

# RF Power LDMOS Transistor

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

This RF power transistor is designed for short pulse applications operating at frequencies from 850 to 950 MHz.

**Typical Performance:**  $V_{DD} = 50 \text{ Vdc}$ ,  $I_{DQ(A+B)} = 100 \text{ mA}$

| Frequency (MHz) | Signal Type                                     | $P_{out}$ (W) | $G_{ps}$ (dB) | $\eta_D$ (%) |
|-----------------|-------------------------------------------------|---------------|---------------|--------------|
| 950             | Pulse<br>(100 $\mu\text{sec}$ , 20% Duty Cycle) | 1050 Peak     | 21.3          | 63.7         |

### Load Mismatch/Ruggedness

| Frequency (MHz) | Signal Type                                     | VSWR                       | $P_{in}$ (W)                  | Test Voltage | Result                |
|-----------------|-------------------------------------------------|----------------------------|-------------------------------|--------------|-----------------------|
| 950             | Pulse<br>(100 $\mu\text{sec}$ , 20% Duty Cycle) | > 20:1 at all Phase Angles | 15 W Peak<br>(3 dB Overdrive) | 50           | No Device Degradation |

### Features

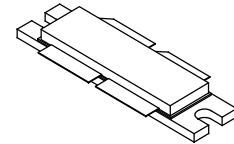
- Internally input and output matched for broadband operation and ease of use
- Device can be used in a single-ended, push-pull or quadrature configuration
- Qualified up to 50 V
- High ruggedness, handles > 20:1 VSWR
- Integrated ESD protection with greater negative voltage range for improved Class C operation and gate voltage pulsing
- Characterized with series equivalent large-signal impedance parameters

### Typical Applications

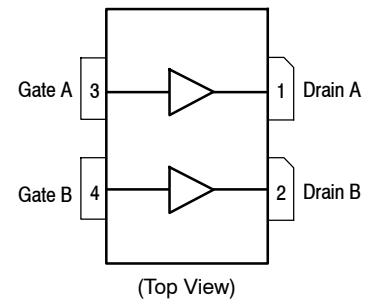
- Land- or sea-based UHF radar

**MMRF1050H**

**850–950 MHz, 1050 W PEAK, 50 V  
RF POWER LDMOS TRANSISTOR**



NI-1230H-4S



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                       | $V_{DS}$  | -0.5, +105  | Vdc  |
| Gate-Source Voltage                        | $V_{GS}$  | -6.0, +10   | Vdc  |
| Storage Temperature Range                  | $T_{stg}$ | -65 to +150 | °C   |
| Case Operating Temperature Range           | $T_C$     | -55 to 150  | °C   |
| Operating Junction Temperature Range (1,2) | $T_J$     | -55 to 225  | °C   |

**Table 2. Thermal Characteristics**

| Characteristic                                                                                                                                                          | Symbol          | Value (2,3) | Unit |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-------------|------|
| Thermal Impedance, Junction to Case<br>Pulse: Case Temperature 87°C, 1050 W Peak, 100 $\mu$ sec Pulse Width,<br>20% Duty Cycle, 50 Vdc, $I_{DQ(A+B)} = 100$ mA, 950 MHz | $Z_{\theta JC}$ | 0.034       | °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 1000 V |

**Table 4. Electrical Characteristics** ( $T_A = 25^\circ\text{C}$  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  | $\mu$ Adc |
| Drain-Source Breakdown Voltage<br>( $V_{GS} = 0$ Vdc, $I_D = 10$ $\mu$ A)          | $V_{(BR)DS}$ | 105 | — | —  | Vdc       |
| Zero Gate Voltage Drain Leakage Current<br>( $V_{DS} = 50$ Vdc, $V_{GS} = 0$ Vdc)  | $I_{DSS}$    | —   | — | 1  | $\mu$ Adc |
| Zero Gate Voltage Drain Leakage Current<br>( $V_{DS} = 105$ Vdc, $V_{GS} = 0$ Vdc) | $I_{DSS}$    | —   | — | 10 | $\mu$ Adc |

**On Characteristics**

|                                                                                                           |              |      |      |      |     |
|-----------------------------------------------------------------------------------------------------------|--------------|------|------|------|-----|
| Gate Threshold Voltage (4)<br>( $V_{DS} = 10$ Vdc, $I_D = 396$ $\mu$ Adc)                                 | $V_{GS(th)}$ | 1.3  | 1.7  | 2.3  | Vdc |
| Gate Quiescent Voltage (5)<br>( $V_{DD} = 50$ Vdc, $I_{DQ(A+B)} = 100$ mAdc, Measured in Functional Test) | $V_{GS(Q)}$  | 1.7  | 2.0  | 2.3  | Vdc |
| Drain-Source On-Voltage (4)<br>( $V_{GS} = 10$ Vdc, $I_D = 1.98$ Adc)                                     | $V_{DS(on)}$ | 0.05 | 0.14 | 0.35 | Vdc |

**Dynamic Characteristics (4)**

|                                                                                                   |           |   |      |   |    |
|---------------------------------------------------------------------------------------------------|-----------|---|------|---|----|
| Reverse Transfer Capacitance<br>( $V_{DS} = 50$ Vdc $\pm 30$ mV(rms)ac @ 1 MHz, $V_{GS} = 0$ Vdc) | $C_{rss}$ | — | 1.85 | — | pF |
|---------------------------------------------------------------------------------------------------|-----------|---|------|---|----|

1. Continuous use at maximum temperature will affect MTTF.
2. MTTF calculator available at <http://www.nxp.com>.
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.
5. Measurement made with device in push-pull configuration.

(continued)

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

| Characteristic                                                                                                                                                                                                                                                        | Symbol   | Min  | Typ   | Max  | Unit |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|------|-------|------|------|
| <b>Functional Tests</b> <sup>(1)</sup> (In NXP Production Test Fixture, 50 ohm system) $V_{DD} = 50\text{ Vdc}$ , $I_{DQ(A+B)} = 100\text{ mA}$ , $P_{out} = 1050\text{ W Peak}$ (210 W Avg.), $f = 950\text{ MHz}$ , 100 $\mu\text{sec}$ Pulse Width, 20% Duty Cycle |          |      |       |      |      |
| Power Gain                                                                                                                                                                                                                                                            | $G_{ps}$ | 19.0 | 21.3  | 23.5 | dB   |
| Drain Efficiency                                                                                                                                                                                                                                                      | $\eta_D$ | 57.0 | 63.7  | —    | %    |
| Input Return Loss                                                                                                                                                                                                                                                     | IRL      | —    | -18.5 | -9.0 | dB   |

**Table 5. Load Mismatch/Ruggedness** (In NXP Production Test Fixture, 50 ohm system)  $I_{DQ(A+B)} = 100\text{ mA}$ 

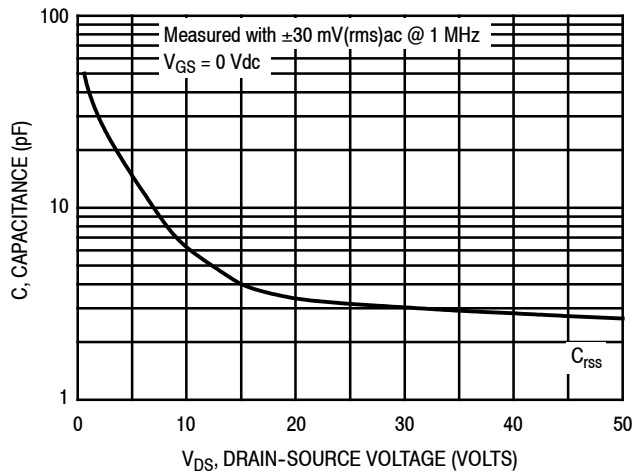
| Frequency (MHz) | Signal Type                                        | VSWR                          | $P_{in}$ (W)                  | Test Voltage, $V_{DD}$ | Result                   |
|-----------------|----------------------------------------------------|-------------------------------|-------------------------------|------------------------|--------------------------|
| 950             | Pulse<br>(100 $\mu\text{sec}$ ,<br>20% Duty Cycle) | > 20:1 at all<br>Phase Angles | 15 W Peak<br>(3 dB Overdrive) | 50                     | No Device<br>Degradation |

**Table 6. Ordering Information**

| Device      | Tape and Reel Information                             | Package     |
|-------------|-------------------------------------------------------|-------------|
| MMRF1050HR6 | R6 Suffix = 150 Units, 56 mm Tape Width, 13-inch Reel | NI-1230H-4S |

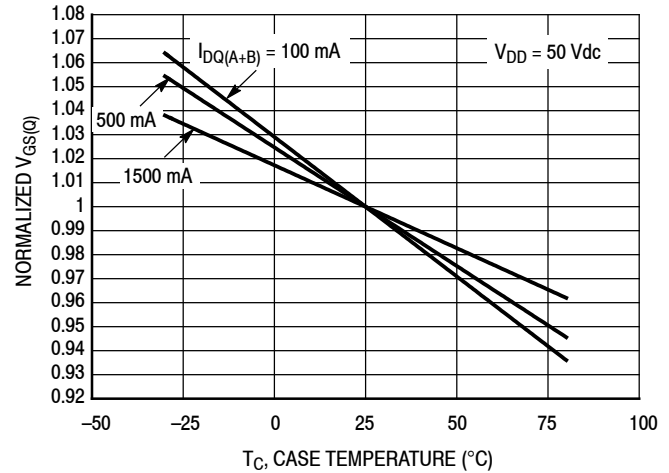
1. Measurement made with device in push-pull configuration.

## TYPICAL CHARACTERISTICS



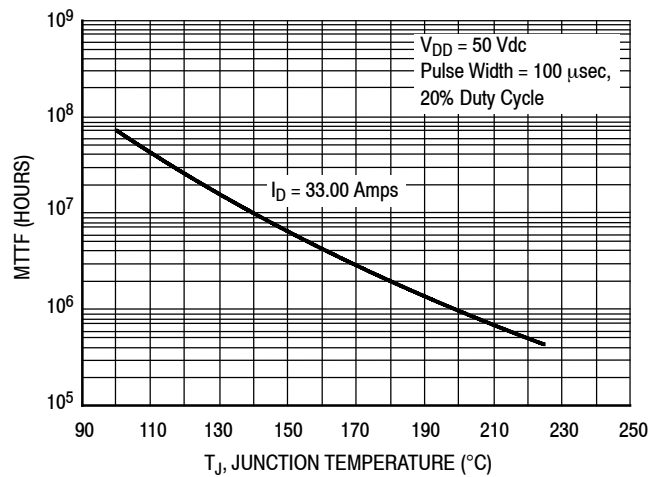
**Note:** Each side of device measured separately.

**Figure 2. Capacitance versus Drain-Source Voltage**



| $I_{DQ}$ (mA) | Slope (mV/°C) |
|---------------|---------------|
| 100           | -2.36         |
| 500           | -2.26         |
| 1500          | -1.84         |

**Figure 3. Normalized  $V_{GS}$  versus Quiescent Current and Case Temperature**

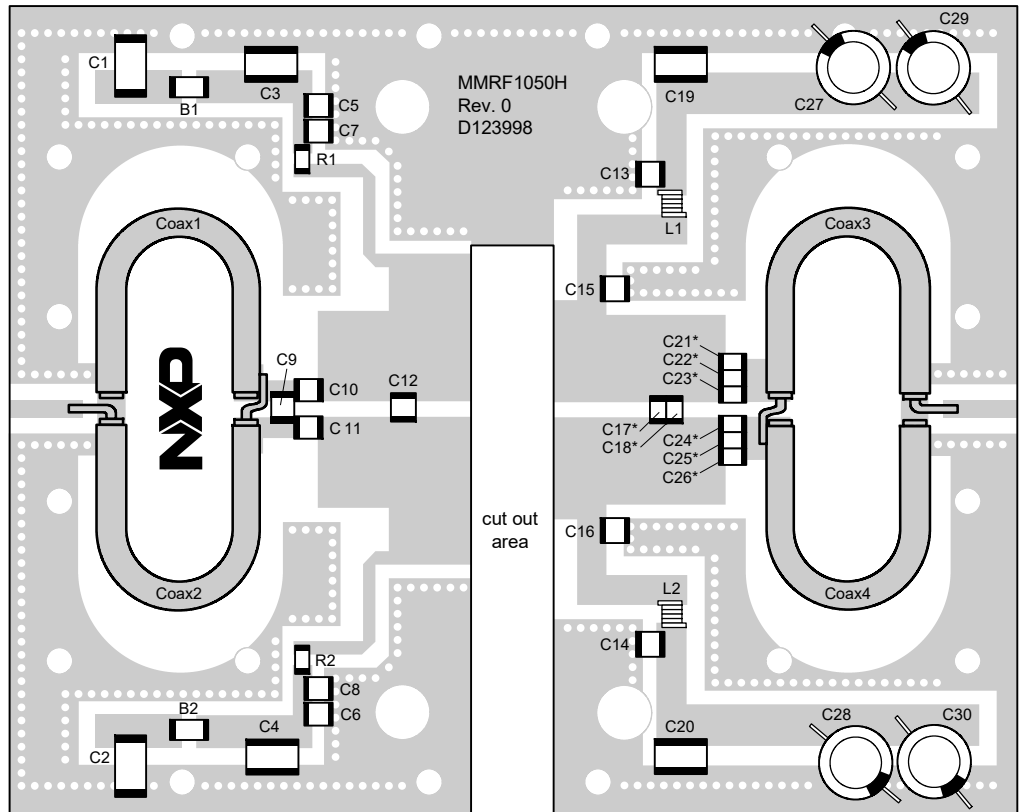


**Note:** MTTF value represents the total cumulative operating time under indicated test conditions.

MTTF calculator available at <http://www.nxp.com>.

**Figure 4. MTTF versus Junction Temperature — Pulse**

# 950 MHz PRODUCTION FIXTURE — 4" × 5" (10.2 cm × 12.7 cm)



\* C17, C18, C21, C22, C23, C24, C25 and C26 are mounted vertically.

aaa-039673

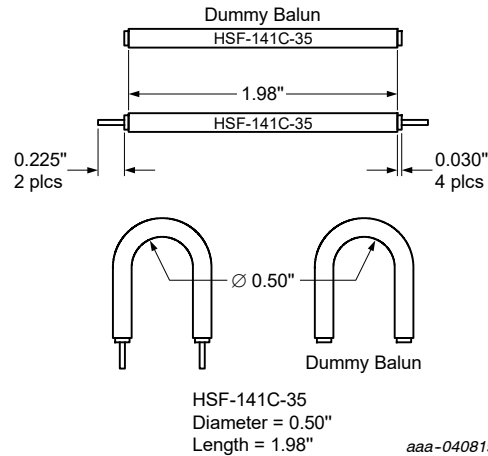
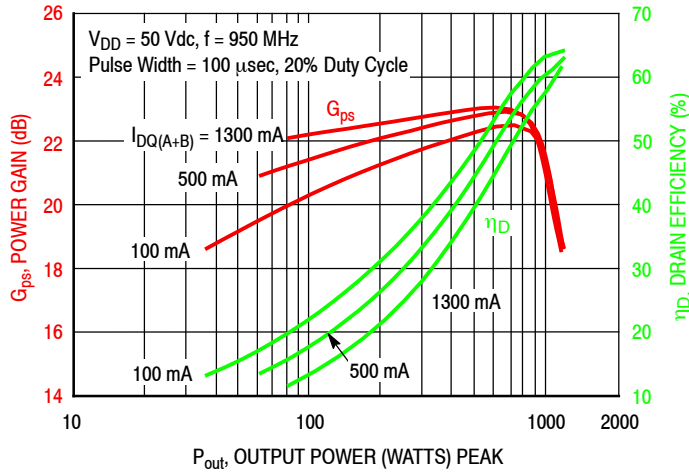


Figure 5. MMRF1050H Production Fixture Component Layout — 950 MHz

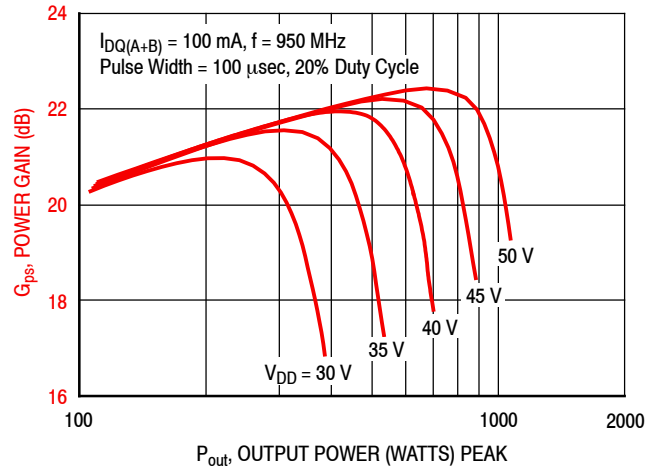
**Table 7. MMRF1050H Production Fixture Component Designations and Values — 950 MHz**

| Part                         | Description                                           | Part Number       | Manufacturer     |
|------------------------------|-------------------------------------------------------|-------------------|------------------|
| B1, B2                       | Short RF Bead                                         | 2743019447        | Fair-Rite        |
| C1, C2                       | 22 $\mu$ F, 35 V Tantalum Capacitor                   | T491X226K035AS    | Kemet            |
| C3, C4                       | 2.2 $\mu$ F Chip Capacitor                            | C1825C225J5RACTU  | Kemet            |
| C5, C6                       | 0.1 $\mu$ F Chip Capacitor                            | CDR33BX104AKWS    | AVX              |
| C7, C8, C13, C14             | 36 pF Chip Capacitor                                  | 100B360JT500XT    | ATC              |
| C9                           | 2.7 pF Chip Capacitor                                 | 100B2R7BT500XT    | ATC              |
| C10, C11                     | 30 pF Chip Capacitor                                  | 100B300JT500XT    | ATC              |
| C12                          | 6.2 pF Chip Capacitor                                 | 100B6R2BT500XT    | ATC              |
| C15, C16                     | 8.2 pF Chip Capacitor                                 | 100B8R2CT500XT    | ATC              |
| C17, C18                     | 4.7 pF Chip Capacitor                                 | 100B4R7CT500XT    | ATC              |
| C19, C20                     | 0.01 $\mu$ F Chip Capacitor                           | C1825C103K1GAC-TU | Kemet            |
| C21, C22, C23, C24, C25, C26 | 43 pF Chip Capacitor                                  | 100B430JT500XT    | ATC              |
| C27, C28, C29, C30           | 470 $\mu$ F, 63 V Electrolytic Capacitor              | MCGPR63V477M13X26 | Multicomp        |
| Coax1, 2, 3, 4               | 35 $\Omega$ Semirigid Coax Cable, 1.98" Shield Length | HSF-141C-35       | Hangzhou Hongsen |
| L1, L2                       | 12 nH, 3 Turn Inductor                                | GA3094-ALC        | Coilcraft        |
| Q1                           | RF Power LDMOS Transistor                             | MMRF1050H         | NXP              |
| R1, R2                       | 1000 $\Omega$ , 1/4 W Chip Resistor                   | CRCW12061K00FKEA  | Vishay           |
| PCB                          | Arlon 450 0.030", $\epsilon_r = 2.55$ , 2 oz. Copper  | D123998           | MTL              |

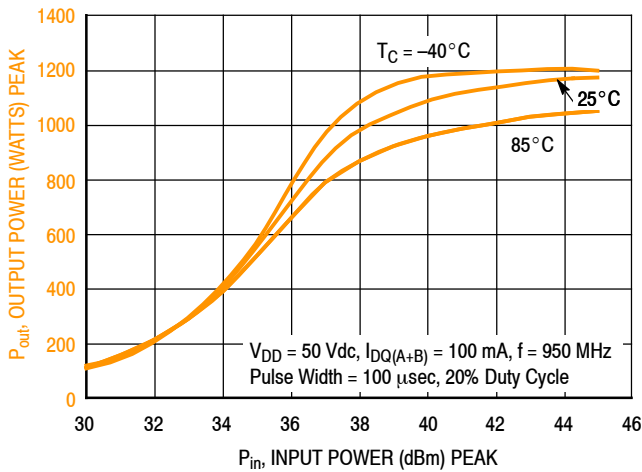
**TYPICAL CHARACTERISTICS — 950 MHz,  $T_C = 25^\circ\text{C}$**   
**PRODUCTION TEST FIXTURE**



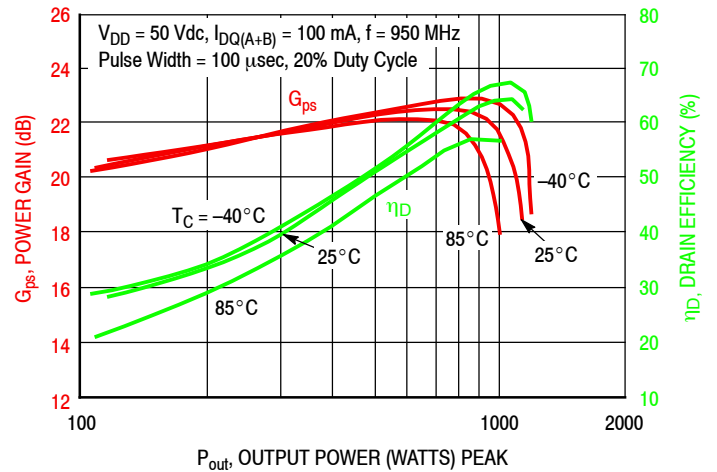
**Figure 6. Power Gain and Drain Efficiency versus Output Power and Quiescent Current**



**Figure 7. Power Gain versus Output Power and Drain-Source Voltage**



**Figure 8. Output Power versus Input Power over Temperature**



**Figure 9. Power Gain and Drain Efficiency versus Output Power over Temperature**

## PRODUCTION FIXTURE

### Band-Specific Optimized Performance and Impedance Information ( $T_C = 25^\circ\text{C}$ )

The measured input and output impedances are presented to the input of the device at the package reference plane. Measurements are performed in NXP optimally tuned fixtures in the frequency ranges of 850 and 950 MHz.

| f<br>(MHz) | $Z_{\text{source}}$<br>( $\Omega$ ) | $Z_{\text{load}}$<br>( $\Omega$ ) |
|------------|-------------------------------------|-----------------------------------|
| 850        | $3.0 - j3.1$                        | $4.3 - j2.0$                      |
| 950        | $6.2 - j2.9$                        | $4.0 - j1.1$                      |

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

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

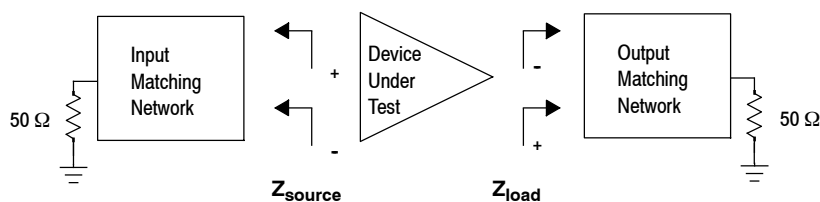
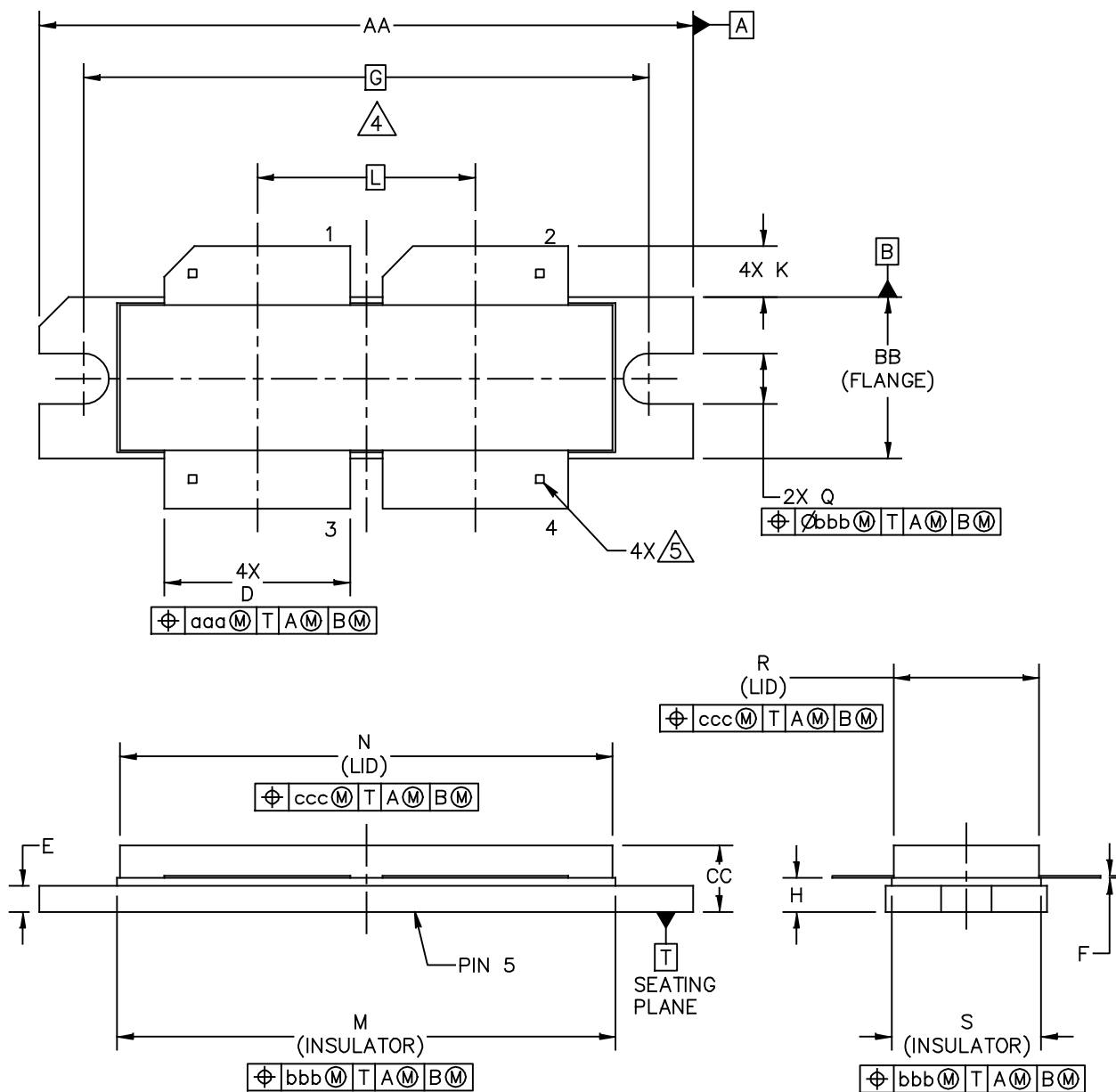


Figure 10. Series Equivalent Source and Load Impedance

## PACKAGE INFORMATION

H-CFM-F-5 I/O 41.15 X 10.16 X 4.575 PKG, 13.72 PITCH – 4S  
NI-1230H-4S

SOT1787-1



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| MECHANICAL OUTLINE<br>PRINT VERSION NOT TO SCALE | STANDARD:<br>NON JEDEC | DRAWING NUMBER:<br>98ASB16977C | REVISION:<br>H | PAGE:<br>1 OF 2 |
|--------------------------------------------------|------------------------|--------------------------------|----------------|-----------------|
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MMRF1050H

## 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 THE FLANGE TO CLEAR THE EPOXY FLOW OUT REGION PARALLEL TO DATUM B.

4. RECOMMENDED BOLT CENTER DIMENSION OF 1.52 INCH (38.61 MM) BASED ON M3 SCREW.

5. FIDUCIALS ARE OPTIONAL ON PINS 3 & 4.

| 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 |     |       |       |            |       |

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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

- Electromigration MTTF Calculator
- .s2p File

### Development Tools

- Printed Circuit Boards

## REVISION HISTORY

The following table summarizes revisions to this document.

| Revision | Date      | Description                                                                     |
|----------|-----------|---------------------------------------------------------------------------------|
| 0        | Feb. 2021 | <ul style="list-style-type: none"><li>• Initial release of data sheet</li></ul> |

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