



RF Power LDMOS Transistor

High Ruggedness N-Channel Enhancement-Mode Lateral MOSFET

This high ruggedness device is designed for use in high VSWR industrial, scientific and medical applications and sub-GHz aerospace and defense and mobile radio applications. Its unmatched input and output design allows for wide frequency range use from 1.8 to 1215 MHz.

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

| Frequency (MHz) | Signal Type | P_{out} (W) | G_{ps} (dB) | η_D (%) |
|-----------------|-------------|---------------|---------------|--------------|
| 30–520 (1,2) | CW | 50 CW | 14.0 | 40.0 |
| 520 (3) | CW | 85 CW | 25.6 | 73.3 |

Load Mismatch/Ruggedness

| Frequency (MHz) | Signal Type | VSWR | P_{in} (W) | Test Voltage | Result |
|-----------------|-------------|-------------------------------|--------------------------|--------------|-----------------------|
| 520 (3) | CW | > 65:1 at all Phase Angles | 0.56 (3 dB Overdrive) | 50 | No Device Degradation |

1. Measured in 30–520 MHz broadband reference circuit.
2. The values shown are the minimum measured performance numbers across the indicated frequency range.
3. Measured in 520 MHz narrowband test circuit (page 5).

Features

- Unmatched input and output allowing wide frequency range utilization
- Device can be used single-ended or in a push-pull configuration
- Characterized from 30 to 50 V for ease of use
- Suitable for linear application
- Integrated ESD protection with greater negative gate-source voltage range for improved Class C operation

Typical Applications

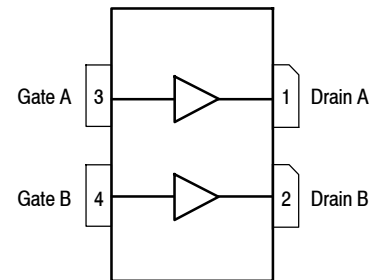
- Industrial, scientific, medical (ISM)
 - Laser generation
 - Plasma etching
 - Particle accelerators
 - Industrial heating, welding and drying systems
- Broadcast
 - Radio broadcast
 - VHF TV broadcast
- Aerospace
 - VHF omnidirectional range (VOR)
 - HF and VHF communications
 - Weather radar
- Mobile radio
 - VHF and UHF radios

MRF085H

**1.8–1215 MHz, 85 W CW, 50 V
 WIDEBAND
 RF POWER LDMOS TRANSISTOR**



NI-650H-4L



(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} | -0.5, +133 | Vdc |
| Gate-Source Voltage | V_{GS} | -6.0, +10 | Vdc |
| Operating Voltage | V_{DD} | 50, +0 | 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 +225 | °C |
| Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C | P_D | 235 1.18 | W W/°C |

Table 2. Thermal Characteristics

| Characteristic | Symbol | Value (2,3) | Unit |
|--|-----------------|-------------|------|
| Thermal Resistance, Junction to Case CW: Case Temperature 85°C , 85 W CW, 50 Vdc, $I_{DQ(A+B)} = 100\text{ mA}$, 520 MHz | $R_{\theta JC}$ | 0.85 | °C/W |

Table 3. ESD Protection Characteristics

| Test Methodology | Class |
|---------------------------------------|------------------|
| Human Body Model (per JESD22-A114) | 2, passes 2000 V |
| Charge Device Model (per JESD22-C101) | C2, passes 500 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 ($V_{GS} = 5\text{ Vdc}$, $V_{DS} = 0\text{ Vdc}$) | I_{GSS} | — | — | 400 | nAdc |
| Drain-Source Breakdown Voltage ($V_{GS} = 0\text{ Vdc}$, $I_D = 50\text{ mA}$) | $V_{(BR)DSS}$ | 133 | — | — | Vdc |
| Zero Gate Voltage Drain Leakage Current ($V_{DS} = 50\text{ Vdc}$, $V_{GS} = 0\text{ Vdc}$) | I_{DSS} | — | — | 2 | μAdc |
| Zero Gate Voltage Drain Leakage Current ($V_{DS} = 100\text{ Vdc}$, $V_{GS} = 0\text{ Vdc}$) | I_{DSS} | — | — | 7 | μAdc |

On Characteristics

| | | | | | |
|--|--------------|-----|------|-----|-----|
| Gate Threshold Voltage (4) ($V_{DS} = 10\text{ Vdc}$, $I_D = 85\ \mu\text{Adc}$) | $V_{GS(th)}$ | 1.5 | 2.0 | 3.0 | Vdc |
| Gate Quiescent Voltage ($V_{DD} = 50\text{ Vdc}$, $I_{D(A+B)} = 100\text{ mAdc}$, Measured in Functional Test) | $V_{GS(Q)}$ | 2.0 | 2.6 | 3.3 | Vdc |
| Drain-Source On-Voltage (4) ($V_{GS} = 10\text{ Vdc}$, $I_D = 210\text{ mAdc}$) | $V_{DS(on)}$ | — | 0.27 | — | Vdc |

Dynamic Characteristics (4)

| | | | | | |
|---|-----------|---|------|---|----|
| Reverse Transfer Capacitance ($V_{DS} = 50\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$) | C_{rss} | — | 0.17 | — | pF |
| Output Capacitance ($V_{DS} = 50\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$) | C_{oss} | — | 14.7 | — | pF |
| Input Capacitance ($V_{DS} = 50\text{ Vdc}$, $V_{GS} = 0\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz) | C_{iss} | — | 39.0 | — | pF |

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.
4. Each side of device measured separately.

(continued)

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

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|----------|------|------|------|------|
| Functional Tests (In NXP Test Fixture, 50 ohm system) $V_{DD} = 50\text{ Vdc}$, $I_{DQ(A+B)} = 100\text{ mA}$, $P_{out} = 85\text{ W CW}$, $f = 520\text{ MHz}$ | | | | | |
| Power Gain | G_{ps} | 24.0 | 25.6 | 28.0 | dB |
| Drain Efficiency | η_D | 70.0 | 73.3 | — | % |
| Input Return Loss | IRL | — | -21 | -9 | dB |

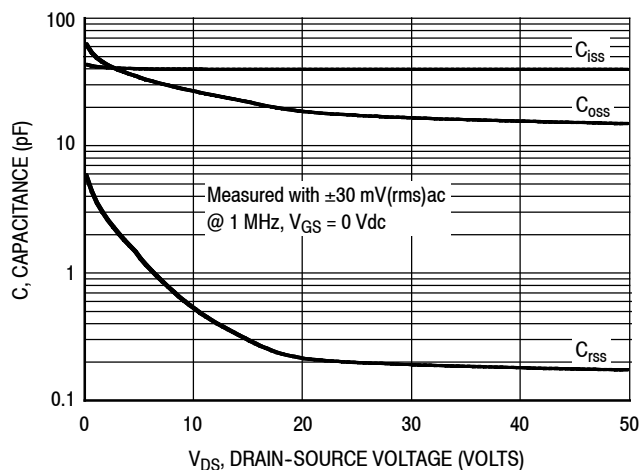
Load Mismatch/Ruggedness (In NXP Test Fixture, 50 ohm system) $I_{DQ} = 150\text{ mA}$

| Frequency (MHz) | Signal Type | VSWR | P_{in} (W) | Test Voltage, V_{DD} | Result |
|-----------------|-------------|-------------------------------|--------------------------|------------------------|-----------------------|
| 520 | CW | > 65:1 at all Phase Angles | 0.56 (3 dB Overdrive) | 50 | No Device Degradation |

Table 5. Ordering Information

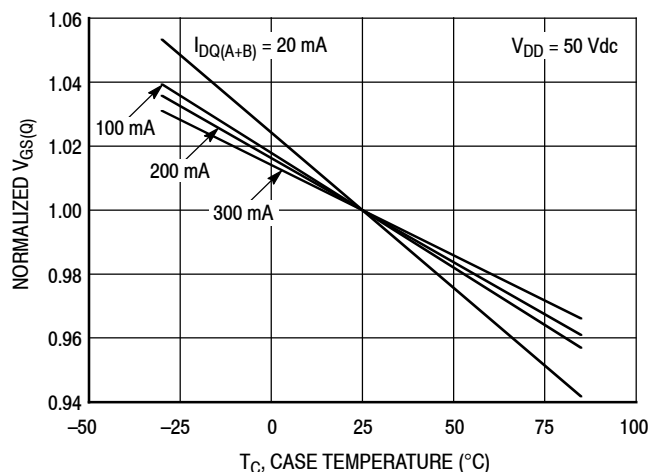
| Device | Tape and Reel Information | Package |
|-----------|---|------------|
| MRF085HR3 | R3 Suffix = 250 Units, 44 mm Tape Width, 13-inch Reel | NI-650H-4L |
| MRF085HR5 | R5 Suffix = 50 Units, 44 mm Tape Width, 13-inch Reel | NI-650H-4L |

TYPICAL CHARACTERISTICS



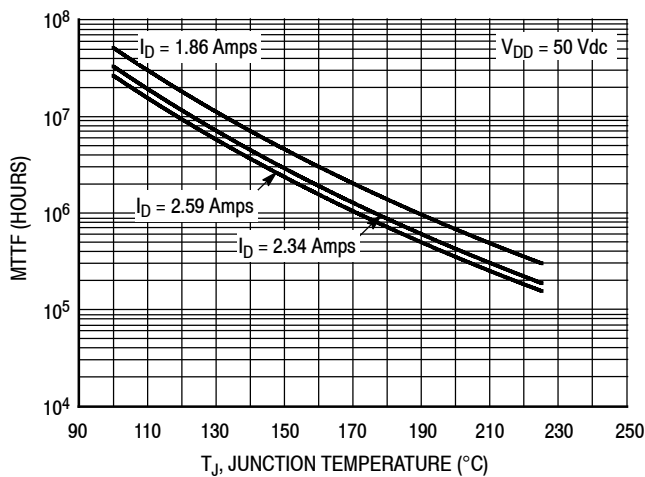
Note: Each side of device measured separately.

Figure 2. Capacitance versus Drain-Source Voltage



| I_{DQ} (mA) | Slope (mV/°C) |
|---------------|---------------|
| 20 | -2.35 |
| 100 | -1.88 |
| 200 | -1.78 |
| 300 | -1.59 |

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/RF/calculators>.

Figure 4. MTTF versus Junction Temperature – CW

520 MHz NARROWBAND PRODUCTION TEST FIXTURE – 4.0" x 5.0" (10.2 mm x 12.7 mm)

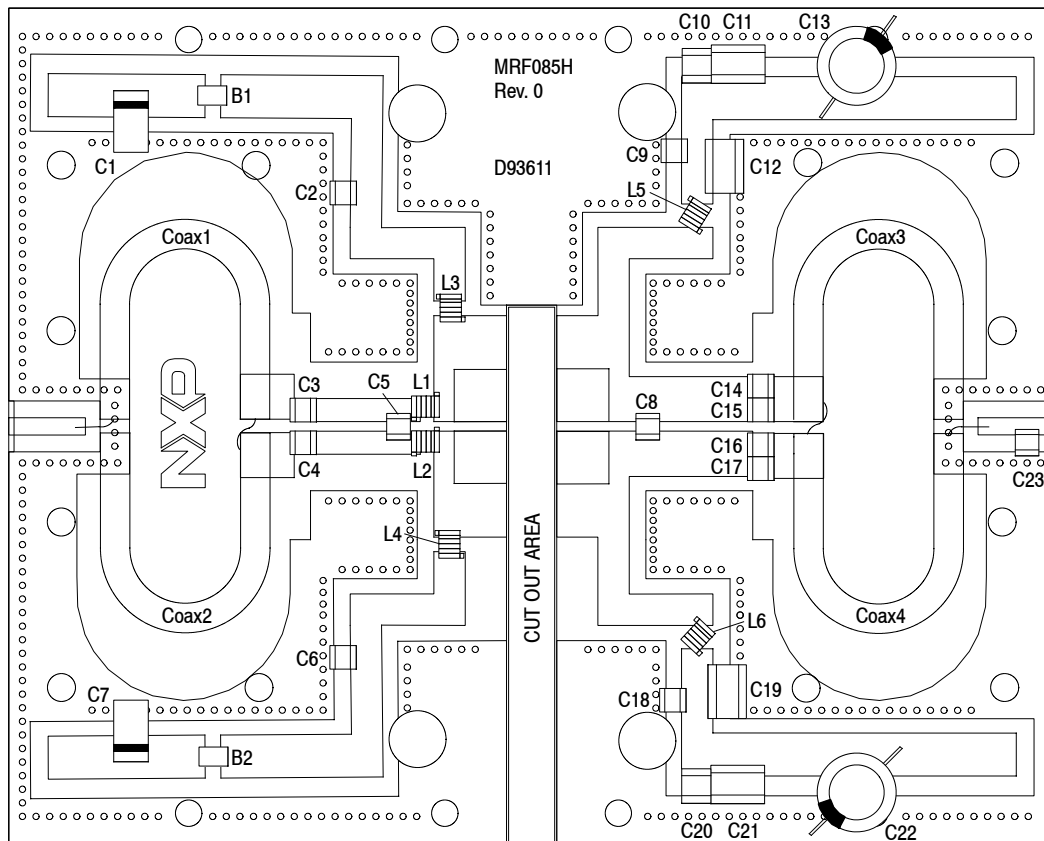
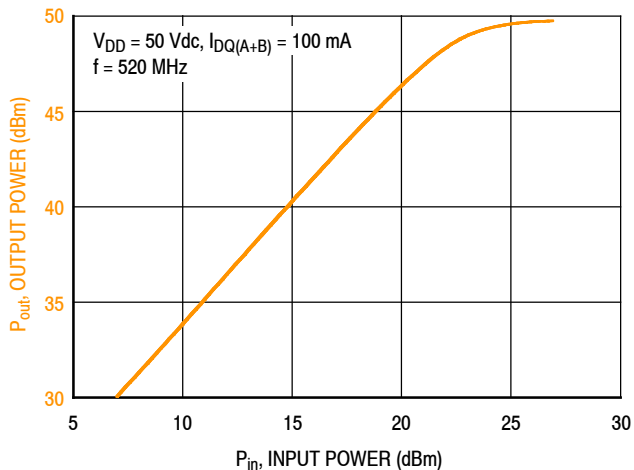


Figure 5. MRF085H Narrowband Test Circuit Component Layout – 520 MHz

Table 6. MRF085H Narrowband Test Circuit Component Designations and Values – 520 MHz

| Part | Description | Part Number | Manufacturer |
|--------------------|---|-----------------------|------------------------|
| B1, B2 | Short RF Bead | 2743019447 | Fair-Rite |
| C1, C7 | 22 μ F, 35 V Tantalum Capacitor | T491X226K035AT | Kemet |
| C2, C6, C9, C18 | 240 pF Chip Capacitor | ATC100B241JT200XT | ATC |
| C3, C4 | 51 pF Chip Capacitor | ATC100B510GT500XT | ATC |
| C5 | 36 pF Chip Capacitor | ATC100B360JT500XT | ATC |
| C8 | 5.1 pF Chip Capacitor | ATC100B5R1CT500XT | ATC |
| C10, C20 | 10 pF Chip Capacitor | ATC200B103KT50XT | ATC |
| C11, C21 | 0.01 μ F Chip Capacitor | C1825C103K1GACTU | Kemet |
| C12, C19 | 0.1 μ F Chip Capacitor | C1812F104K1RACTU | Kemet |
| C13, C22 | 220 μ F, 100 V Electrolytic Capacitor | MCGPR100V227M16X26-RH | Multicomp |
| C14, C15, C16, C17 | 120 pF Chip Capacitor | ATC100B121JT300XT | ATC |
| C23 | 5.6 pF Chip Capacitor | ATC100B5R6CT500XT | ATC |
| Coax1, 2, 3, 4 | 25 Ω , Semi Rigid Coax, 2.4" Shield Length | UT141-25 | Precision Tube Company |
| L1, L2, L5, L6 | 2.5 nH Inductor, 1 Turn | A01TKLC | Coilcraft |
| L3, L4 | 22 nH Inductor, 7 Turns | B07TJLC | Coilcraft |
| PCB | Arlon AD255A, 0.030", $\epsilon_r = 2.55$ | D93611 | MTL |

**TYPICAL CHARACTERISTICS – 520 MHz
PRODUCTION TEST FIXTURE**



| f (MHz) | P1dB (W) | P3dB (W) |
|---------|----------|----------|
| 520 | 88 | 94 |

Figure 6. CW Output Power versus Input Power

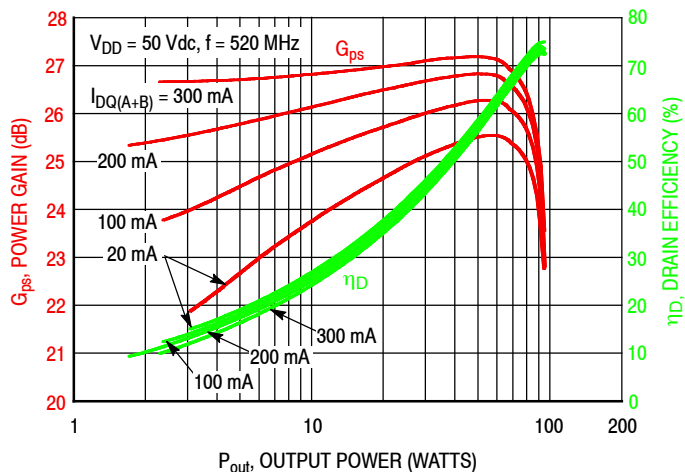


Figure 7. Power Gain and Drain Efficiency versus CW Output Power and Quiescent Current

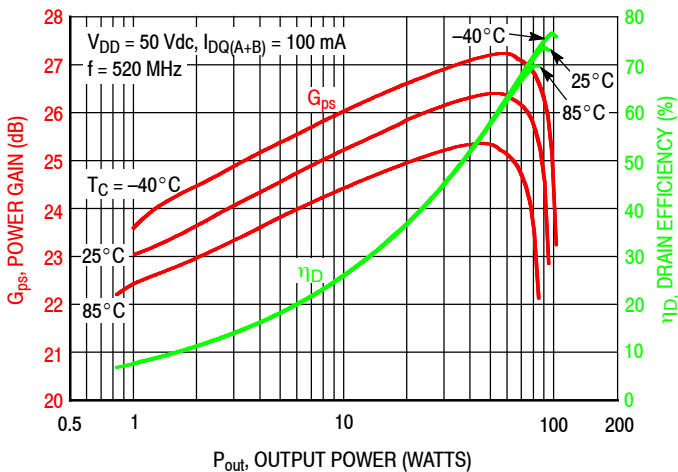


Figure 8. Power Gain and Drain Efficiency versus CW Output Power

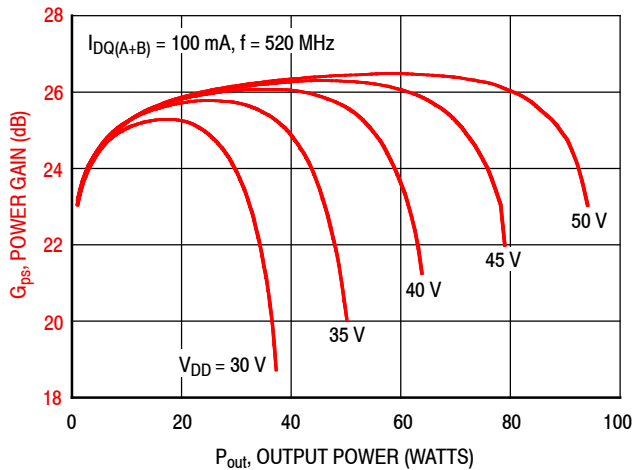


Figure 9. Power Gain versus CW Output Power and Drain-Source Voltage

520 MHz NARROWBAND PRODUCTION TEST FIXTURE

| f MHz | Z_{source} Ω | Z_{load} Ω |
|----------|---------------------------------|-------------------------------|
| 520 | $1.32 + j20.2$ | $22.6 + j18.2$ |

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.

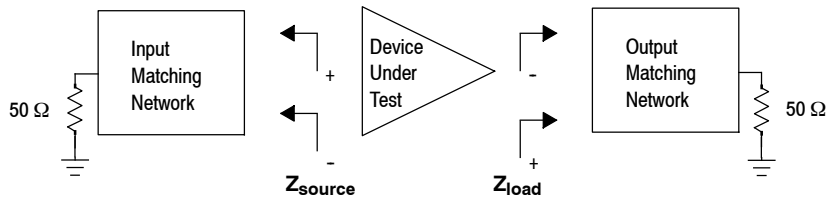
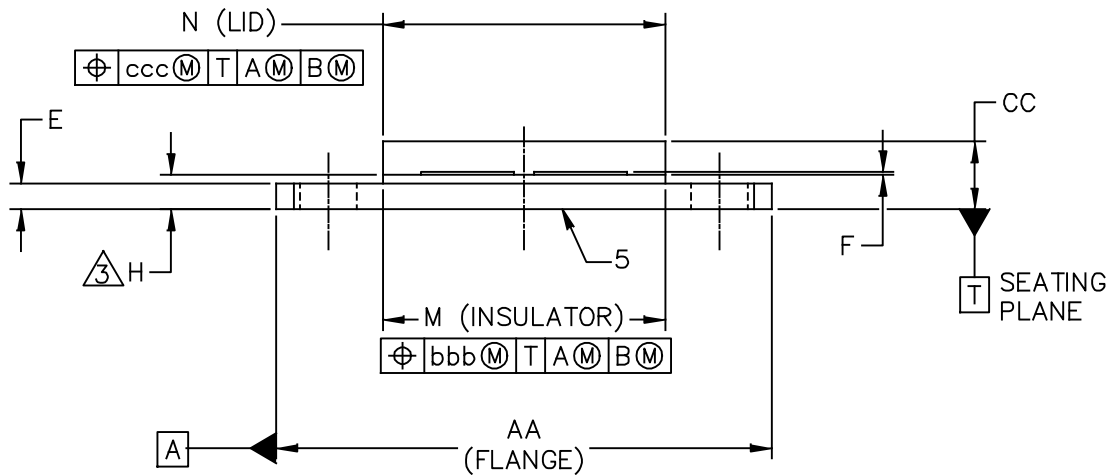
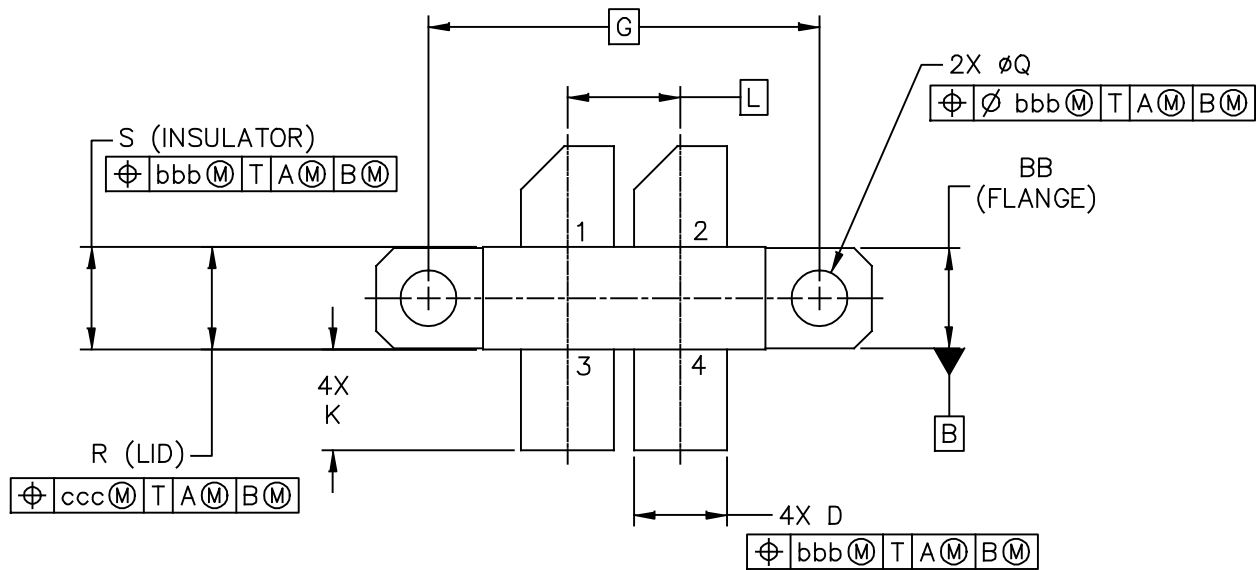


Figure 10. Narrowband Series Equivalent Source and Load Impedance — 520 MHz

PACKAGE DIMENSIONS



| | | |
|--|--------------------------|----------------------------|
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| TITLE: NI-650H-4L | DOCUMENT NO: 98ARB18494C | REV: F |
| | STANDARD: NON-JEDEC | |
| | SOT1911-1 | 26 JAN 2017 |

NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M–1994.

2. CONTROLLING DIMENSION: INCH.

3. DIMENSION H IS MEASURED .030 INCH (0.762 MM) AWAY FROM THE FLANGE PARALLEL TO DATUM B TO CLEAR EPOXY FLOW OUT.

4. DELETED REV. B.

| DIM | INCH | | MILLIMETER | | DIM | INCH | | MILLIMETER | |
|--|----------|-------|--------------------|-------|--------------------------------------|----------------------------|-------|-------------|-------|
| | MIN | MAX | MIN | MAX | | MIN | MAX | MIN | MAX |
| AA | 1.135 | 1.145 | 28.83 | 29.08 | Q | ∅.125 | ∅.135 | ∅3.18 | ∅3.43 |
| BB | .225 | .235 | 5.72 | 5.97 | R | .227 | .233 | 5.77 | 5.92 |
| CC | .135 | .178 | 3.43 | 4.52 | S | .225 | .235 | 5.72 | 5.97 |
| D | .210 | .220 | 5.33 | 5.59 | bbb | .010 | | 0.25 | |
| E | .055 | .065 | 1.40 | 1.65 | ccc | .015 | | 0.38 | |
| F | .004 | .006 | 0.10 | 0.15 | | | | | |
| G | .900 BSC | | 22.86 BSC | | | | | | |
| H | .077 | .087 | 1.96 | 2.21 | | | | | |
| K | .220 | .250 | 5.59 | 6.35 | | | | | |
| L | .260 BSC | | 6.60 BSC | | | | | | |
| M | .643 | .657 | 16.33 | 16.69 | | | | | |
| N | .638 | .650 | 16.21 | 16.51 | | | | | |
| © NXP SEMICONDUCTORS N.V. ALL RIGHTS RESERVED | | | MECHANICAL OUTLINE | | | PRINT VERSION NOT TO SCALE | | | |
| TITLE: NI-650H-4L | | | | | DOCUMENT NO: 98ARB18494C REV: F | | | | |
| | | | | | STANDARD: NON-JEDEC | | | | |
| | | | | | SOT1911-1 | | | 26 JAN 2017 | |

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
- 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 | July 2017 | • Initial release of data sheet |
| 1 | Oct. 2017 | • Table 5, Ordering Information: added MRF085HR3 to table and R3 suffix tape and reel information, p. 3 |

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