Document Number: Order from RF Marketing
Rev. 1.0, 04/2017

RoHS

# RF Power LDMOS Transistor

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

**MRFX1K80H**

**PREPRODUCTION**

**1.8–470 MHz, 1800 W CW, 65 V WIDEBAND RF POWER LDMOS TRANSISTOR**

This high ruggedness device is designed for use in high VSWR industrial, medical, broadcast, aerospace and mobile radio applications. Its unmatched input and output design allows for wide frequency range use from 1.8 to 470 MHz.

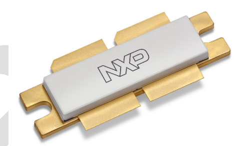
### Typical Performance

| Frequency (MHz) | Signal Type | $V_{DD}$ (V) | $P_{out}$ (W) | $G_{ps}$ (dB) | $\eta_D$ (%) |
|---|---|---|---|---|---|
| 27 (1) | CW | 50 | 1200 CW | 26.0 | 82.3 |
| | | 57.5 | 1520 CW | 27.0 | 80.1 |
| | | 65 | 1800 CW | 27.8 | 75.6 |
| 87.5–108 (2,3) | CW | 60 | 1550 CW | 21.9 | 82.2 |
| 144 | CW | 65 | 1800 CW | 23.5 | 77.5 |
| 230 (4) | Pulse (100 μsec, 20% Duty Cycle) | 65 | 1800 Peak | 24.0 | 74.0 |

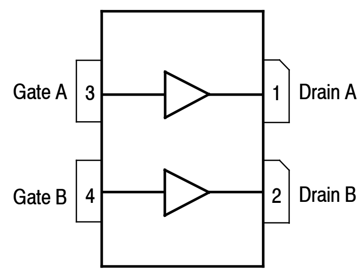
### Load Mismatch/Ruggedness

| Frequency (MHz) | Signal Type | VSWR | $P_{in}$ (W) | Test Voltage | Result |
|---|---|---|---|---|---|
| 230 | Pulse (100 μsec, 20% Duty Cycle) | > 65:1 at all Phase Angles | 14 W Peak (3 dB Overdrive) | 65 | No Device Degradation |

1. Data from 27 MHz narrowband reference circuit (page 4).
2. Data from 87.5–108 MHz broadband reference circuit (page 5).
3. The values shown are the center band performance numbers across the indicated frequency range.
4. Data from 230 MHz narrowband production test fixture (page 6).



NI-1230H-4S




(Top View)

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

**Figure 1. Pin Connections**

### Features

- Unmatched input and output allowing wide frequency range utilization
- Device can be used single-ended or in a push-pull configuration
- Qualified up to a maximum of 65 $V_{DD}$ operation
- Characterized from 30 to 65 V for extended power range
- High breakdown voltage for enhanced reliability
- Suitable for linear application with appropriate biasing
- Integrated ESD protection with greater negative gate-source voltage range for improved Class C operation
- Characterized with series equivalent large-signal impedance parameters
- Lower thermal resistance part available: MRFX1K80N
- 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, RF ablation and skin treatment
  - Industrial heating, welding and drying systems
- Radio and VHF TV broadcast
- Aerospace
  - VHF omnidirectional range (VOR)
  - HF communications
  - Weather radar

This document contains information on a preproduction product. Specifications and information herein are subject to change without notice.

## Table 1. Maximum Ratings

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Drain-Source Voltage | $V_{DSS}$ | –0.5, +182 | Vdc |
| Gate-Source Voltage | $V_{GS}$ | –6.0, +10 | 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) | $T_J$ | –40 to +225 | °C |
| Total Device Dissipation @ $T_C$ = 25°C<br>Derate above 25°C | $P_D$ | 2222 (2)<br>11.11 (2) | W<br>W/°C |

## Table 2. Thermal Characteristics

| Characteristic | Symbol | Value (3) | Unit |
|---|---|---|---|
| Thermal Resistance, Junction to Case<br>CW: Case Temperature 95°C, 1800 W CW, 65 Vdc, $I_{DQ(A+B)}$ = 150 mA, 98 MHz | $R_{\theta JC}$ | 0.09 (2) | °C/W |

## Table 3. Electrical Characteristics ($T_A$ = 25°C unless otherwise noted)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **Off Characteristics (4)** | | | | | |
| 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, $I_D$ = 100 mAdc) | $V_{(BR)DSS}$ | 182 | — | — | Vdc |
| Zero Gate Voltage Drain Leakage Current<br>($V_{DS}$ = 65 Vdc, $V_{GS}$ = 0 Vdc) | $I_{DSS}$ | — | — | 10 | μAdc |
| Zero Gate Voltage Drain Leakage Current<br>($V_{DS}$ = 182 Vdc, $V_{GS}$ = 0 Vdc) | $I_{DSS}$ | — | — | 100 | mAdc |
| **On Characteristics** | | | | | |
| Gate Threshold Voltage (4)<br>($V_{DS}$ = 10 Vdc, $I_D$ = 740 μAdc) | $V_{GS(th)}$ | 1.7 | 2.4 | 2.7 | Vdc |
| Gate Quiescent Voltage<br>($V_{DD}$ = 65 Vdc, $I_{D(A+B)}$ = 100 mAdc, Measured in Functional Test) | $V_{GS(Q)}$ | 2.3 | 2.8 | 3.3 | Vdc |
| Drain-Source On-Voltage (4)<br>($V_{GS}$ = 10 Vdc, $I_D$ = 2.76 Adc) | $V_{DS(on)}$ | — | 0.15 | — | Vdc |
| Forward Transconductance (4)<br>($V_{DS}$ = 10 Vdc, $I_D$ = 43 Adc) | $g_{fs}$ | — | 44.7 | — | S |

1. Continuous use at maximum temperature will affect MTTF.
2. Data is based on preliminary results and is subject to change.
3. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers.* Go to http://www.nxp.com/RF and search for AN1955.
4. Each side of device measured separately.

(continued)

**Table 3. Electrical Characteristics** ($T_A$ = 25°C unless otherwise noted) **(continued)**

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **Dynamic Characteristics** [1] | | | | | |
| Reverse Transfer Capacitance ($V_{DS}$ = 65 Vdc ± 30 mV(rms)ac @ 1 MHz, $V_{GS}$ = 0 Vdc) | $C_{rss}$ | — | 2.8 | — | pF |
| Output Capacitance ($V_{DS}$ = 65 Vdc ± 30 mV(rms)ac @ 1 MHz, $V_{GS}$ = 0 Vdc) | $C_{oss}$ | — | 201 | — | pF |
| Input Capacitance ($V_{DS}$ = 65 Vdc, $V_{GS}$ = 0 Vdc ± 30 mV(rms)ac @ 1 MHz) | $C_{iss}$ | — | 762 | — | pF |
| **Functional Tests** (In NXP Production Test Fixture, 50 ohm system) $V_{DD}$ = 65 Vdc, $I_{DQ(A+B)}$ = 100 mA, $P_{out}$ = 1800 W Peak (360 W Avg.), f = 230 MHz, 100 μsec Pulse Width, 20% Duty Cycle | | | | | |
| Power Gain | $G_{ps}$ | 23.0 | 24.0 | — | dB |
| Drain Efficiency | $\eta_D$ | 69.0 | 74.0 | — | % |
| Input Return Loss | IRL | — | –15 | –9 | dB |

**Table 4. Load Mismatch/Ruggedness** (In NXP Production Test Fixture, 50 ohm system) $I_{DQ(A+B)}$ = 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 | 14 W Peak (3 dB Overdrive) | 65 | No Device Degradation |

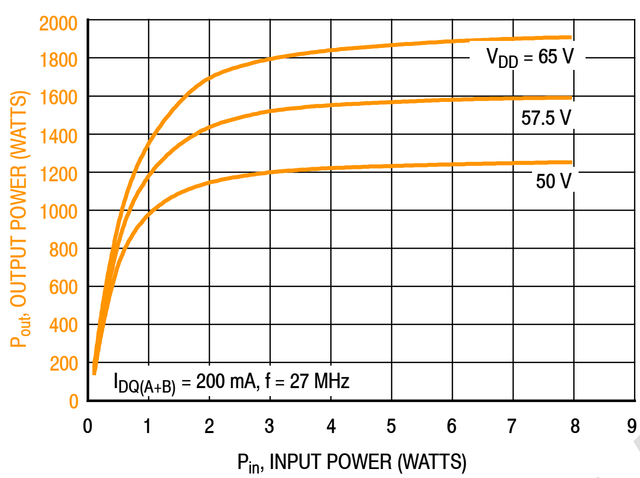
1. Each side of device measured separately.

## 27 MHz NARROWBAND REFERENCE CIRCUIT – 2.88″ × 6.91″ (73 mm × 176 mm)

**Table 5. 27 MHz Narrowband Performance** (In NXP Reference Circuit, 50 ohm system)
$I_{DQ(A+B)}$ = 200 mA, $P_{in}$ = 3 W, CW

| Frequency (MHz) | $V_{DD}$ (V) | $P_{out}$ (W) | $G_{ps}$ (dB) | $\eta_D$ (%) |
|---|---|---|---|---|
| 27 | 50 | 1200 | 26.0 | 82.3 |
| | 57.5 | 1520 | 27.0 | 80.1 |
| | 65 | 1800 | 27.8 | 75.6 |

## TYPICAL CHARACTERISTICS




| f (MHz) | $V_{DD}$ (V) | P1dB (W) | $P_{sat}$ (W) |
|---|---|---|---|
| 27 | 50 | 825 | 1250 |
| | 57.5 | 1010 | 1600 |
| | 65 | 1150 | 1900 |

**Figure 2. CW Output Power versus Input Power and Drain-Source Voltage**

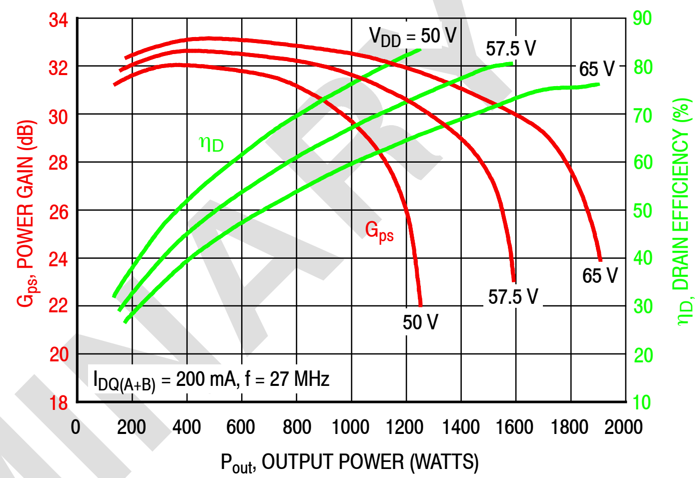



**Figure 3. Power Gain and Drain Efficiency versus CW Output Power and Drain-Source Voltage**

## 87.5–108 MHz BROADBAND REFERENCE CIRCUIT – 2.88″ × 5.12″ (73 mm × 130 mm)

**Table 6. 87.5–108 MHz Broadband Performance** (In NXP Reference Circuit, 50 ohm system)
$I_{DQ(A+B)}$ = 150 mA, $P_{in}$ = 10 W, CW

| Frequency (MHz) | $V_{DD}$ (V) | $P_{out}$ (W) | $G_{ps}$ (dB) | $\eta_D$ (%) |
|---|---|---|---|---|
| 87.5 | 60 | 1502 | 21.8 | 83.2 |
| 98 | 60 | 1556 | 21.9 | 82.2 |
| 108 | 60 | 1488 | 21.7 | 79.4 |

## TYPICAL CHARACTERISTICS

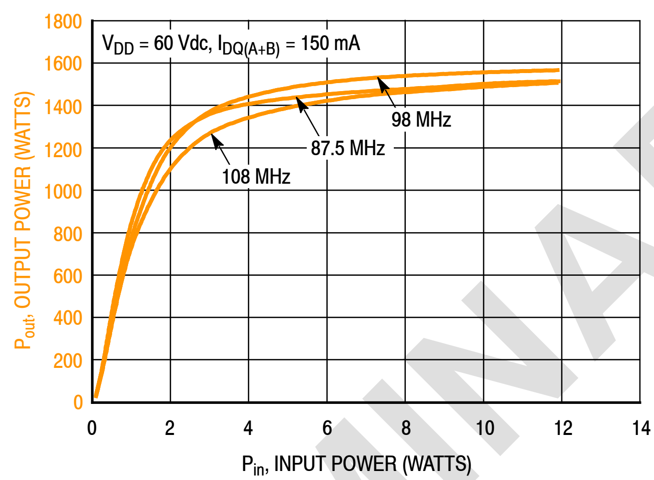



**Figure 4. CW Output Power versus Input Power and Frequency**

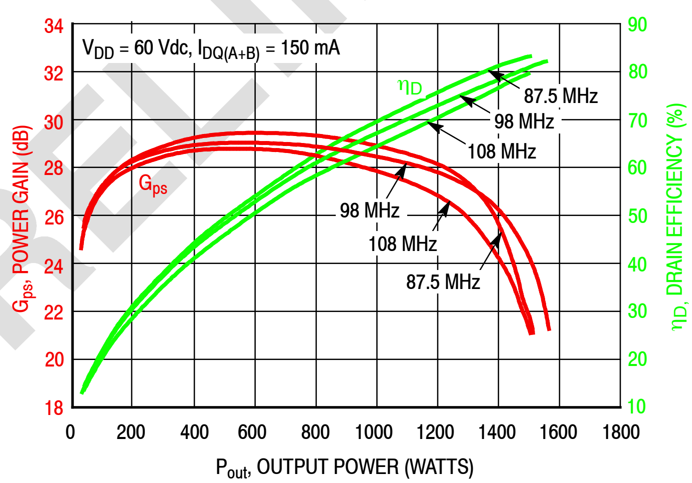
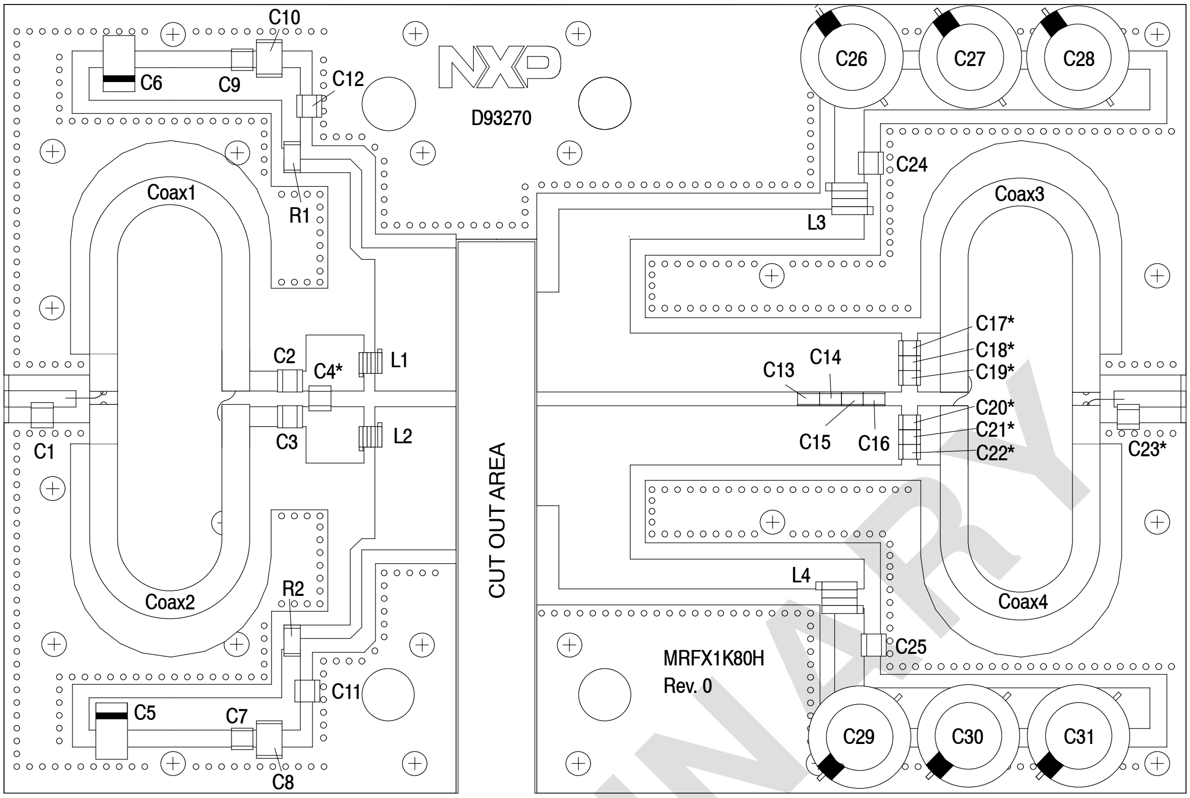



**Figure 5. Power Gain and Drain Efficiency versus CW Output Power and Frequency**

## 230 MHz NARROWBAND PRODUCTION TEST FIXTURE – 6.0″ × 4.0″ (152 mm × 102 mm)



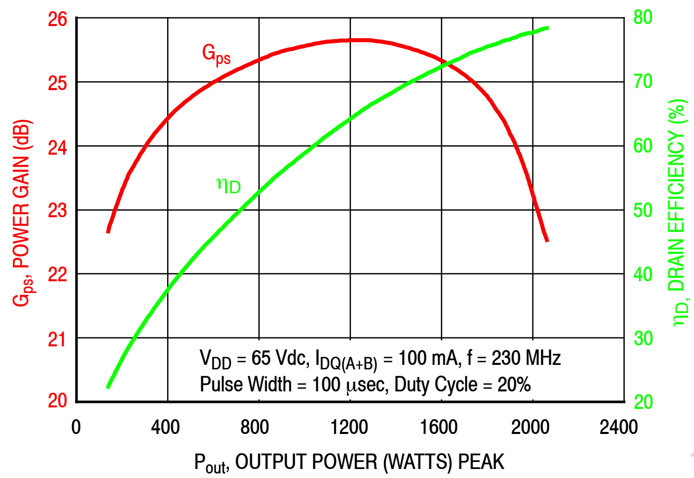

*C4, C17, C18, C19, C20, C21, C22 and C23 are mounted vertically.

**Figure 6. MRFX1K80H Narrowband Test Circuit Component Layout — 230 MHz**

**Table 7. MRFX1K80H Narrowband Test Circuit Component Designations and Values — 230 MHz**

| Part | Description | Part Number | Manufacturer |
|---|---|---|---|
| C1, C2, C3 | 22 pF Chip Capacitor | ATC100B220JT500XT | ATC |
| C4 | 27 pF Chip Capacitor | ATC100B270JT500XT | ATC |
| C5, C6 | 22 μF, 35 V Tantalum Capacitor | T491X226K035AT | Kemet |
| C7, C9 | 0.1 μF Chip Capacitor | CDR33BX104AKWS | AVX |
| C8, C10 | 220 nF Chip Capacitor | C1812C224K5RACTU | Kemet |
| C11, C12, C24, C25 | 1000 pF Chip Capacitor | ATC100B102JT50XT | ATC |
| C13 | 24 pF Chip Capacitor | ATC800R240JT500XT | ATC |
| C14, C15, C16 | 20 pF Chip Capacitor | ATC800R200JT500XT | ATC |
| C17, C18, C19, C20, C21, C22 | 240 pF Chip Capacitor | ATC100B241JT200XT | ATC |
| C23 | 7.5 pF Chip Capacitor | ATC100B7R5CT500XT | ATC |
| C26, C27, C28, C29, C30, C31 | 470 μF, 63 V Electrolytic Capacitor | MCGPR63V477M13X26-RH | Multicomp |
| Coax1, 2, 3, 4 | 25 Ω Semi Rigid Coax Cable, 2.2″ Shield Length | UT-141C-25 | Micro-Coax |
| L1, L2 | 5 nH Inductor | A02TKLC | Coilcraft |
| L3, L4 | 6.6 nH Inductor | GA3093-ALC | Coilcraft |
| R1, R2 | 10 Ω, 1/4 W Chip Resistor | CRCW120610R0JNEA | Vishay |
| PCB | Arlon AD255A 0.030″, $\varepsilon_r$ = 2.55 | D93270 | MTL |

# TYPICAL CHARACTERISTICS




| f (MHz) | P1dB (W) | P3dB (W) |
|---|---|---|
| 230 | 1800 | 2030 |

**Figure 7. Power Gain and Drain Efficiency versus Output Power**

| f MHz | $Z_{source}$ Ω | $Z_{load}$ Ω |
|---|---|---|
| 230 | 1.1 + j2.7 | 2.2 + j2.9 |

$Z_{source}$ = Test circuit impedance as measured from gate to gate, balanced configuration.

$Z_{load}$ = Test circuit impedance as measured from drain to drain, balanced configuration.

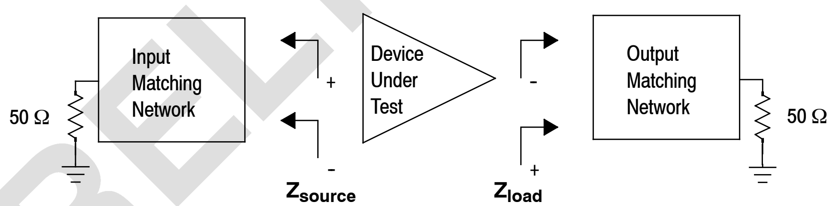
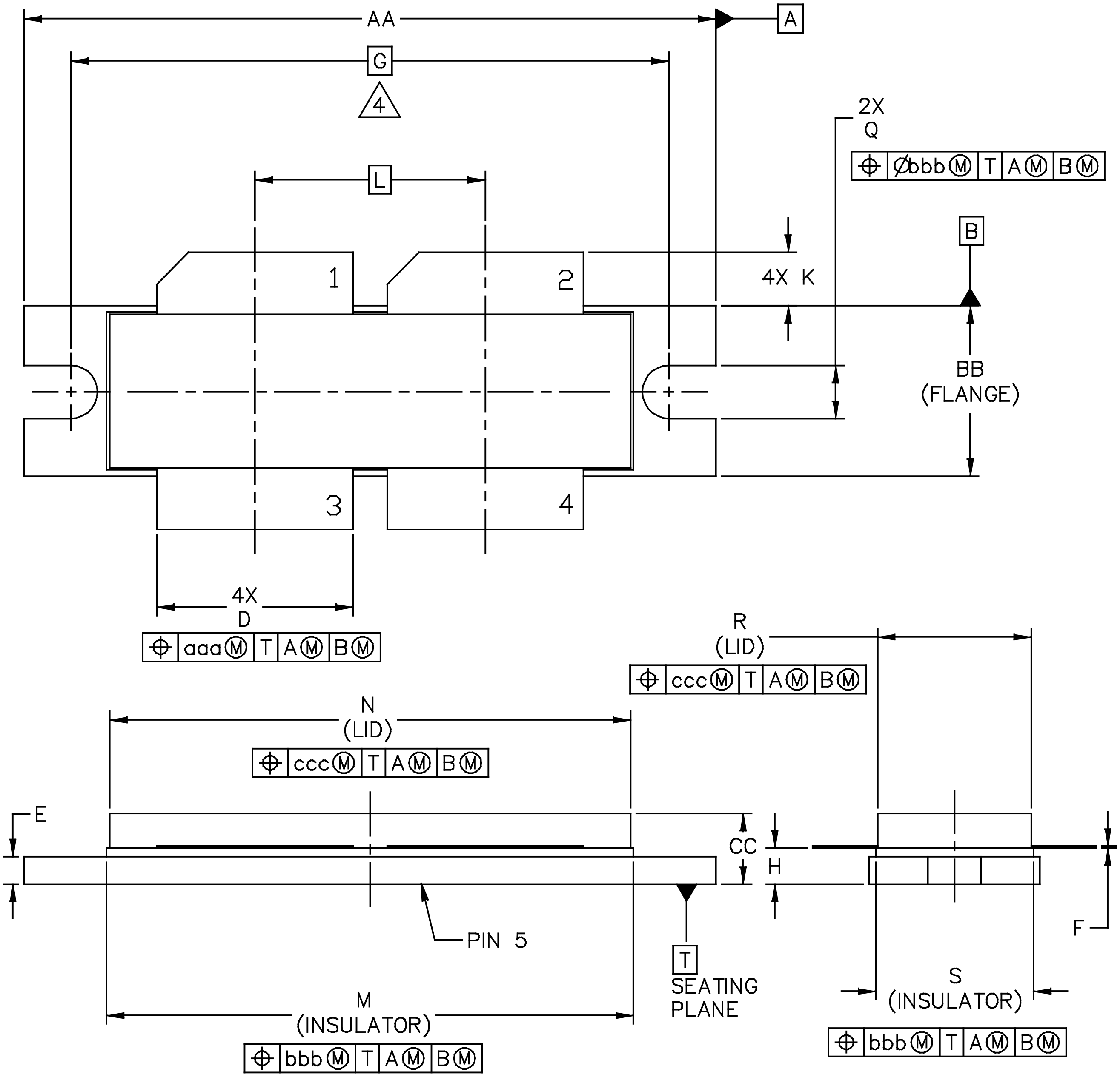



**Figure 8. Narrowband Series Equivalent Source and Load Impedance — 230 MHz**

## PACKAGE DIMENSIONS




| | | |
|---|---|---|
|  | MECHANICAL OUTLINE | PRINT VERSION NOT TO SCALE |
| TITLE: NI–1230–4H | DOCUMENT NO: 98ASB16977C | REV: G |
| | STANDARD: NON–JEDEC | |
| | SOT1787–1 | 03 MAR 2016 |

NOTES:

1. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
2. CONTROLLING DIMENSION: INCH
3. DIMENSION H IS MEASURED .030 INCH (0.762 MM) AWAY FROM PACKAGE BODY.
4. RECOMMENDED BOLT CENTER DIMENSION OF 1.52 INCH (38.61 MM) BASED ON M3 SCREW.

| DIM | INCH | | MILLIMETER | | DIM | INCH | | MILLIMETER | |
|---|---|---|---|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | | MIN | MAX | MIN | MAX |
| AA | 1.615 | 1.625 | 41.02 | 41.28 | N | 1.218 | 1.242 | 30.94 | 31.55 |
| BB | .395 | .405 | 10.03 | 10.29 | Q | .120 | .130 | 3.05 | 3.30 |
| CC | .170 | .190 | 4.32 | 4.83 | R | .355 | .365 | 9.02 | 9.27 |
| D | .455 | .465 | 11.56 | 11.81 | S | .365 | .375 | 9.27 | 9.53 |
| E | .062 | .066 | 1.57 | 1.68 | | | | | |
| F | .004 | .007 | 0.10 | 0.18 | | | | | |
| G | 1.400 BSC | | 35.56 BSC | | aaa | .013 | | 0.33 | |
| H | .082 | .090 | 2.08 | 2.29 | bbb | .010 | | 0.25 | |
| K | .117 | .137 | 2.97 | 3.48 | ccc | .020 | | 0.51 | |
| L | .540 BSC | | 13.72 BSC | | | | | | |
| M | 1.219 | 1.241 | 30.96 | 31.52 | | | | | |

| | | |
|---|---|---|
| © NXP SEMICONDUCTORS N.V. ALL RIGHTS RESERVED | MECHANICAL OUTLINE | PRINT VERSION NOT TO SCALE |
| TITLE: NI-1230-4H | DOCUMENT NO: 98ASB16977C | REV: G |
| | STANDARD: NON-JEDEC | |
| | SOT1787-1 | 03 MAR 2016 |

## *How to Reach Us:*

**Home Page:**
nxp.com

**Web Support:**
nxp.com/support

Information in this document is provided solely to enable system and software implementers to use NXP products. There are no express or implied copyright licenses granted hereunder to design or fabricate any integrated circuits based on the information in this document. NXP reserves the right to make changes without further notice to any products herein.

NXP makes no warranty, representation, or guarantee regarding the suitability of its products for any particular purpose, nor does NXP assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation consequential or incidental damages. "Typical" parameters that may be provided in NXP data sheets and/or specifications can and do vary in different applications, and actual performance may vary over time. All operating parameters, including "typicals," must be validated for each customer application by customer's technical experts. NXP does not convey any license under its patent rights nor the rights of others. NXP sells products pursuant to standard terms and conditions of sale, which can be found at the following address: nxp.com/SalesTermsandConditions.



Document Number: Order from RF Marketing
Rev. 1.0, 04/2017