**NXP Semiconductors**
Technical Data

Document Number: MRF300AN
Rev. 0, 05/2018

# RF Power LDMOS Transistors

## High Ruggedness N-Channel Enhancement-Mode Lateral MOSFETs

**MRF300AN**
**MRF300BN**

**1.8–250 MHz, 300 W CW, 50 V**
**WIDEBAND**
**RF POWER LDMOS TRANSISTORS**

These high ruggedness devices are designed for use in high VSWR industrial, scientific and medical applications and HF and VHF communications as well as radio and VHF TV broadcast, sub-GHz aerospace and mobile radio applications. Their unmatched input and output design allows for wide frequency range use from 1.8 to 250 MHz.

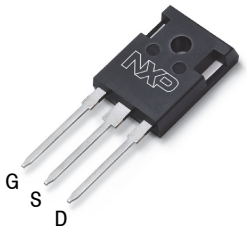
**Typical Performance:** $V_{DD}$ = 50 Vdc

| Frequency (MHz) | Signal Type | $P_{out}$ (W) | $G_{ps}$ (dB) | $\eta_D$ (%) |
|---|---|---|---|---|
| 27 | CW | 340 CW | 27.3 | 80.6 |
| 40.68 (1) | CW | 330 CW | 28.2 | 79.0 |
| 81.36 | CW | 310 CW | 26.0 | 76.5 |
| 230 (2) | Pulse (100 μsec, 20% Duty Cycle) | 330 Peak | 20.4 | 75.5 |

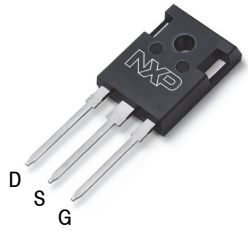
**Load Mismatch/Ruggedness**

| Frequency (MHz) | Signal Type | VSWR | $P_{in}$ (W) | Test Voltage | Result |
|---|---|---|---|---|---|
| 40.68 | Pulse (100 μsec, 20% Duty Cycle) | > 65:1 at all Phase Angles | 2 Peak (3 dB Overdrive) | 50 | No Device Degradation |
| 230 | Pulse (100 μsec, 20% Duty Cycle) | > 65:1 at all Phase Angles | 6 Peak (3 dB Overdrive) | 50 | No Device Degradation |

1. Measured in 40.68 MHz narrowband reference circuit (page 5).
2. Measured in 230 MHz typical narrowband fixture (page 10).




**TO-247-3L**
**MRF300AN**

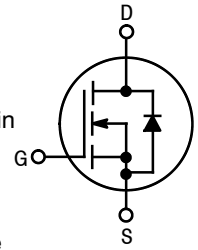



**TO-247-3L**
**MRF300BN**

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

### Features

- Unmatched input and output allowing wide frequency range utilization
- Two opposite pin-connection versions (A and B) to be used in a push-pull, two-up configuration for wideband performance
- 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




### Typical Applications

- Industrial, scientific, medical (ISM)
  - Laser generation
  - Plasma etching
  - Particle accelerators
  - MRI and other medical applications
  - Industrial heating, welding and drying systems
- Broadcast
  - Radio broadcast
  - VHF TV broadcast
- Mobile radio
  - VHF base stations
- 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<br>Derate above 25°C | $P_D$ | 272<br>1.82 | W<br>W/°C |

**Table 2. Thermal Characteristics**

| Characteristic | Symbol | Value (2,3) | Unit |
|---|---|---|---|
| Thermal Resistance, Junction to Case<br>CW: Case Temperature 76°C, 300 W CW, 50 Vdc, $I_{DQ}$ = 50 mA, 40.68 MHz | $R_{\theta JC}$ | 0.55 | °C/W |
| Thermal Impedance, Junction to Case<br>Pulse: Case Temperature 74°C, 300 W Peak, 100 μsec Pulse Width, 20% Duty Cycle, 50 Vdc, $I_{DQ}$ = 100 mA, 230 MHz | $Z_{\theta JC}$ | 0.13 | °C/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) | C3, passes 1200 V |

**Table 4. Moisture Sensitivity Level**

| Test Methodology | Rating | Package Peak Temperature | Unit |
|---|---|---|---|
| Per JESD22-A113, IPC/JEDEC J-STD-020 | 0 | 260 | °C |

**Table 5. Electrical Characteristics** ($T_A$ = 25°C unless otherwise noted)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **Off Characteristics** | | | | | |
| Gate-Source Leakage Current<br>($V_{GS}$ = 5 Vdc, $V_{DS}$ = 0 Vdc) | $I_{GSS}$ | — | — | 1 | μAdc |
| Drain-Source Breakdown Voltage<br>($V_{GS}$ = 0 Vdc, $I_D$ = 50 mAdc) | $V_{(BR)DSS}$ | 133 | — | — | Vdc |
| Zero Gate Voltage Drain Leakage Current<br>($V_{DS}$ = 100 Vdc, $V_{GS}$ = 0 Vdc) | $I_{DSS}$ | — | — | 10 | μAdc |
| **On Characteristics** | | | | | |
| Gate Threshold Voltage<br>($V_{DS}$ = 10 Vdc, $I_D$ = 840 μAdc) | $V_{GS(th)}$ | 1.7 | 2.2 | 2.7 | Vdc |
| Gate Quiescent Voltage<br>($V_{DS}$ = 50 Vdc, $I_D$ = 100 mAdc) | $V_{GS(Q)}$ | — | 2.5 | — | Vdc |
| Drain-Source On-Voltage<br>($V_{GS}$ = 10 Vdc, $I_D$ = 1 Adc) | $V_{DS(on)}$ | — | 0.16 | — | Vdc |
| Forward Transconductance<br>($V_{DS}$ = 10 Vdc, $I_D$ = 30 Adc) | $g_{fs}$ | — | 28 | — | 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 5. 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) | $C_{rss}$ | — | 2.31 | — | pF |
| Output Capacitance ($V_{DS}$ = 50 Vdc ± 30 mV(rms)ac @ 1 MHz, $V_{GS}$ = 0 Vdc) | $C_{oss}$ | — | 104 | — | pF |
| Input Capacitance ($V_{DS}$ = 50 Vdc, $V_{GS}$ = 0 Vdc ± 30 mV(rms)ac @ 1 MHz) | $C_{iss}$ | — | 403 | — | pF |
| **Typical Narrowband Performance – 230 MHz** (In NXP Narrowband 230 MHz Fixture, 50 ohm system) $V_{DD}$ = 50 Vdc, $I_{DQ}$ = 100 mA, $P_{in}$ = 3 W, f = 230 MHz, 100 μsec Pulse Width, 20% Duty Cycle | | | | | |
| Common-Source Amplifier Output Power | $P_{out}$ | — | 330 | — | W |
| Drain Efficiency | $\eta_D$ | — | 75.5 | — | % |
| Input Return Loss | IRL | — | –21 | — | dB |

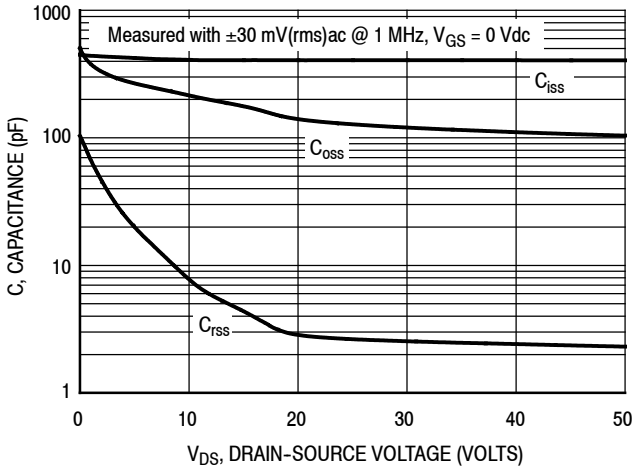
**Table 6. Load Mismatch/Ruggedness** (In NXP Narrowband 230 MHz Fixture, 50 ohm system) $I_{DQ}$ = 100 mA

| 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 | 6 Peak (3 dB Overdrive) | 50 | No Device Degradation |

**Table 7. Ordering Information**

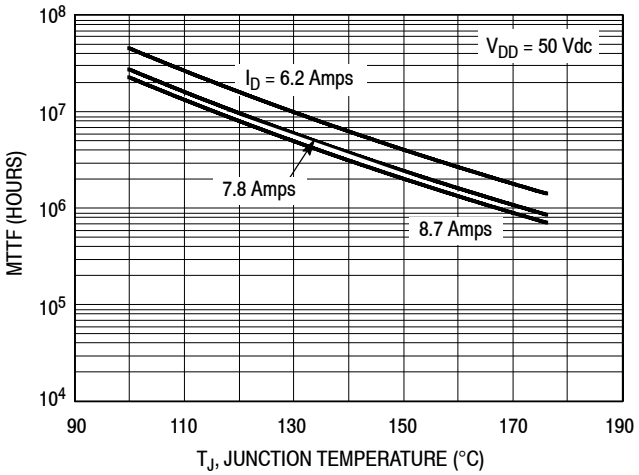
| Device | Shipping Information | Package |
|---|---|---|
| MRF300AN | MPQ = 240 devices (30 devices per tube, 8 tubes per box) | TO-247-3L (Pin 1: Gate, Pin 2: Source, Pin 3: Drain) |
| MRF300BN | | TO-247-3L (Pin 1: Drain, Pin 2: Source, Pin 3: Gate) |

## TYPICAL CHARACTERISTICS




**Note:** Each side of device measured separately.

**Figure 1. Capacitance versus Drain-Source Voltage**




**Note:** MTTF value represents the total cumulative operating time under indicated test conditions.

MTTF calculator available at http:/www.nxp.com/RF/calculators.

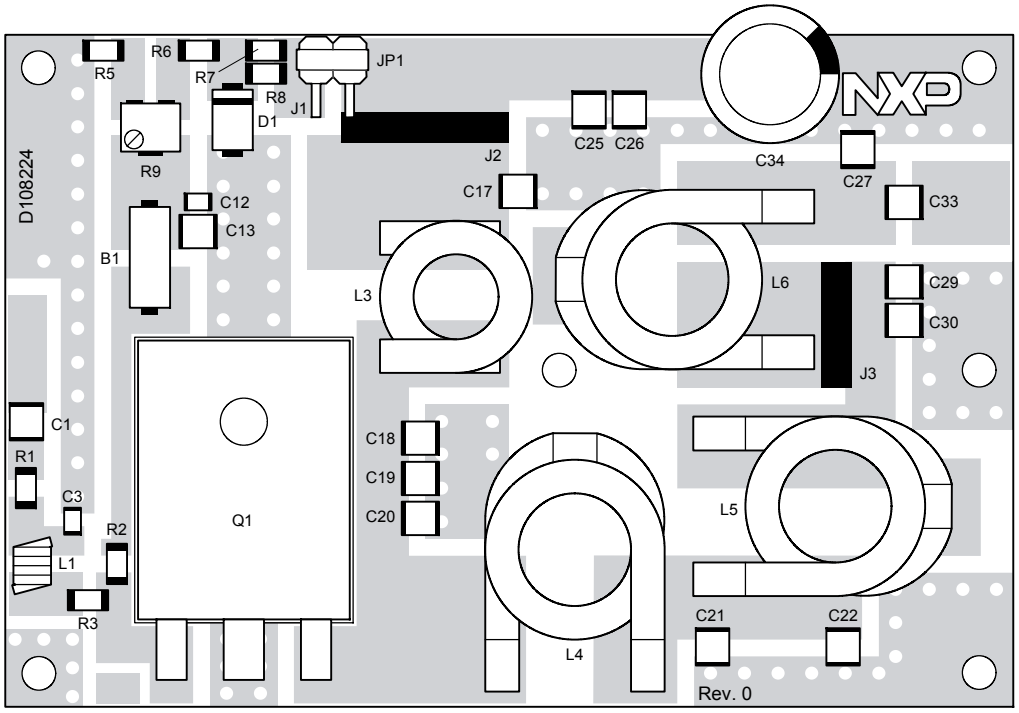
**Figure 2. MTTF versus Junction Temperature — CW**

## 40.68 MHz NARROWBAND REFERENCE CIRCUIT (MRF300AN)

**Table 8. 40.68 MHz Narrowband Performance** (In NXP Reference Circuit, 50 ohm system)
$V_{DD}$ = 50 Vdc, $I_{DQ}$ = 50 mA, $P_{in}$ = 0.5 W, CW

| Frequency (MHz) | $G_{ps}$ (dB) | $\eta_D$ (%) | $P_{out}$ (W) |
|---|---|---|---|
| 40.68 | 28.2 | 79.0 | 330 |

## 40.68 MHz NARROWBAND REFERENCE CIRCUIT (MRF300AN) — 2.0″ × 3.0″ (5.1 cm × 7.6 cm)




Note: Component numbers C2, C4–C11, C14–C16, C23, C24, C28, C31, C32, R4 and L2 are not used.

aaa-030512

**Figure 3. MRF300AN 40.68 MHz Narrowband Reference Circuit Component Layout**

## 40.68 MHz NARROWBAND REFERENCE CIRCUIT (MRF300AN)

**Table 9. MRF300AN Narrowband Reference Circuit Component Designations and Values — 40.68 MHz**

| Part | Description | Part Number | Manufacturer |
|---|---|---|---|
| B1 | Long Ferrite Bead | 2743021447 | Fair-Rite |
| C1, C13, C17 | 22,000 pF Chip Capacitor | ATC200B223KT50XT | ATC |
| C3 | 200 pF Chip Capacitor | GQM2195C2A201GB12D | Murata |
| C12 | 1 μF Chip Capacitor | GRM31CR72A105KA01L | Murata |
| C18, C19, C20 | 68 pF Chip Capacitor | ATC100B680JT500XT | ATC |
| C21 | 200 pF Chip Capacitor | ATC100B201JT300XT | ATC |
| C22 | 220 pF Chip Capacitor | ATC100B221JT200XT | ATC |
| C25 | 0.1 μF Chip Capacitor | GRM32NR72A104KA01B | Murata |
| C26 | 10 μF Chip Capacitor | GRM32ER61H106KA12L | Murata |
| C27 | 56 pF Chip Capacitor | ATC100B560CT500XT | ATC |
| C29 | 75 pF Chip Capacitor | ATC100B750JT500XT | ATC |
| C30 | 91 pF Chip Capacitor | ATC100B910JT500XT | ATC |
| C33 | 5100 pF Chip Capacitor | ATC700B512KT50XT | ATC |
| C34 | 220 μF, 63 V Electrolytic Capacitor | EEU-FC1J221 | Panasonic |
| D1 | 8.2 V Zener Diode | SMAJ4738A-TP | Micro Commercial Components |
| J1 | Right Angle Breakaway Headers (2 Pins) | 9-146305-0 | TE Connectivity |
| J2, J3 | Jumper | Copper Foil | |
| JP1 | Shunt (J1) | 382811-8 | TE Connectivity |
| L1 | 120 nH Chip Inductor | 1008CS-121XJLB | Coilcraft |
| L3 | 117 nH Chip Inductor | 1212VS-111MEB | Coilcraft |
| L4 | 33 nH Chip Inductor | 2014VS-33NMEB | Coilcraft |
| L5 | 108 nH Chip Inductor | 2014VS-111MEB | Coilcraft |
| L6 | 155 nH Chip Inductor | 2014VS-151MEB | Coilcraft |
| Q1 | RF Power LDMOS Transistor | MRF300AN | NXP |
| R1, R3 | 0 Ω, 1/4 W Chip Resistor | CRCW12060000Z0EA | Vishay |
| R2 | 100 Ω, 1/4 W Chip Resistor | CRCW1206100RFKEA | Vishay |
| R5 | 12 kΩ, 1/4 W Chip Resistor | CRCW120612K0FKEA | Vishay |
| R6 | 27 kΩ, 1/4 W Chip Resistor | CRCW120627K0FKEA | Vishay |
| R7, R8 | 20 kΩ, 1/4 W Chip Resistor | CRCW120620K0FKEA | Vishay |
| R9 | 5.0 kΩ Multi−turn Cermet Trimmer Potentiometer | 3224W-1-502E | Bourns |
| PCB | FR4 0.087″, $\varepsilon_r$ = 4.8, 2 oz. Copper | D108224 | MTL |

## TYPICAL CHARACTERISTICS — 40.68 MHz NARROWBAND REFERENCE CIRCUIT (MRF300AN)

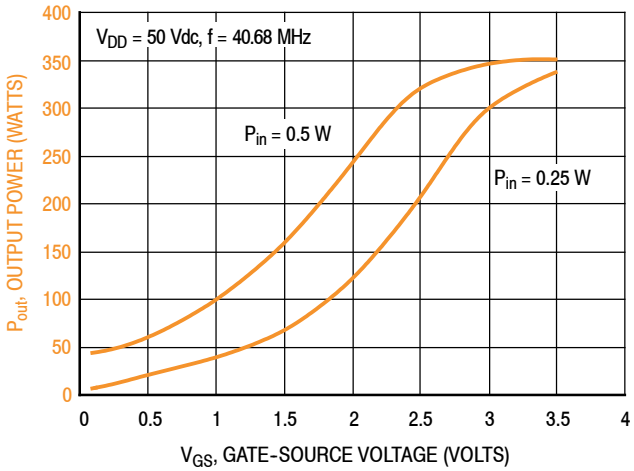
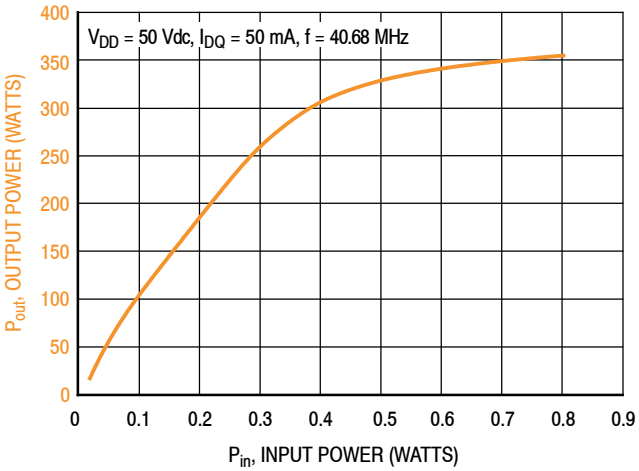



**Figure 4. CW Output Power versus Gate-Source Voltage at a Constant Input Power**




| f (MHz) | P1dB (W) | P3dB (W) |
|---|---|---|
| 40.68 | 250 | 340 |

**Figure 5. CW Output Power versus Input Power**

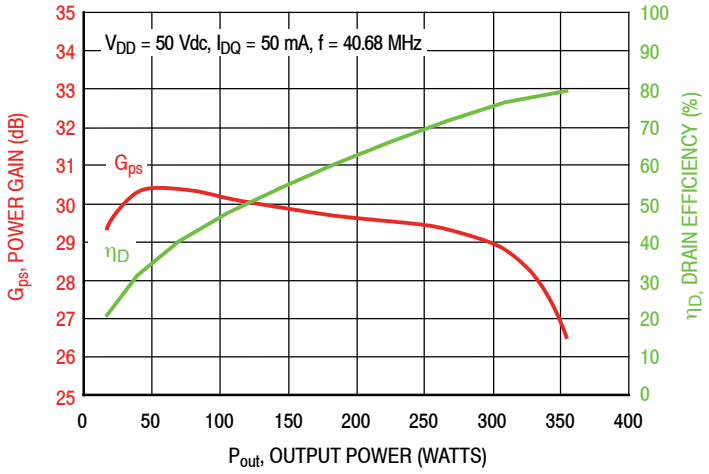



**Figure 6. Power Gain and Drain Efficiency versus CW Output Power**

## 40.68 MHz NARROWBAND REFERENCE CIRCUIT (MRF300AN)

| f<br>MHz | $Z_{source}$<br>Ω | $Z_{load}$<br>Ω |
|---|---|---|
| 40.68 | 7.83 + j13.51 | 5.34 + j1.03 |

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

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

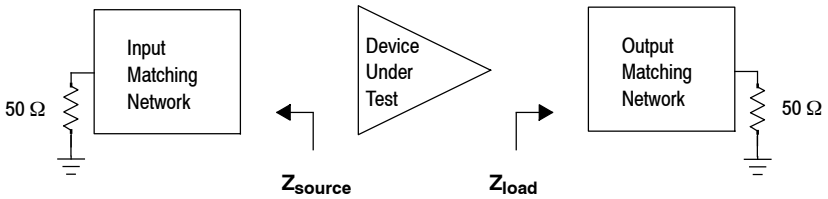



**Figure 7. Narrowband Series Equivalent Source and Load Impedance — 40.68 MHz**

## 230 MHz NARROWBAND FIXTURE (MRF300AN) — 4.0″ × 5.0″ (10.2 cm × 12.7 cm)

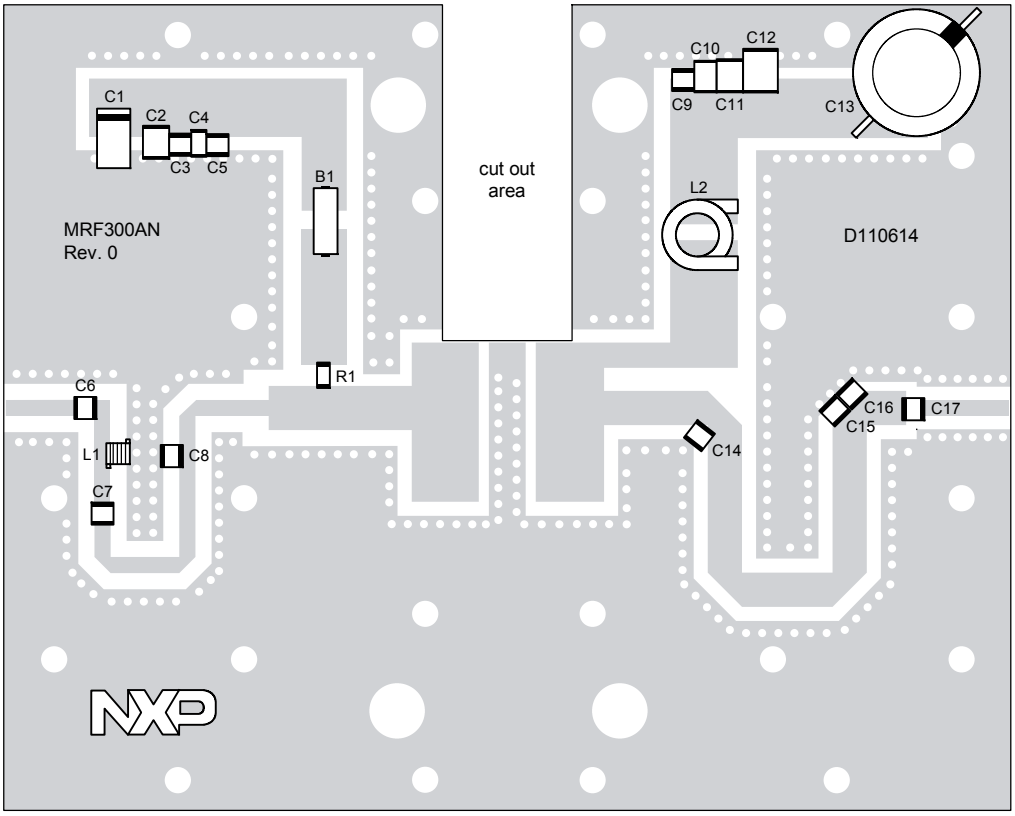



**Figure 8. MRF300AN Narrowband Fixture Component Layout — 230 MHz**

**Table 10. MRF300AN Narrowband Fixture Component Designations and Values — 230 MHz**

| Part | Description | Part Number | Manufacturer |
|---|---|---|---|
| B1 | Long Ferrite Bead | 2743021447 | Fair-Rite |
| C1 | 47 μF, 16 V Tantalum Capacitor | T491D476K016AT | Kemet |
| C2 | 2.2 μF Chip Capacitor | C3225X7R1H225K250AB | TDK |
| C3 | 10 nF Chip Capacitor | C1210C103J5GACTU | Kemet |
| C4 | 0.1 μF Chip Capacitor | GRM319R72A104KA01D | Murata |
| C5, C9 | 1000 pF Chip Capacitor | ATC800B102JT50XT | ATC |
| C6, C7 | 18 pF Chip Capacitor | ATC100B180JT500XT | ATC |
| C8, C14 | 56 pF Chip Capacitor | ATC100B560CT500XT | ATC |
| C10 | 0.1 μF Chip Capacitor | C1812104K1RACTU | Kemet |
| C11 | 2.2 μF Chip Capacitor | C3225X7R2A225K230AB | TDK |
| C12 | 2.2 μF Chip Capacitor | HMK432B7225KM-T | Taiyo Yuden |
| C13 | 220 μF, 100 V Electrolytic Capacitor | MCGPR100V227M16X26 | Multicomp |
| C15 | 1.2 pF Chip Capacitor | ATC100B1R2BT500XT | ATC |
| C16 | 24 pF Chip Capacitor | ATC100B240JT500XT | ATC |
| C17 | 470 pF Chip Capacitor | ATC800B471JT200XT | ATC |
| L1 | 47 nH Chip Inductor | 1812SMS-47NJLC | Coilcraft |
| L2 | 146 nH Chip Inductor | 1010VS-141NME | Coilcraft |
| R1 | 470 Ω, 1/4 W Chip Resistor | CRCW1206470RFKEA | Vishay |
| PCB | Rogers AD255C 0.030″, $\varepsilon_r$ = 2.55, 2 oz. Copper | D110614 | MTL |

## TYPICAL CHARACTERISTICS — 230 MHz, $T_C$ = 25°C
## NARROWBAND FIXTURE (MRF300AN)

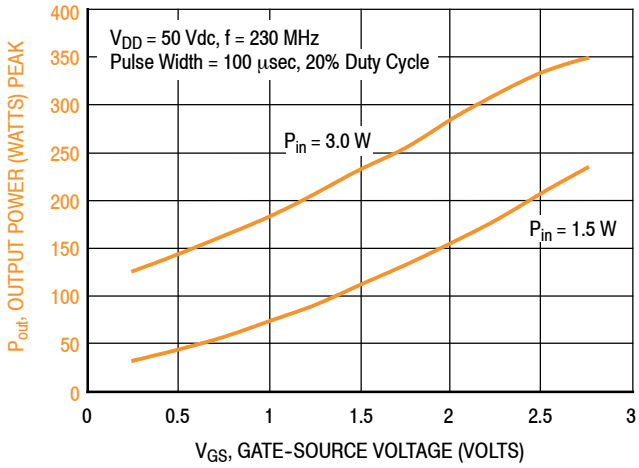
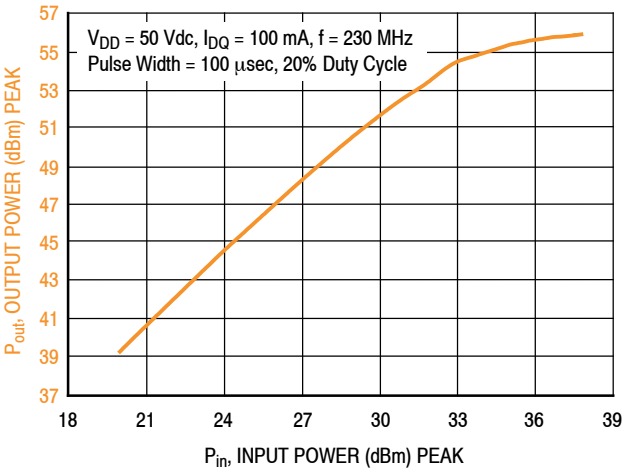



**Figure 9. Output Power versus Gate-Source Voltage at a Constant Input Power**




| f (MHz) | P1dB (W) | P3dB (W) |
|---|---|---|
| 230 | 334 | 382 |

**Figure 10. Output Power versus Input Power**

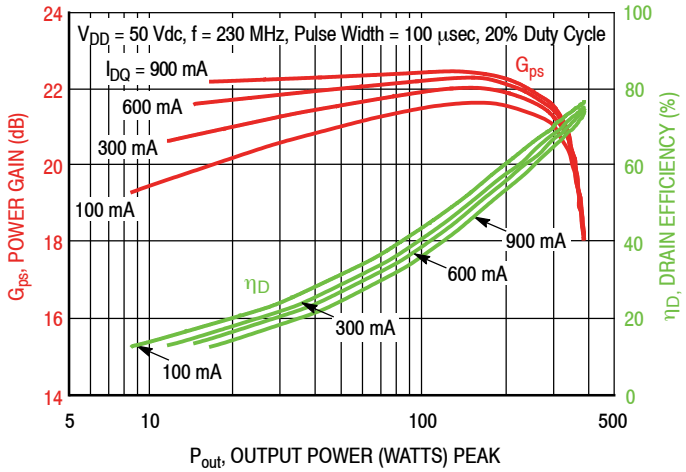



**Figure 11. Power Gain and Drain Efficiency versus Output Power and Quiescent Current**

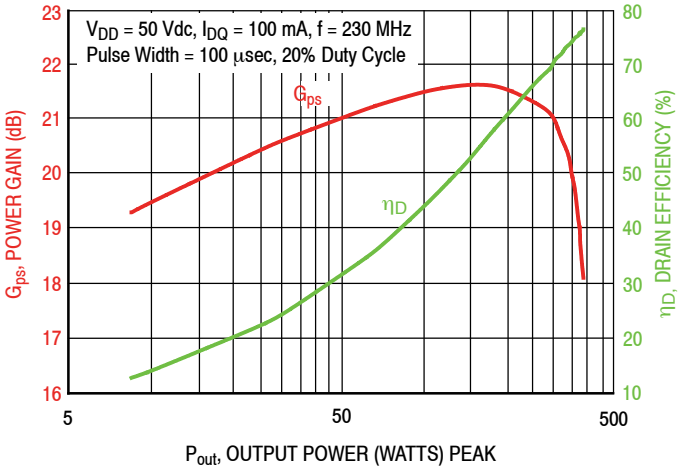



**Figure 12. Power Gain and Drain Efficiency versus Output Power**

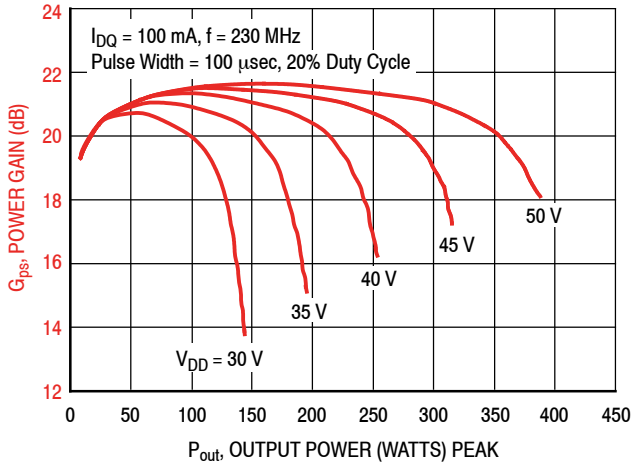



**Figure 13. Power Gain versus Output Power and Drain-Source Voltage**

## 230 MHz NARROWBAND FIXTURE (MRF300AN)

| f<br>MHz | $Z_{source}$<br>Ω | $Z_{load}$<br>Ω |
|---|---|---|
| 230 | 1.77 + j1.90 | 2.50 + j0.78 |

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

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

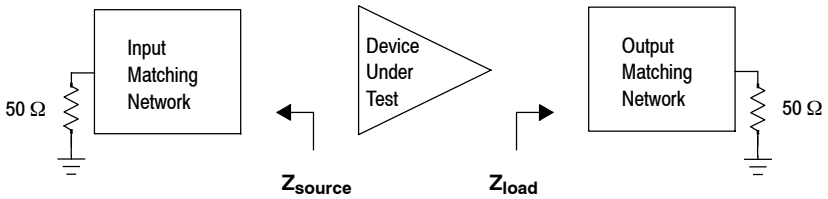
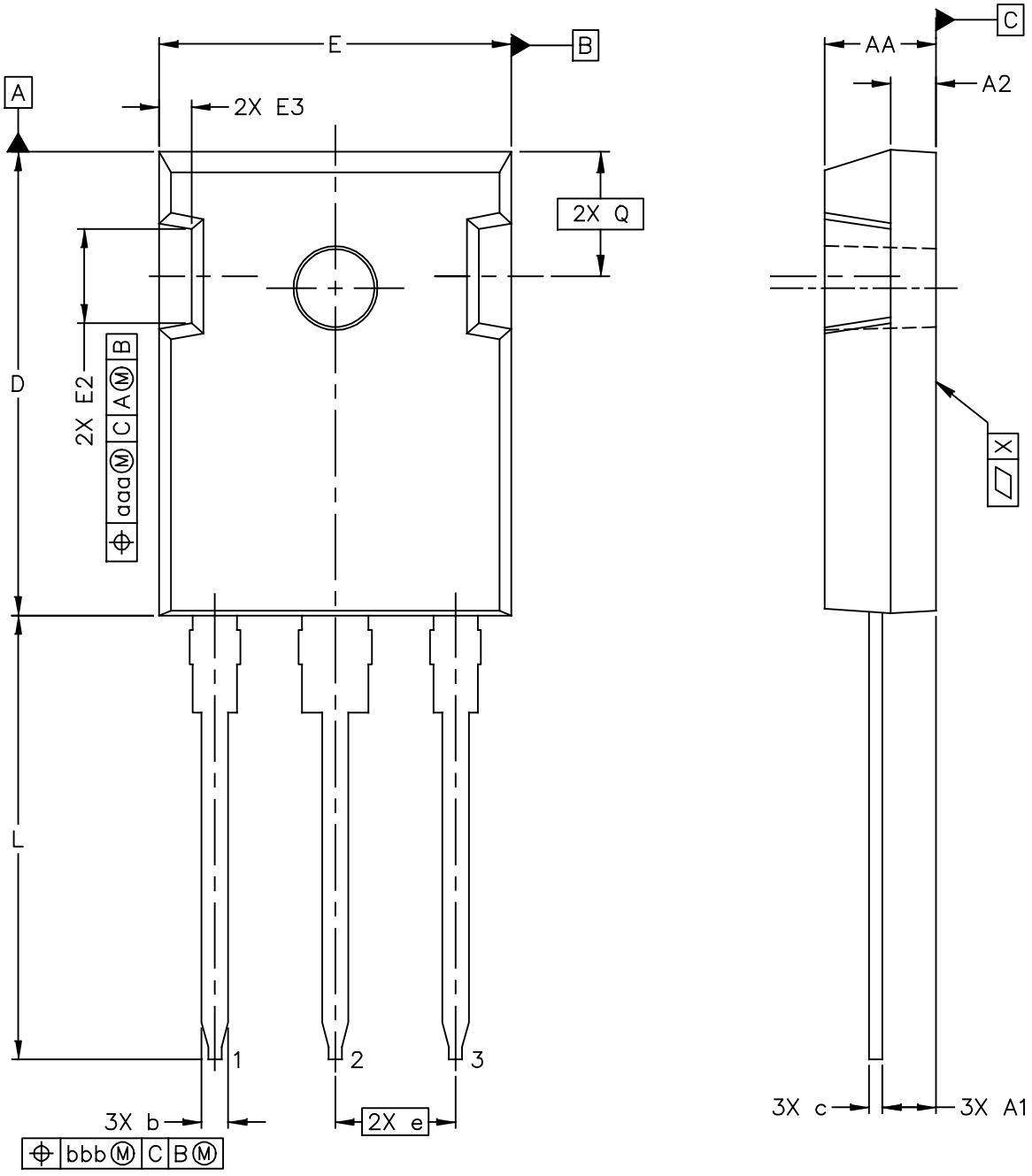



**Figure 14. Narrowband Series Equivalent Source and Load Impedance — 230 MHz**

## PACKAGE DIMENSIONS

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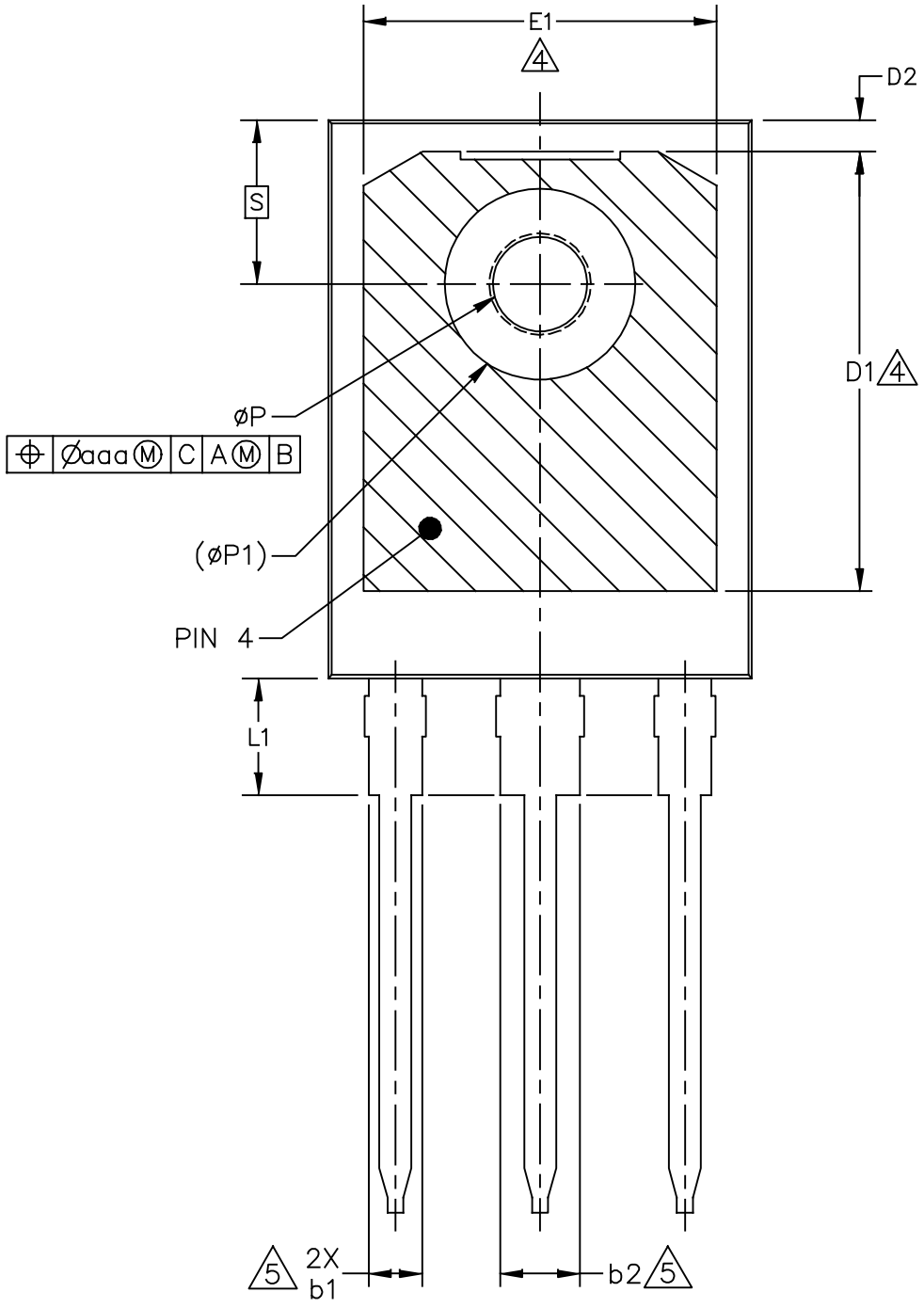
|---|---|---|
| TITLE: TO-247-3L | DOCUMENT NO: 98ASA01082D | REV: O |
| | STANDARD: NON-JEDEC | |
| | SOT1930-1 | 18 OCT 2017 |

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|---|---|---|
| TITLE: TO−247−3L | DOCUMENT NO: 98ASA01082D | REV: O |
| | STANDARD: NON−JEDEC | |
| | SOT1930−1 | 18 OCT 2017 |

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 D1 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 & b2 DO NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.15 MM (.006 INCH) PER SIDE IN EXCESS OF THE DIMENSIONS b1 & b2 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)

7. ø P TO HAVE MAXIMUM DRAFT ANGLE 1.5°.

| DIM | INCH MIN | INCH MAX | MILLIMETER MIN | MILLIMETER MAX | DIM | INCH MIN | INCH MAX | MILLIMETER MIN | MILLIMETER MAX |
|---|---|---|---|---|---|---|---|---|---|
| AA | .190 | .205 | 4.83 | 5.21 | E3 | .039 | .102 | 0.99 | 2.60 |
| A1 | .090 | .100 | 2.29 | 2.54 | e | .214 BSC | | 5.44 BSC | |
| A2 | .075 | .085 | 1.90 | 2.16 | L | .780 | .800 | 19.80 | 20.32 |
| b | .042 | .052 | 1.07 | 1.33 | L1 | --- | .173 | --- | 4.40 |
| b1 | .075 | .095 | 1.91 | 2.41 | P | .138 | .146 | 3.50 | 3.71 |
| b2 | .113 | .133 | 2.87 | 3.38 | P1 | --- | .291 | --- | 7.40 |
| c | .022 | .027 | 0.55 | 0.69 | Q | .228 BSC | | 5.79 BSC | |
| D | .819 | .831 | 20.80 | 21.11 | S | .242 BSC | | 6.15 BSC | |
| D1 | .515 | --- | 13.08 | --- | X | --- | .004 | --- | 0.01 |
| D2 | .020 | --- | 0.51 | --- | aaa | .025 | | 0.64 | |
| E | .618 | .635 | 15.70 | 16.13 | bbb | .010 | | 0.25 | |
| E1 | .487 | --- | 12.37 | --- | | | | | |
| E2 | .145 | .201 | 3.68 | 5.11 | | | | | |



MECHANICAL OUTLINE | PRINT VERSION NOT TO SCALE

TITLE: TO–247–3L

DOCUMENT NO: 98ASA01082D REV: O

STANDARD: 18 OCT 2017

SOT1930–1 18 OCT 2017

## PRODUCT DOCUMENTATION, SOFTWARE AND TOOLS

Refer to the following resources to aid your design process.

**Application Notes**

- AN1907: Solder Reflow Attach Method for High Power RF Devices in Over-Molded Plastic Packages
- 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 | May 2018 | • Initial release of data sheet |

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