vdc, I_{DQ} = 100 mA, P_{in} = 0.79 W, CW

Frequency (MHz)	P_{out} (W)	G_{ps} (dB)	η_D (%)
135	117	21.7	80.0
155	104	21.2	76.5
175	107	21.3	75.4

136–174 MHz COMPACT VHF BROADBAND REFERENCE CIRCUIT (MRF101AN) — 0.7″× 2.0″ (1.8 cm × 5.0 cm)

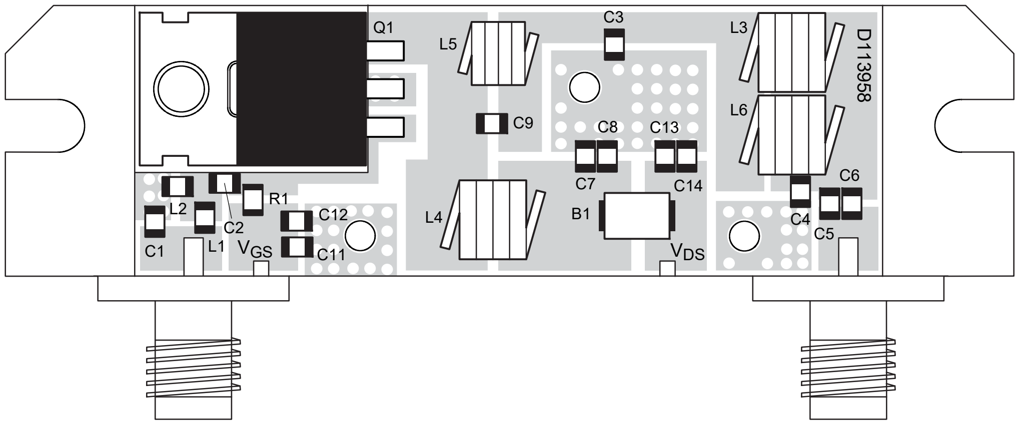


Figure 8. MRF101AN Compact Reference Circuit Component Layout and Assembly Example — 136–174 MHz

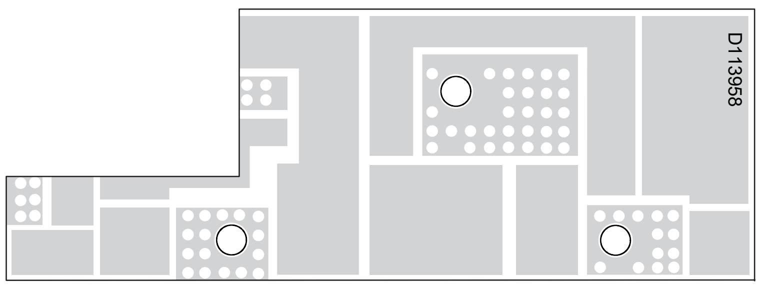


Figure 9. MRF101AN Compact Reference Circuit Board

Table 10. MRF101AN Compact VHF Broadband Reference Circuit Component Designations and Values — 136–174 MHz

Part	Description	Part Number	Manufacturer
B1	Short RF Bead	2743019447	Fair-Rite
C1	39 pF Chip Capacitor	GQM2195C2E390GB12D	Murata
C2, C5, C6, C7, C8, C12	510 pF Chip Capacitor	GRM2165C2A511JA01D	Murata
C3	68 pF Chip Capacitor	GQM2195C2E680GB12D	Murata
C4	27 pF Chip Capacitor	GQM2195C2E270GB12D	Murata
C9	10 pF Chip Capacitor	GQM2195C2E100FB12D	Murata
C11	1 μF Chip Capacitor	GJ821BR71H105KA12L	Murata
C13	10 nF Chip Capacitor	GRM21BR72A103KA01B	Murata
C14	1 μF Chip Capacitor	C3216X7R2A105K160AA	TDK
L1	22 nH Chip Inductor	0805WL220JT	ATC
L2	12 nH Chip Inductor	0805WL120JT	ATC
L3, L4, L6	68 nH Air Core Inductor	1812SMS-68NJLC	Coilcraft
L5	12 nH, 3 Turn Inductor	GA3094-ALC	Coilcraft
Q1	RF Power LDMOS Transistor	MRF101AN	NXP
R1	75 Ω, 1/4 W Chip Resistor	SG73P2ATTD75R0F	KOA Speer
PCB	FR4 0.09″, ε_r = 4.8, 2 oz. Copper	D113958	MTL

TYPICAL CHARACTERISTICS — 136–174 MHz
COMPACT VHF BROADBAND REFERENCE CIRCUIT (MRF101AN)

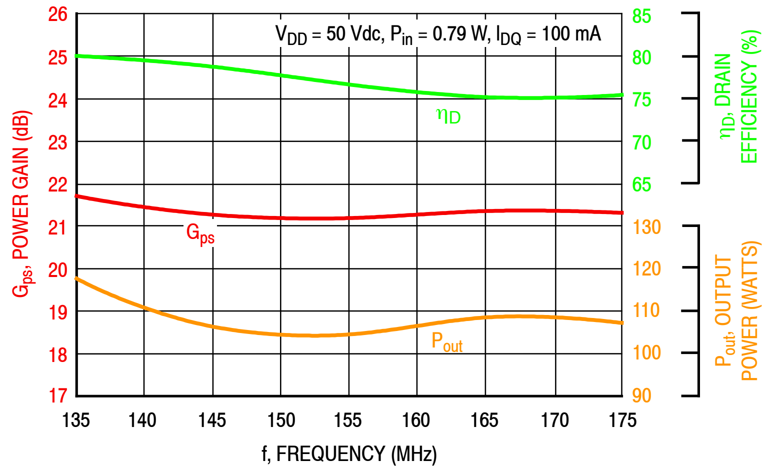


Figure 10. Power Gain, Drain Efficiency and CW Output Power versus Frequency at a Constant Input Power

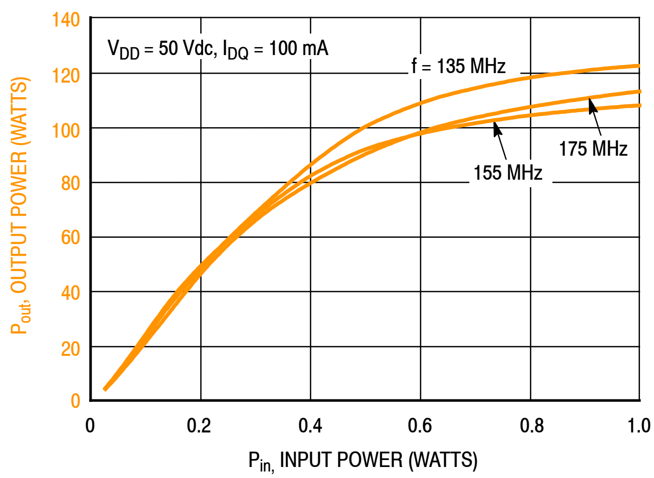


Figure 11. CW Output Power versus Input Power and Frequency

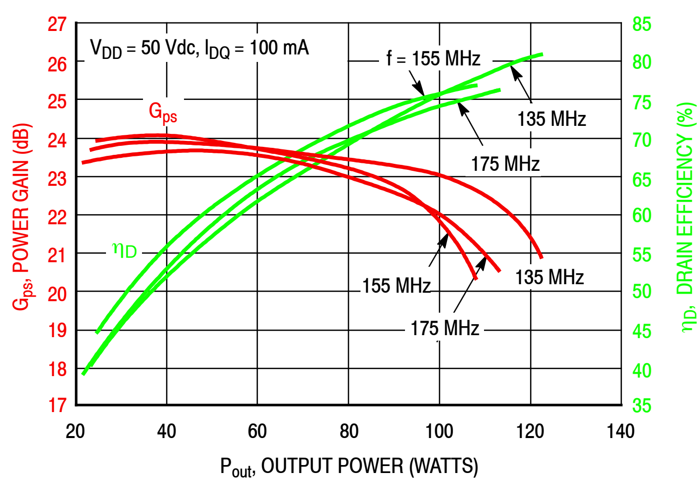


Figure 12. Power Gain and Drain Efficiency versus CW Output Power and Frequency

136–174 MHz COMPACT VHF BROADBAND REFERENCE CIRCUIT (MRF101AN)

f MHz	Z_{source} Ω	Z_{load} Ω
135	6.8 + j10.2	9.5 + j5.2
145	6.2 + j10.2	9.9 + j5.9
155	5.3 + j10.8	10.2 + j6.2
165	4.4 + j11.9	10.0 + j5.9
175	3.9 + j13.4	8.8 + j5.0

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

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

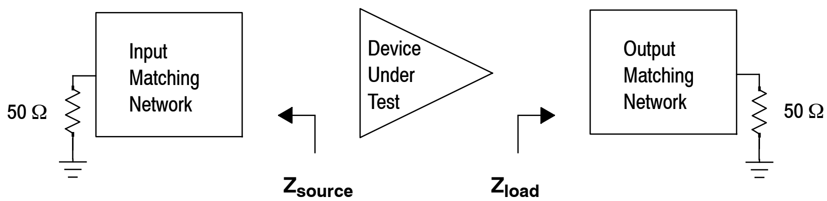


Figure 13. Series Equivalent Source and Load Impedance — 136–174 MHz

230 MHz FIXTURE (MRF101AN) — 4.0″ × 5.0″ (10.2 cm × 12.7 cm)

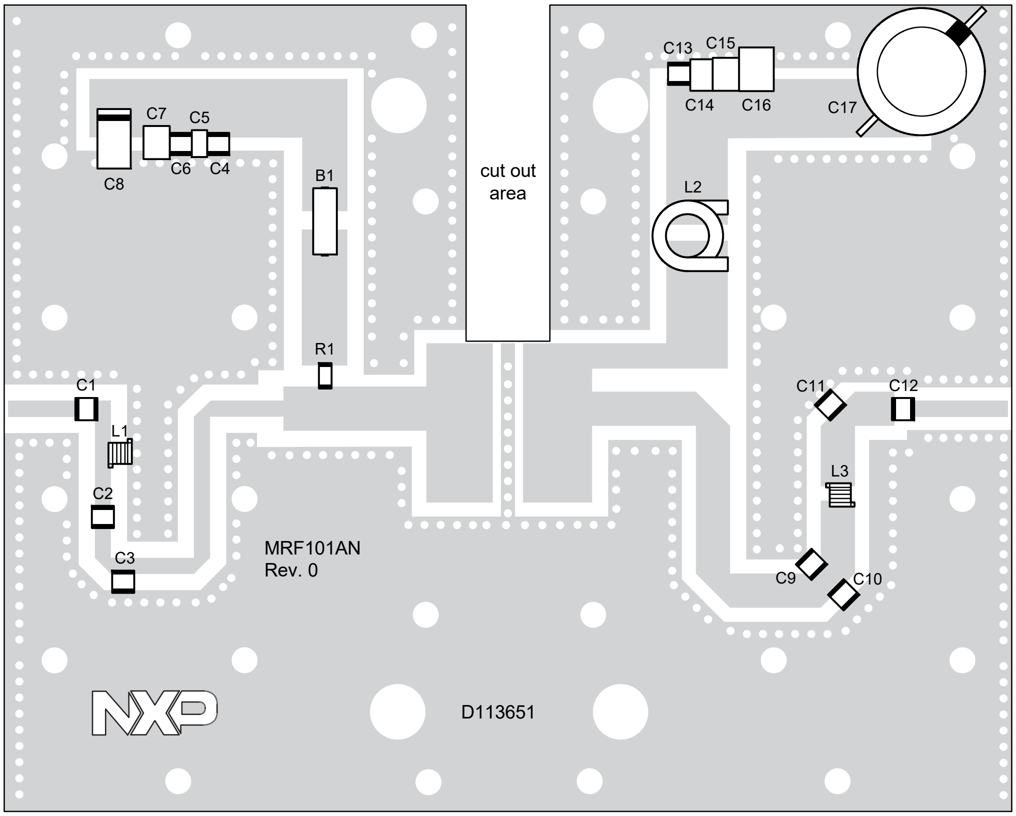


Figure 14. MRF101AN Fixture Component Layout — 230 MHz

Table 11. MRF101AN Fixture Component Designations and Values — 230 MHz

Part	Description	Part Number	Manufacturer
B1	Long Ferrite Bead	2743021447	Fair-Rite
C1, C2, C10	18 pF Chip Capacitor	ATC100B180JT500XT	ATC
C3	43 pF Chip Capacitor	ATC100B430JT500XT	ATC
C4, C13	1000 pF Chip Capacitor	ATC800B102JT50XT	ATC
C5	0.1 μF Chip Capacitor	GRM319R72A104KA01D	Murata
C6	10 nF Chip Capacitor	C1210C103J5GACTU	Kemet
C7	2.2 μF Chip Capacitor	C3225X7R1H225K	TDK
C8	47 μF, 16 V Tantalum Capacitor	T491D476K016AT	Kemet
C9	51 pF Chip Capacitor	ATC100B510JT500XT	ATC
C11	16 pF Chip Capacitor	ATC100B160JT500XT	ATC
C12	470 pF Chip Capacitor	ATC800B471JW50XT	ATC
C14	0.1 μF Chip Capacitor	C1812104K1RACTU	Kemet
C15	2.2 μF Chip Capacitor	C3225X7R2A225K	TDK
C16	2.2 μF Chip Capacitor	HMK432B7225KM-T	Taiyo Yuden
C17	220 μF, 100 V Electrolytic Capacitor	MCGPR100V227M16X26	Multicomp
L1	39 nH Chip Inductor	1812SMS-39NJLC	Coilcraft
L2	46 nH Chip Inductor	1010VS-46NME	Coilcraft
L3	17.5 nH, 4 Turn Inductor	GA3095-ALC	Coilcraft
R1	470 Ω, 1/4 W Chip Resistor	CRCW1206470RFKEA	Vishay
PCB	Rogers AD255C, 0.030″, ε_r = 2.55, 2 oz. Copper	D113651	MTL

TYPICAL CHARACTERISTICS — 230 MHz FIXTURE, T_C = 25°C (MRF101AN)

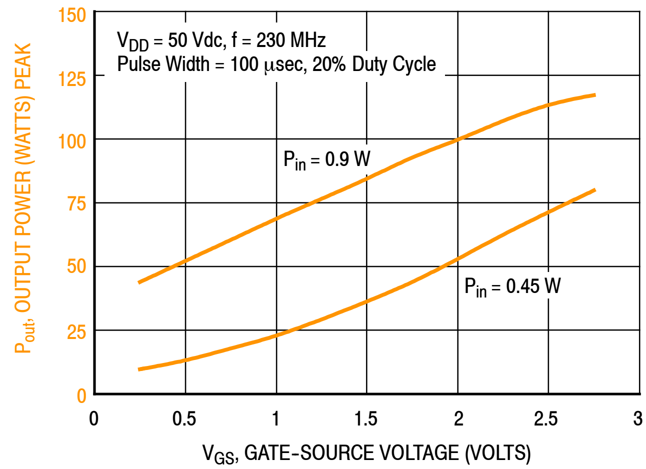
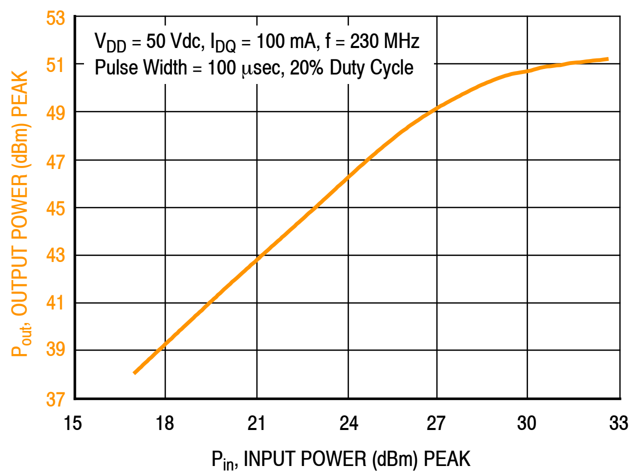


Figure 15. Output Power versus Gate-Source Voltage at a Constant Input Power



f (MHz)	P1dB (W)	P3dB (W)
230	110	128

Figure 16. Output Power versus Input Power

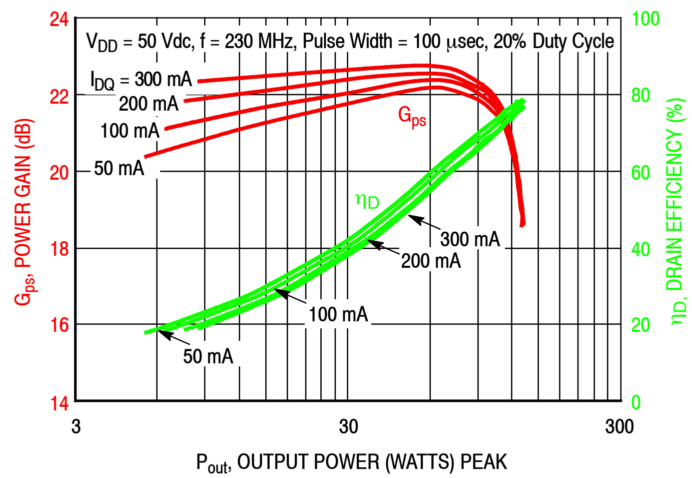


Figure 17. Power Gain and Drain Efficiency versus Output Power and Quiescent Current

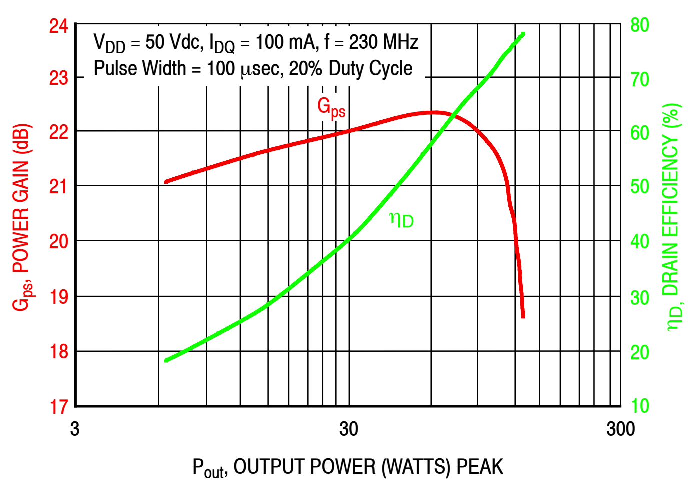


Figure 18. Power Gain and Drain Efficiency versus Output Power

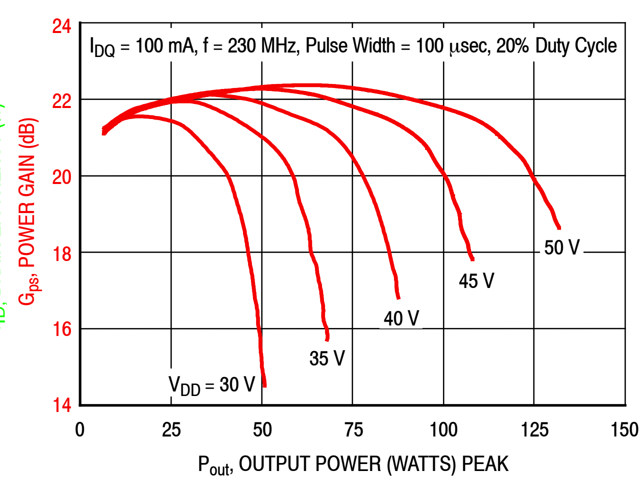


Figure 19. Power Gain versus Output Power and Drain-Source Voltage

230 MHz FIXTURE (MRF101AN)

f MHz	Z_{source} Ω	Z_{load} Ω
230	2.1 + j5.9	5.5 + j3.2

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

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

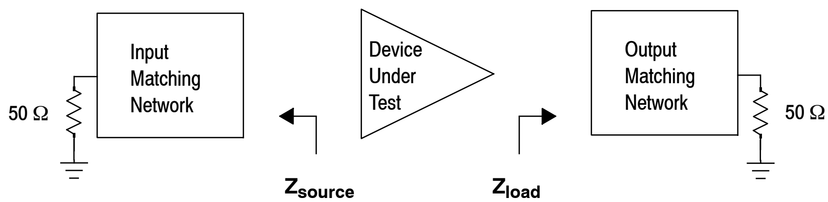
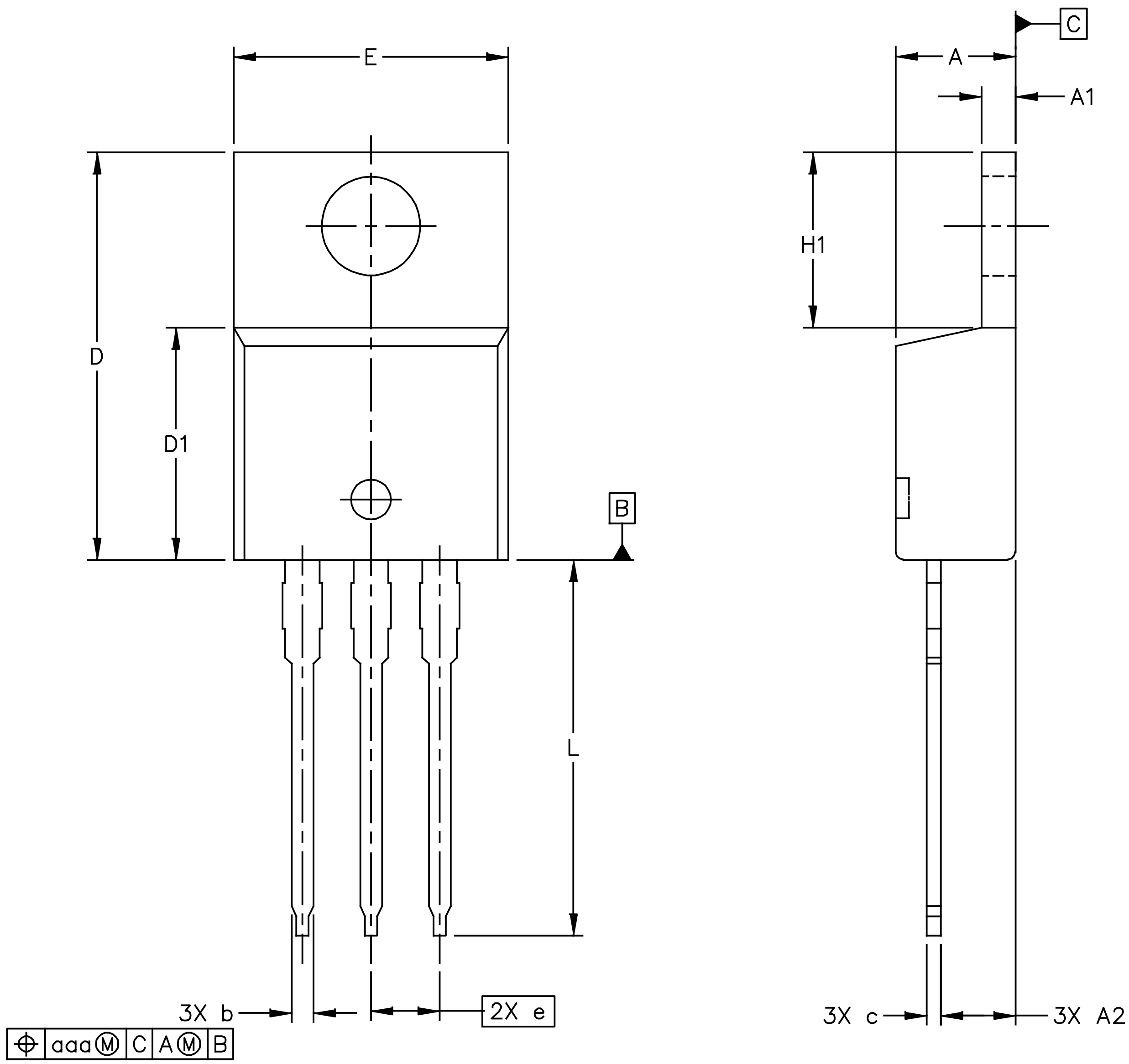


Figure 20. Series Equivalent Source and Load Impedance — 230 MHz

PACKAGE DIMENSIONS



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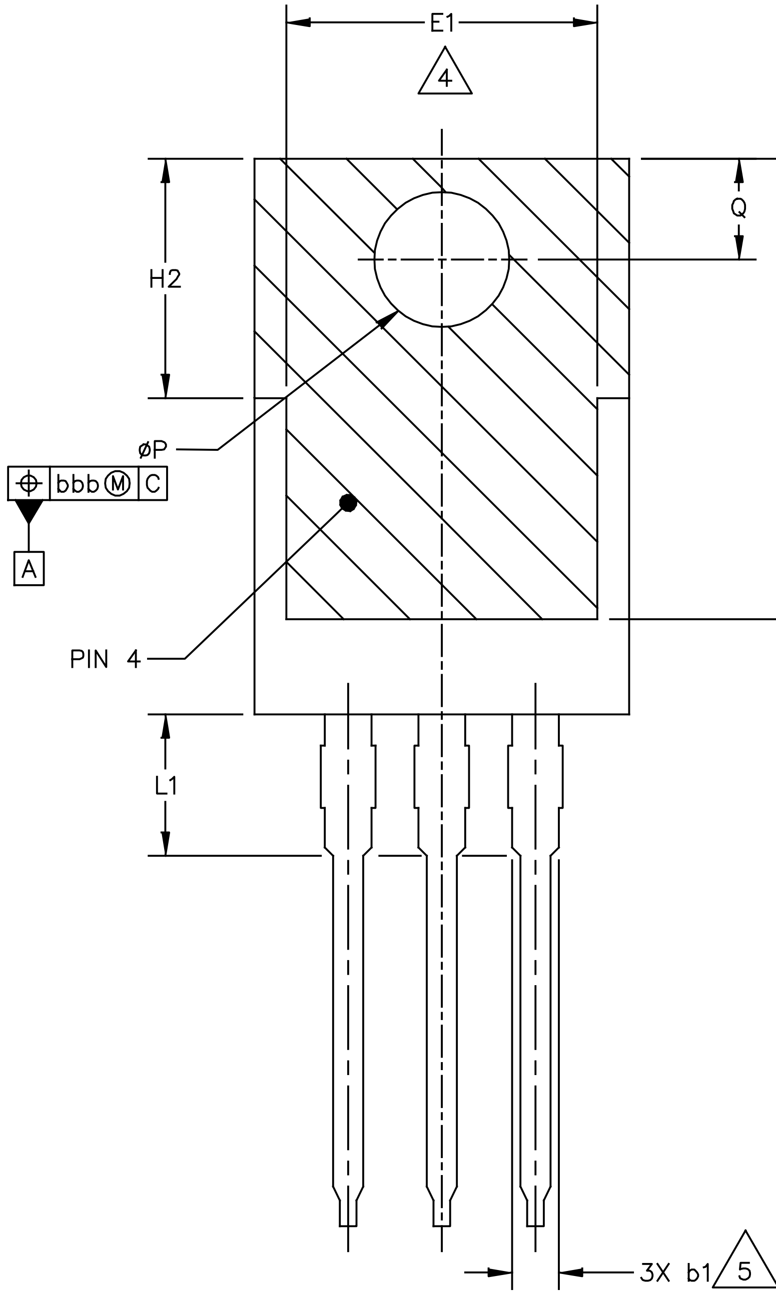

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TITLE: TO–220–3L	DOCUMENT NO: 98ASA01106D REV: 0	
	STANDARD: NON–JEDEC	
	SOT1937–1 19 APR 2018	

NOTES:

1. CONTROLLING DIMENSION: MILLIMETER, ANGLES ARE IN DEGREES.

2. INTERPRET DIMENSIONS AND TOLERANCES AS PER ASME Y14.5M—1994.

3. DIMENSION D AND E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.13 MM (.005 INCH) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREME OF THE PLASTIC BODY.

4. HATCHING REPRESENTS THE EXPOSED AREA OF THE THERMAL PAD (PIN 4). DIMENSIONS D2 AND E1 REPRESENT THE VALUES BETWEEN THE TWO OPPOSITE POINTS ALONG THE EDGES OF THE EXPOSED AREA OF THE THERMAL PAD. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSION D1 AND E1.

5. DIMENSIONS b1 DO NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.15 MM (.006 INCH) PER SIDE IN EXCESS OF THE DIMENSIONS b1 AT MAXIMUM MATERIAL CONDITION.

6. EJECTOR MARKS ON TOP SURFACE ARE PERMITTED AND IT IS SUPPLIER OPTION. THE MAXIMUM DEPTH OF EJECTOR MARK IS 0.25 MM (.010 INCH)

	INCH		MILLIMETER			INCH		MILLIMETER	
DIM	MIN	MAX	MIN	MAX	DIM	MIN	MAX	MIN	MAX
A	.167	.190	4.25	4.83	E1	.303	---	7.70	---
A1	.047	.053	1.20	1.34	e	.10 BSC		2.54 BSC	
A2	.098	.115	2.50	2.92	H1	.240	.264	6.10	6.70
b	.028	.038	0.71	0.97	H2	.240	.264	6.10	6.70
b1	.045	.070	1.14	1.78	L	.500	.567	12.70	14.40
c	.014	.024	0.356	0.61	L1	.144	.159	3.65	4.05
D	.564	.624	14.32	15.86	P	.142	.155	3.60	3.95
D1	.330	---	8.39	---	Q	.100	.119	2.54	3.04
D2	.480	.504	12.20	12.80	aaa	.014		0.35	
E	.392	.412	9.96	10.47	bbb	.014		0.35	

	MECHANICAL OUTLINE	PRINT VERSION NOT TO SCALE
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PRODUCT DOCUMENTATION, SOFTWARE AND TOOLS

Refer to the following resources to aid your design process.

Application Notes

- AN1955: Thermal Measurement Methodology of RF Power Amplifiers

Engineering Bulletins

- EB212: Using Data Sheet Impedances for RF LDMOS Devices

Software

- Electromigration MTTF Calculator
- RF High Power Model
- .s2p File

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	Nov. 2018	• Initial release of data sheet

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