Document Number: MMRF1007H
Rev. 0, 12/2013

RoHS

# RF Power Field Effect Transistors

## N-Channel Enhancement-Mode Lateral MOSFETs

RF power transistors designed for applications operating at frequencies from 900 to 1215 MHz. These devices are suitable for use in defense and commercial pulse applications, such as IFF and DME.

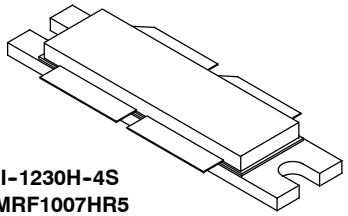
- Typical Pulse Performance: $V_{DD}$ = 50 Vdc, $I_{DQ}$ = 150 mA, $P_{out}$ = 1000 W Peak (100 W Avg.), f = 1030 MHz, Pulse Width = 128 μsec, Duty Cycle = 10%
  Power Gain — 20 dB
  Drain Efficiency — 56%
- Capable of Handling 5:1 VSWR, @ 50 Vdc, 1030 MHz, 1000 W Peak Power

**Features**

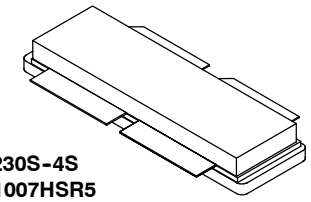
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Qualified Up to a Maximum of 50 $V_{DD}$ Operation
- Integrated ESD Protection
- Designed for Push-Pull Operation
- Greater Negative Gate-Source Voltage Range for Improved Class C Operation
- In Tape and Reel. R5 Suffix = 50 Units, 56 mm Tape Width, 13-inch Reel.

**MMRF1007HR5**
**MMRF1007HSR5**

**965-1215 MHz, 1000 W, 50 V**
**LATERAL N-CHANNEL**
**BROADBAND**
**RF POWER MOSFETs**

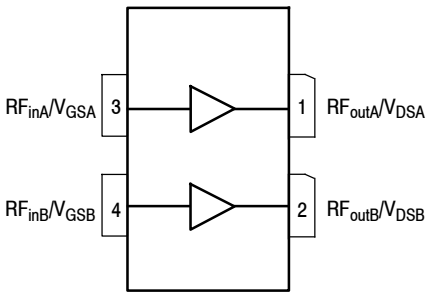


**NI-1230H-4S**
**MMRF1007HR5**



**NI-1230S-4S**
**MMRF1007HSR5**

**PARTS ARE PUSH-PULL**




(Top View)

**Figure 1. Pin Connections**

**Table 1. Maximum Ratings**

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Drain-Source Voltage | $V_{DSS}$ | -0.5, +110 | Vdc |
| Gate-Source Voltage | $V_{GS}$ | -6.0, +10 | Vdc |
| Storage Temperature Range | $T_{stg}$ | -65 to +150 | °C |
| Case Operating Temperature | $T_C$ | 150 | °C |
| Operating Junction Temperature (1) | $T_J$ | 225 | °C |

1. Continuous use at maximum temperature will affect MTTF.



freescale

**Table 2. Thermal Characteristics**

| Characteristic | Symbol | Value (1) | Unit |
|---|---|---|---|
| Thermal Resistance, Junction to Case<br>Case Temperature 67°C, 1000 W Peak, 128 μsec Pulse Width, 10% Duty Cycle, 50 Vdc, $I_{DQ}$ = 150 mA<br>Case Temperature 62°C, Mode-S Pulse Train, 80 Pulses of 32 μsec On, 18 μsec Off, Repeated Every 40 msec, 6.4% Overall Duty Cycle, 50 Vdc, $I_{DQ}$ = 150 mA | $Z_{\theta JC}$ | <br>0.02<br>0.07 | °C/W |

**Table 3. ESD Protection Characteristics**

| Test Methodology | Class |
|---|---|
| Human Body Model (per JESD22-A114) | 1B |
| Machine Model (per EIA/JESD22-A115) | B |
| Charge Device Model (per JESD22-C101) | IV |

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

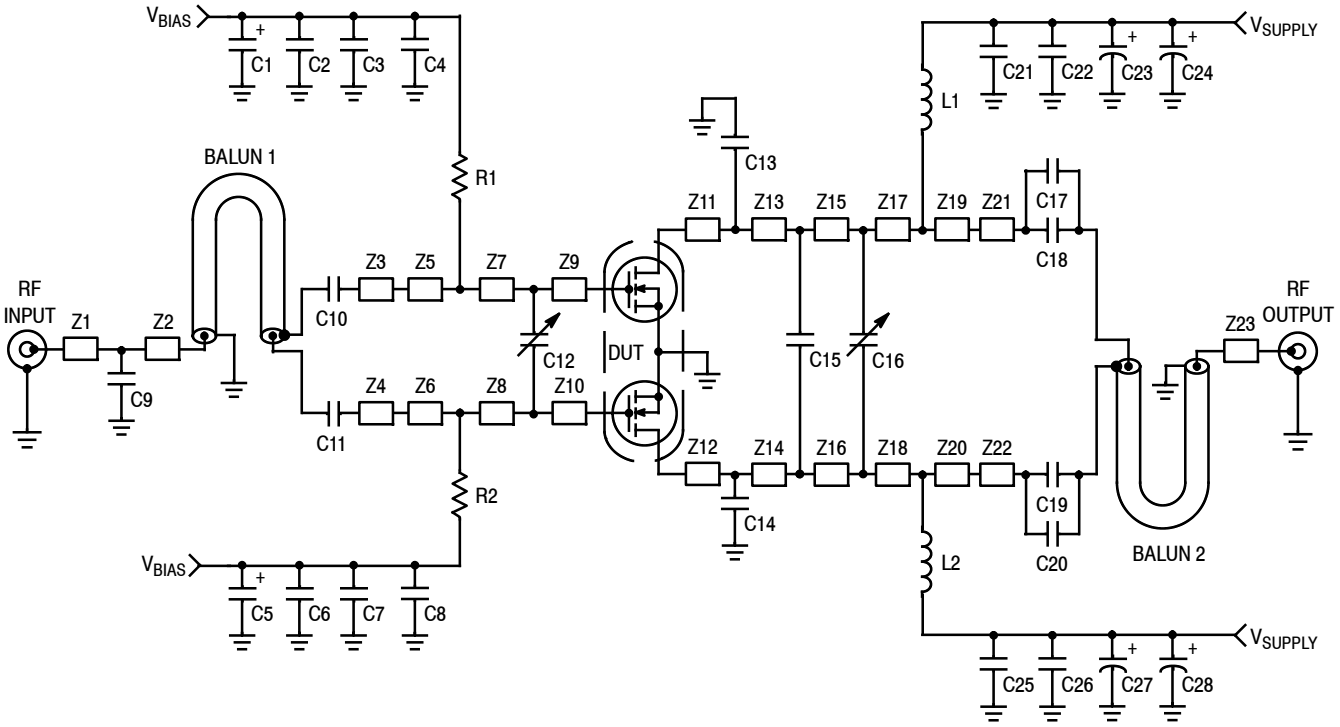
| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **Off Characteristics (2)** | | | | | |
| Gate-Source Leakage Current ($V_{GS}$ = 5 Vdc, $V_{DS}$ = 0 Vdc) | $I_{GSS}$ | — | — | 10 | μAdc |
| Drain-Source Breakdown Voltage ($V_{GS}$ = 0 Vdc, $I_D$ = 165 mA) | $V_{(BR)DSS}$ | 110 | — | — | Vdc |
| Zero Gate Voltage Drain Leakage Current ($V_{DS}$ = 50 Vdc, $V_{GS}$ = 0 Vdc) | $I_{DSS}$ | — | — | 10 | μAdc |
| Zero Gate Voltage Drain Leakage Current ($V_{DS}$ = 100 Vdc, $V_{GS}$ = 0 Vdc) | $I_{DSS}$ | — | — | 100 | μAdc |
| **On Characteristics** | | | | | |
| Gate Threshold Voltage (2) ($V_{DS}$ = 10 Vdc, $I_D$ = 1000 μAdc) | $V_{GS(th)}$ | 0.9 | 1.6 | 2.4 | Vdc |
| Gate Quiescent Voltage (3) ($V_{DD}$ = 50 Vdc, $I_D$ = 150 mAdc, Measured in Functional Test) | $V_{GS(Q)}$ | 1.5 | 2.2 | 3 | Vdc |
| Drain-Source On-Voltage (2) ($V_{GS}$ = 10 Vdc, $I_D$ = 2.7 Adc) | $V_{DS(on)}$ | — | 0.15 | — | Vdc |
| **Dynamic Characteristics (2)** | | | | | |
| Reverse Transfer Capacitance ($V_{DS}$ = 50 Vdc ± 30 mV(rms)ac @ 1 MHz, $V_{GS}$ = 0 Vdc) | $C_{rss}$ | — | 1.27 | — | pF |
| Output Capacitance ($V_{DS}$ = 50 Vdc ± 30 mV(rms)ac @ 1 MHz, $V_{GS}$ = 0 Vdc) | $C_{oss}$ | — | 86.7 | — | pF |
| Input Capacitance ($V_{DS}$ = 50 Vdc, $V_{GS}$ = 0 Vdc ± 30 mV(rms)ac @ 1 MHz) | $C_{iss}$ | — | 539 | — | pF |
| **Functional Tests (3)** (In Freescale Test Fixture, 50 ohm system) $V_{DD}$ = 50 Vdc, $I_{DQ}$ = 150 mA, $P_{out}$ = 1000 W Peak (100 W Avg.), f = 1030 MHz, 128 μsec Pulse Width, 10% Duty Cycle | | | | | |
| Power Gain | $G_{ps}$ | 19 | 20 | 22 | dB |
| Drain Efficiency | $\eta_D$ | 54 | 56 | — | % |
| Input Return Loss | IRL | — | -23 | -9 | dB |

1. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers.* Go to http://www.freescale.com/rf. Select Documentation/Application Notes - AN1955.
2. Each side of device measured separately.
3. Measurement made with device in push-pull configuration.

(continued)

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

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **Typical Performance — 1030 MHz** (In Freescale 1030 MHz Test Fixture, 50 ohm system) $V_{DD}$ = 50 Vdc, $I_{DQ}$ = 150 mA, $P_{out}$ = 1000 W Peak (100 W Avg.), f = 1030 MHz, Mode-S Pulse Train, 80 Pulses of 32 μsec On, 18 μsec Off, Repeated Every 40 msec, 6.4% Overall Duty Cycle | | | | | |
| Power Gain | $G_{ps}$ | — | 19.8 | — | dB |
| Drain Efficiency | $\eta_D$ | — | 59.0 | — | % |
| Burst Droop | $BD_{rp}$ | — | 0.21 | — | dB |
| **Typical Performance — 1090 MHz** (In Freescale 1090 MHz Test Fixture, 50 ohm system) $V_{DD}$ = 50 Vdc, $I_{DQ}$ = 150 mA, $P_{out}$ = 1000 W Peak (100 W Avg.), f = 1090 MHz, 128 μsec Pulse Width, 10% Duty Cycle | | | | | |
| Power Gain | $G_{ps}$ | — | 21.4 | — | dB |
| Drain Efficiency | $\eta_D$ | — | 56.3 | — | % |
| Input Return Loss | IRL | — | -25.3 | — | dB |




| | | | |
|---|---|---|---|
| Z1 | 0.140″ x 0.083″ | Z13, Z14 | 0.143″ x 0.631″ |
| Z2 | 0.300″ x 0.083″ | Z15, Z16 | 0.135″ x 0.631″ |
| Z3, Z4 | 0.746″ x 0.220″ | Z17, Z18 | 0.102″ x 0.632″ |
| Z5, Z6 | 0.075″ x 0.631″ | Z19, Z20 | 0.130″ x 0.631″ |
| Z7, Z8 | 0.329″ x 0.631″ | Z21, Z22 | 0.736″ x 0.215″ |
| Z9, Z10 | 0.326″ x 0.631″ | Z23 | 0.410″ x 0.083″ |
| Z11, Z12 | 0.240″ x 0.631″ | PCB | Arlon CuClad 250GX-0300-55-22, 0.030″, $\varepsilon_r$ = 2.55 |

**Figure 2. MMRF1007HR5(HSR5) Test Circuit Schematic**

**Table 5. MMRF1007HR5(HSR5) Test Circuit Component Designations and Values**

| Part | Description | Manufacturer | Part Number |
|---|---|---|---|
| Balun 1, 2 | Balun Anaren | 3A412 | Anaren |
| C1, C5 | 22 μF, 25 V Tantalum Capacitors | TPSD226M025R | AVX |
| C2, C6 | 2.2 μF, 50 V Chip Capacitors | C1825C225J5RAC | Kemet |
| C3, C7 | 0.22 μF, 100 V Chip Capacitors | C1210C224K1RAC | Kemet |
| C4, C8, C17, C18, C19, C20, C21, C25 | 36 pF Chip Capacitors | ATC100B360JT500XT | ATC |
| C9 | 1.0 pF Chip Capacitor | ATC100B1R0CT500XT | ATC |
| C12, C16 | 0.8–8.0 pF Variable Capacitors | 27291SL | Johanson |
| C10, C11, C13, C14, C15 | 5.1 pF Chip Capacitors | ATC100B5R1CT500XT | ATC |
| C22, C26 | 0.022 μF, 100 V Chip Capacitors | C1825C223K1GAC | Kemet |
| C23, C24, C27, C28 | 470 μF, 63 V Electrolytic Capacitors | MCGPR63V477M13X26-RH | Multicomp |
| L1, L2 | Inductors 3 Turn | GA3094-AL | Coilcraft |
| R1, R2 | 1000 Ω, 1/3 W Chip Resistors | CRCW12101001FKEA | Vishay |

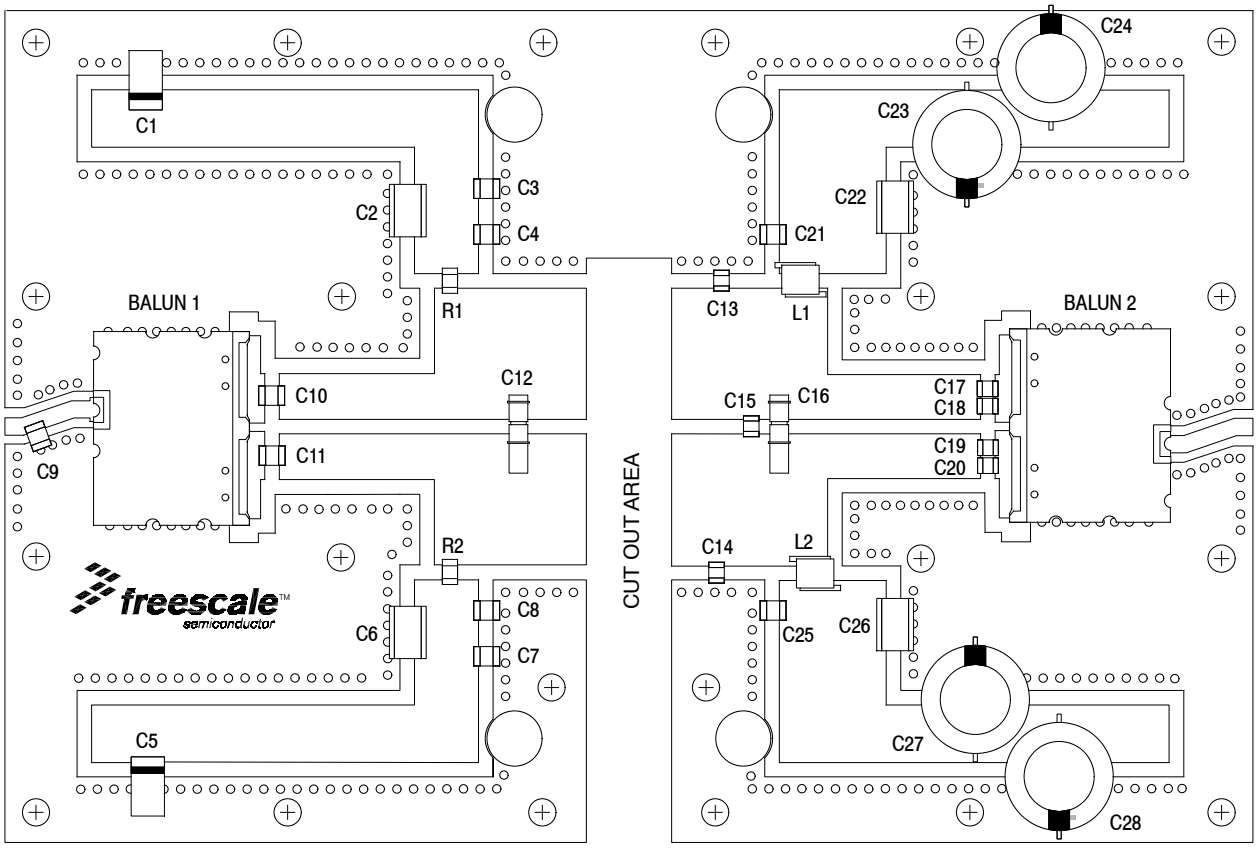
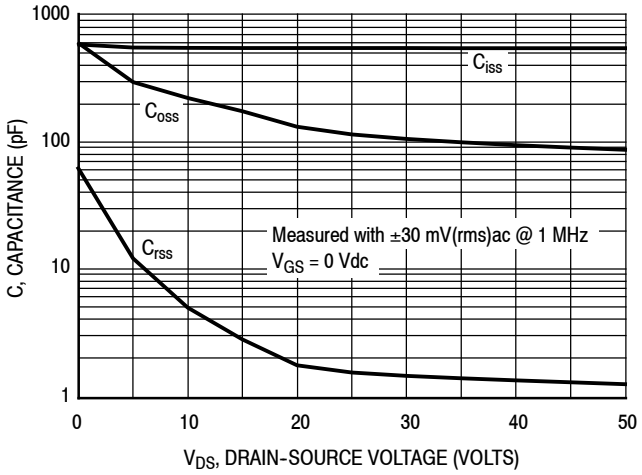



**Figure 3. MMRF1007HR5(HSR5) Test Circuit Component Layout**

## TYPICAL CHARACTERISTICS




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

**Figure 4. Capacitance versus Drain-Source Voltage**

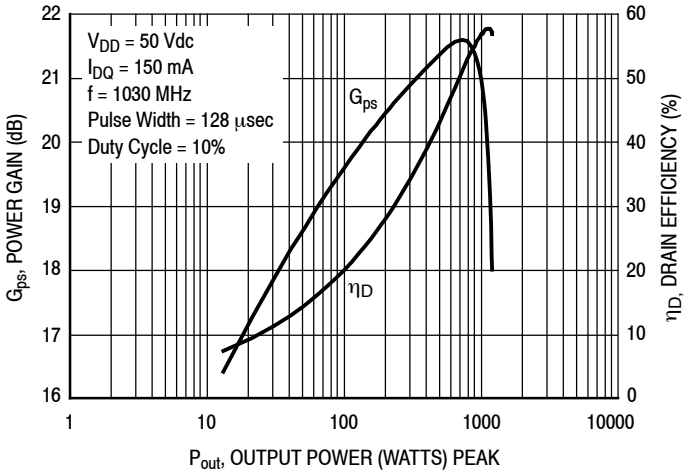



**Figure 5. Power Gain and Drain Efficiency versus Output Power**

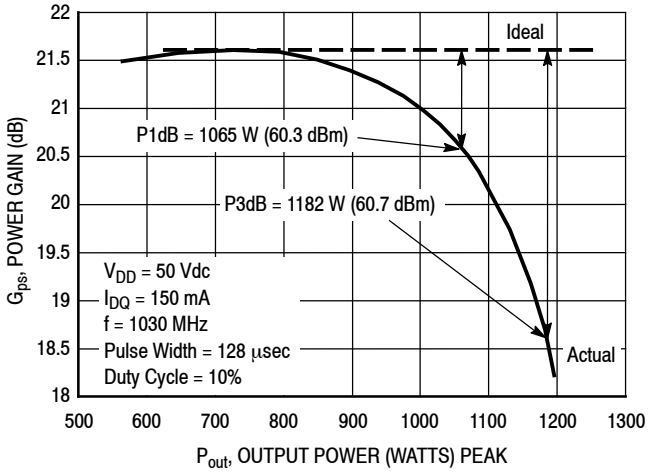



**Figure 6. Power Gain versus Output Power**

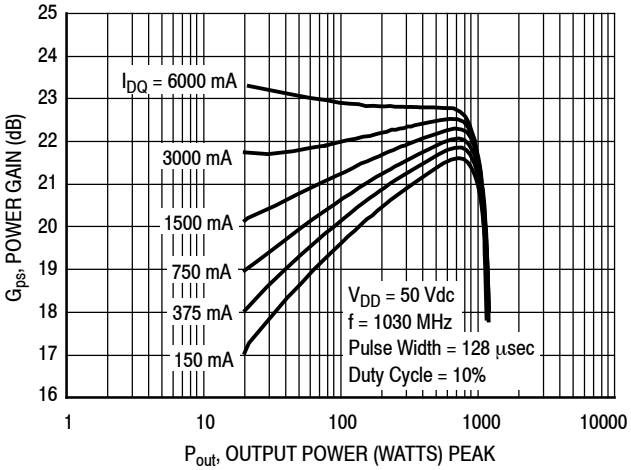



**Figure 7. Power Gain versus Output Power**

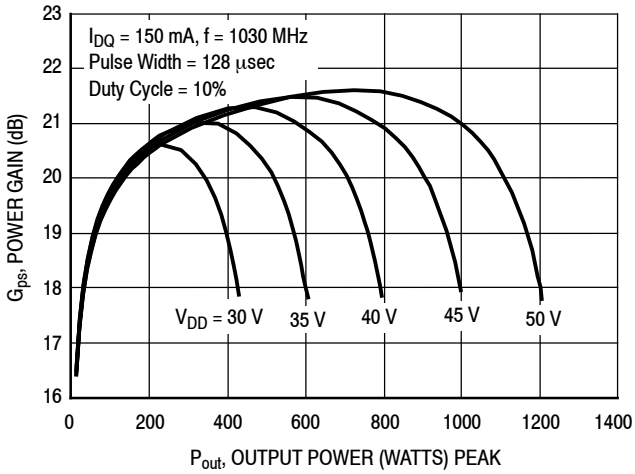



**Figure 8. Power Gain versus Output Power**

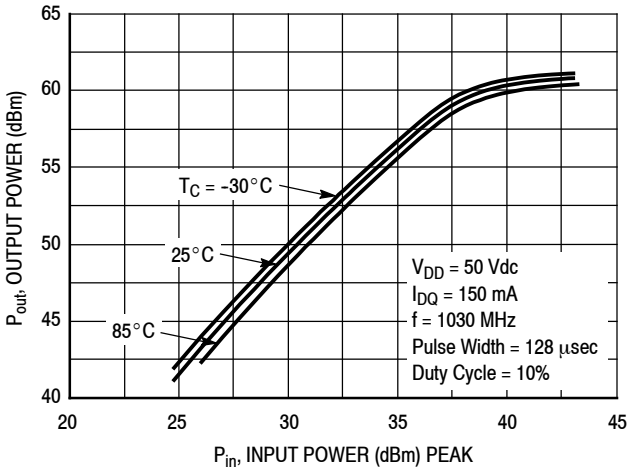



**Figure 9. Output Power versus Input Power**

## TYPICAL CHARACTERISTICS

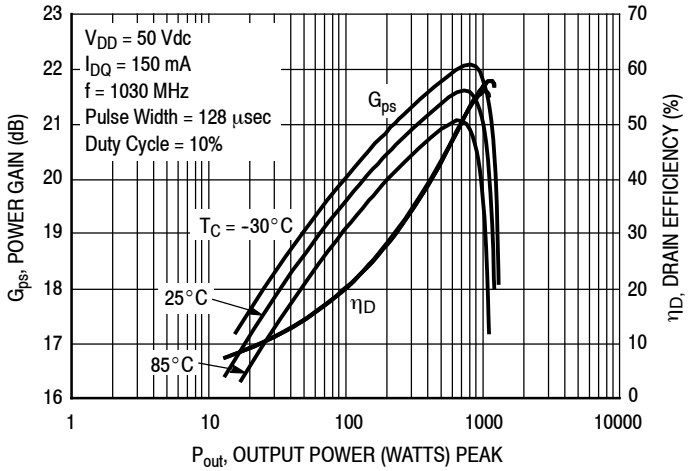
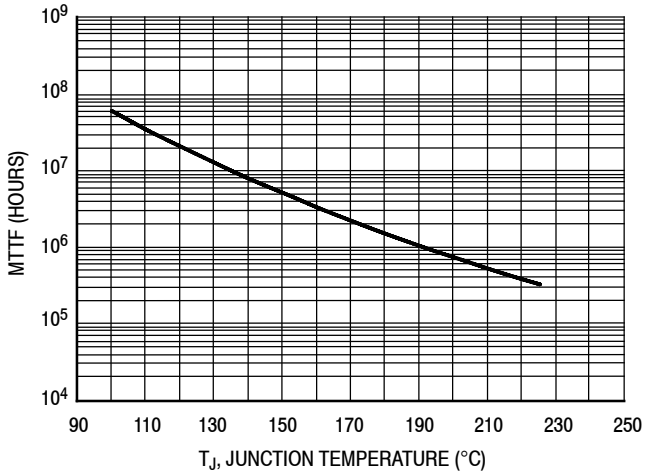


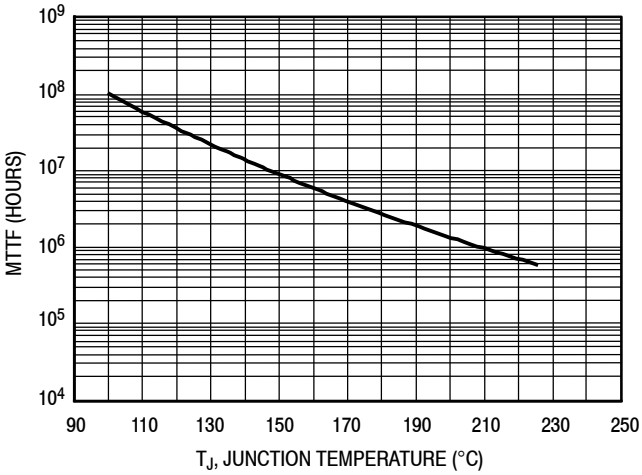

**Figure 10. Power Gain and Drain Efficiency versus Output Power**




This above graph displays calculated MTTF in hours when the device is operated at $V_{DD}$ = 50 Vdc, $P_{out}$ = 1000 W Peak, Pulse Width = 128 μsec, Duty Cycle = 10%, and $\eta_D$ = 56%.

MTTF calculator available at http://www.freescale.com/rf. Select Software & Tools/Development Tools/Calculators to access MTTF calculators by product.

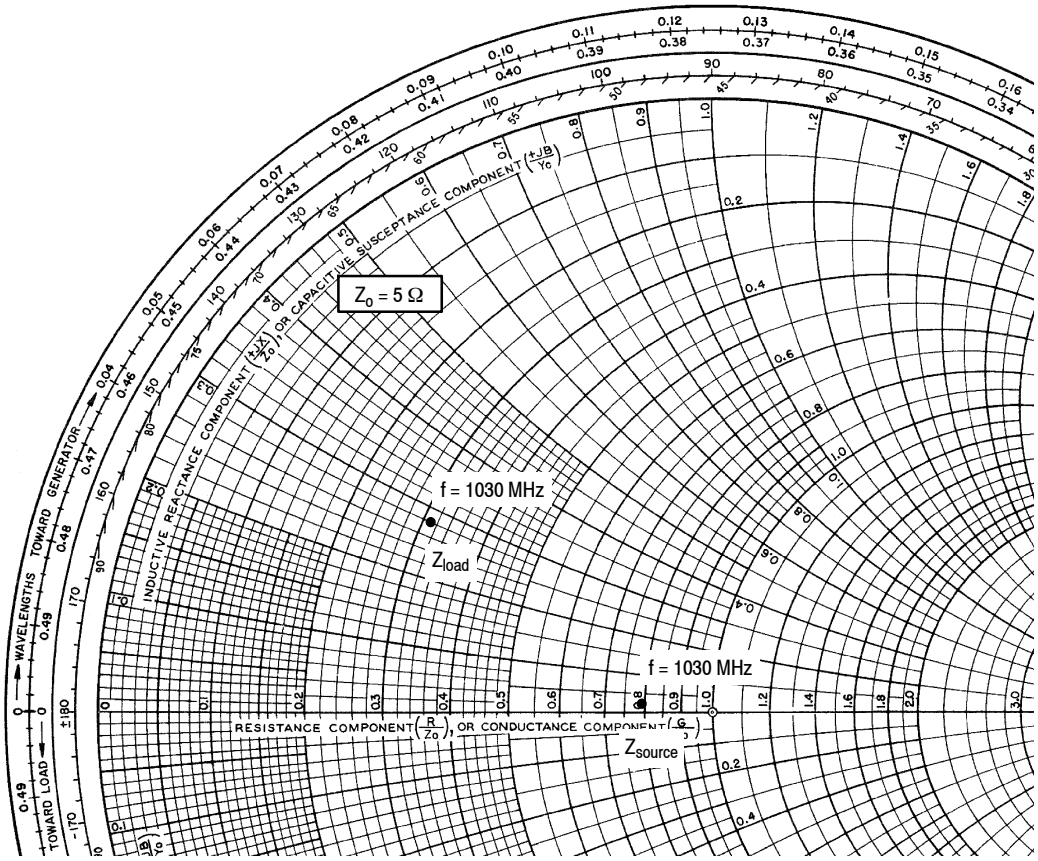
**Figure 11. MTTF versus Junction Temperature - 128 μsec, 10% Duty Cycle**




This above graph displays calculated MTTF in hours when the device is operated at $V_{DD}$ = 50 Vdc, $P_{out}$ = 1000 W Peak, Mode-S Pulse Train, Pulse Width = 32 μsec, Duty Cycle = 6.4%, and $\eta_D$ = 59%.

MTTF calculator available at http://www.freescale.com/rf. Select Software & Tools/Development Tools/Calculators to access MTTF calculators by product.

**Figure 12. MTTF versus Junction Temperature - Mode-S**




$V_{DD}$ = 50 Vdc, $I_{DQ}$ = 150 mA, $P_{out}$ = 1000 W Peak

| f<br>MHz | $Z_{source}$<br>Ω | $Z_{load}$<br>Ω |
|---|---|---|
| 1030 | 3.93 + j0.09 | 1.54 + j1.42 |

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

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

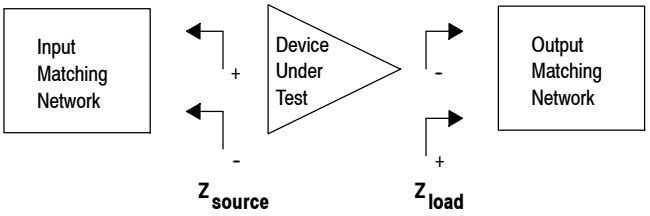



**Figure 13. Series Equivalent Source and Load Impedance**

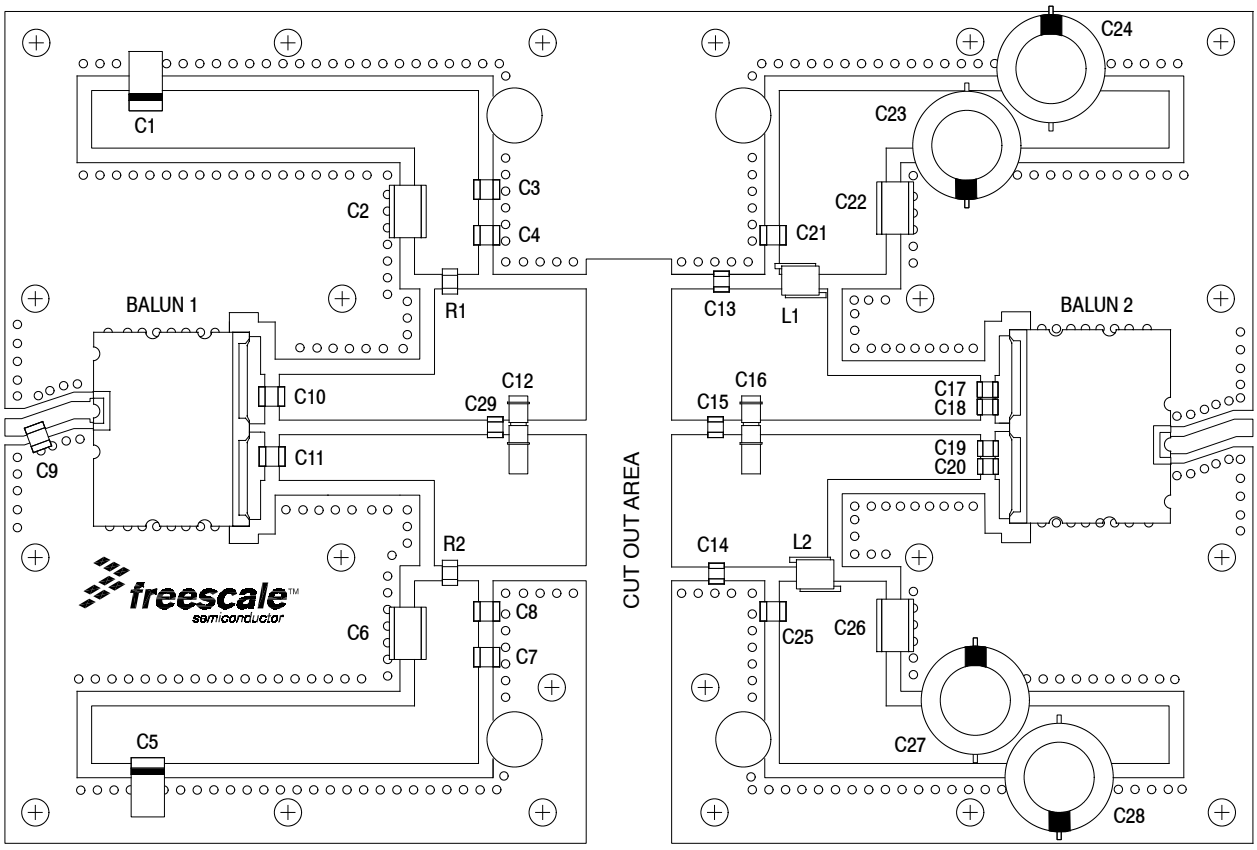



**Figure 14. MMRF1007HR5(HSR5) Test Circuit Component Layout — 1090 MHz**

**Table 6. MMRF1007HR5(HSR5) Test Circuit Component Designations and Values — 1090 MHz**

| Part | Description | Manufacturer | Part Number |
|---|---|---|---|
| Balun 1, 2 | Balun Anaren | 3A412 | Anaren |
| C1, C5 | 22 μF, 25 V Tantalum Capacitors | TPSD226M025R0200 | AVX |
| C2, C6 | 2.2 μF, 50 V 1825 Chip Capacitors | C1825C225J5RAC-TU | Kemet |
| C3, C7 | 0.22 μF, 100 V Chip Capacitors | C1210C224K1RAC-TU | Kemet |
| C4, C8, C17, C18, C19, C20, C21, C25 | 36 pF Chip Capacitors | ATC100B360JT500XT | ATC |
| C9 | 1.0 pF Chip Capacitor | ATC100B1R0BT500XT | ATC |
| C12, C16 | 0.8–8.0 pF Variable Capacitors | 27291SL | Johanson |
| C10, C11, C13, C14, C15, C29 | 5.1 pF Chip Capacitors | ATC100B5R1CT500XT | ATC |
| C22, C26 | 0.022 μF, 100 V Chip Capacitors | C1825C223K1GAC | Kemet |
| C23, C24, C27, C28 | 470 μF, 63 V Electrolytic Capacitors | MCGPR63V477M13X26-RH | Multicomp |
| L1, L2 | Inductors 3 Turn | GA3094-ALC | Coilcraft |
| R1, R2 | 1000 Ω, 1/4 W Chip Resistors | CRCW12061K00FKEA | Vishay |
| PCB | CuClad, 0.030″, $\varepsilon_r$ = 2.55 | 250GX-0300-55-22 | Arlon |

## TYPICAL CHARACTERISTICS — 1090 MHZ

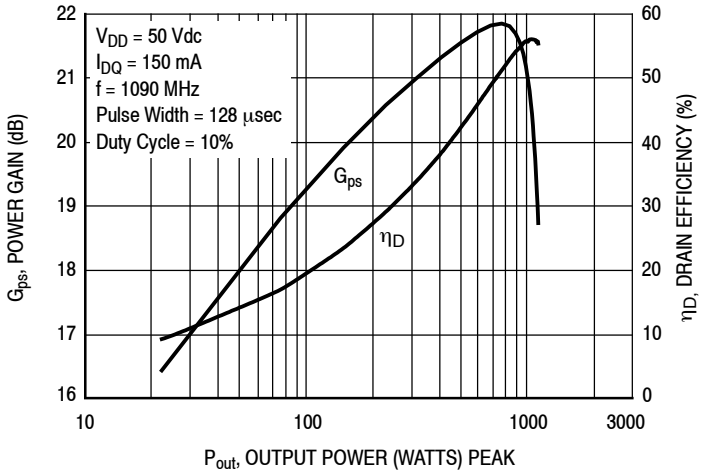
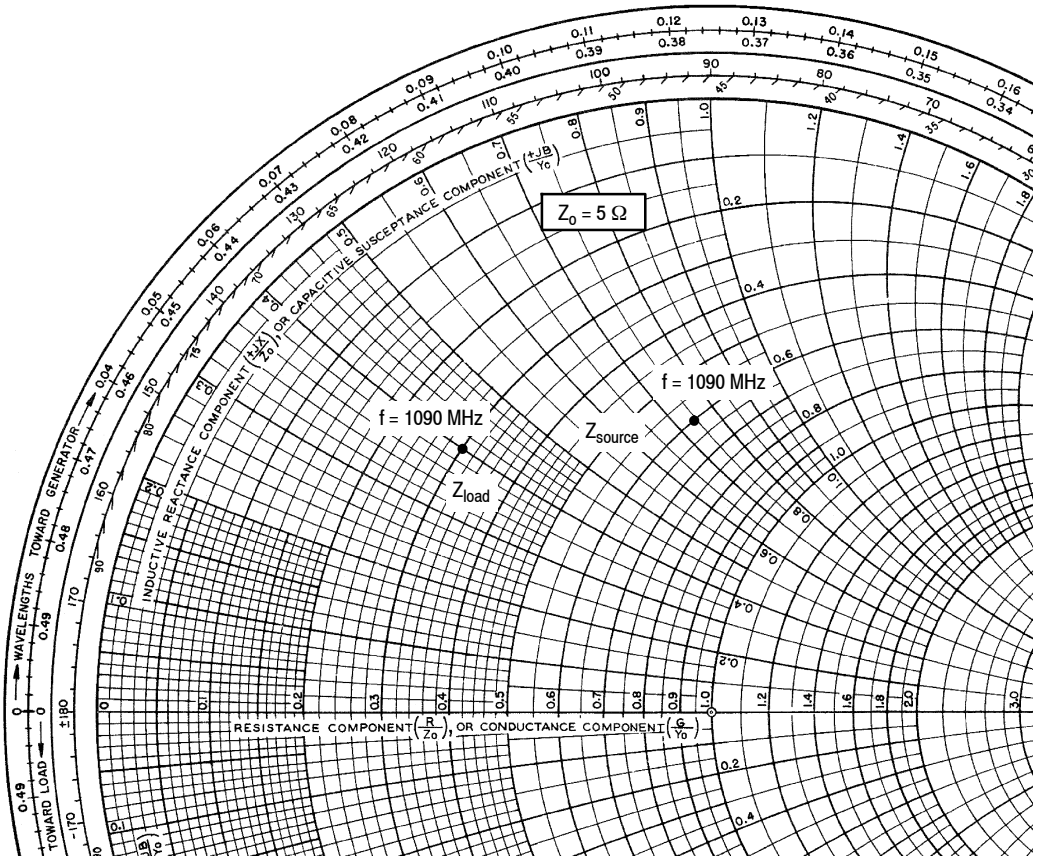



**Figure 15. Power Gain and Drain Efficiency versus Output Power**




$V_{DD}$ = 50 Vdc, $I_{DQ}$ = 150 mA, $P_{out}$ = 1000 W Peak

| f<br>MHz | $Z_{source}$<br>Ω | $Z_{load}$<br>Ω |
|---|---|---|
| 1090 | 2.98 + j3.68 | 1.51 + j2.02 |

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

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

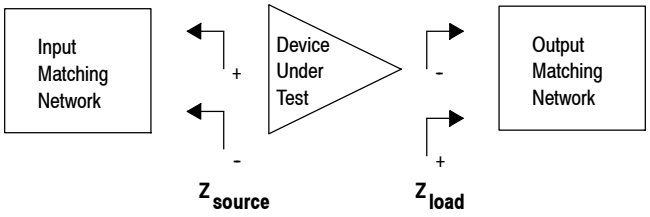
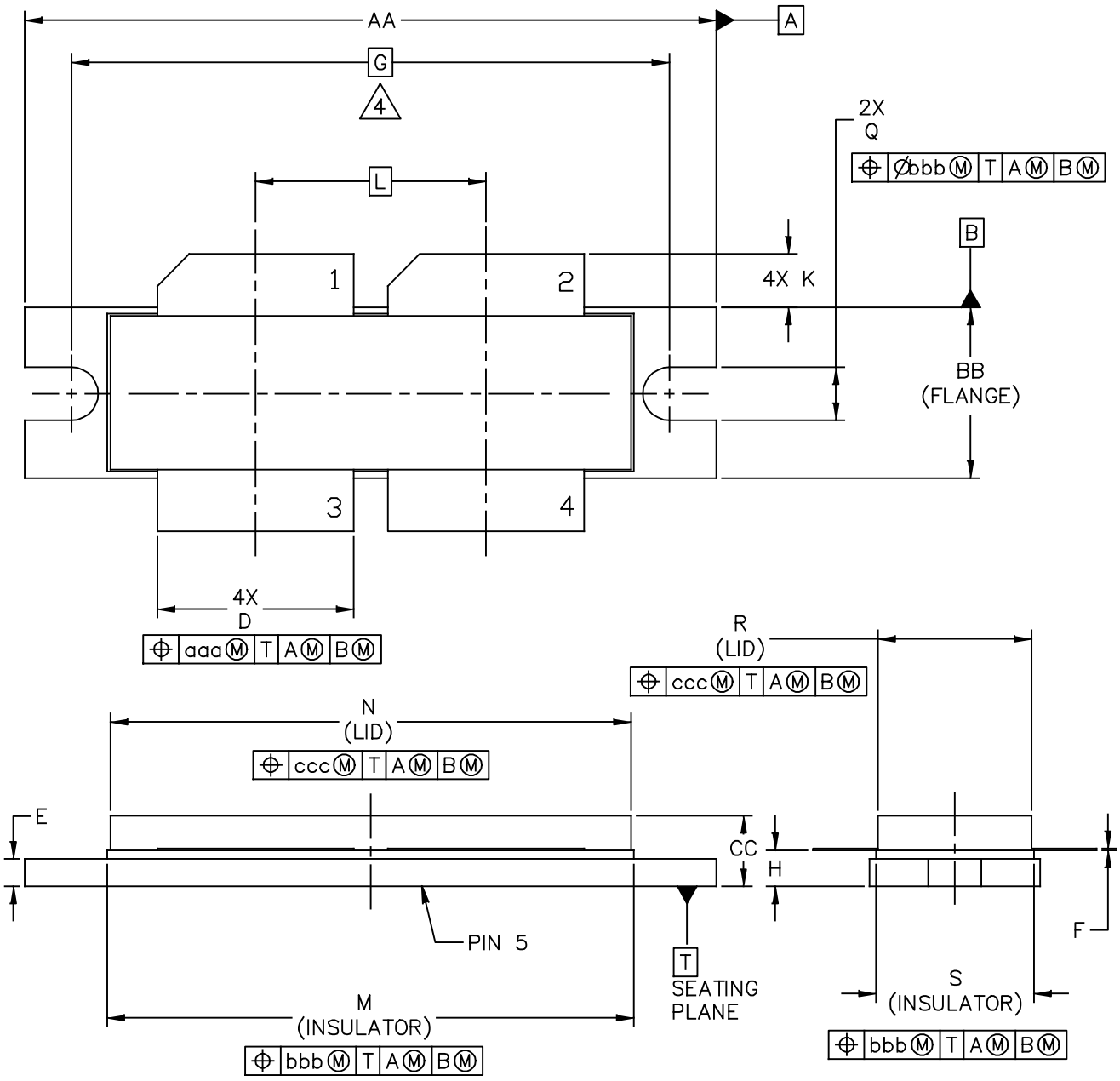



**Figure 16. Series Equivalent Source and Load Impedance — 1090 MHz**

## PACKAGE DIMENSIONS

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|---|---|---|
| TITLE: NI−1230−4H | DOCUMENT NO: 98ASB16977C | REV: F |
| | STANDARD: NON−JEDEC | |
| | 28 FEB 2013 | |

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 MIN | INCH MAX | MILLIMETER MIN | MILLIMETER MAX | DIM | INCH MIN | INCH MAX | MILLIMETER MIN | MILLIMETER 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 | | | | | |



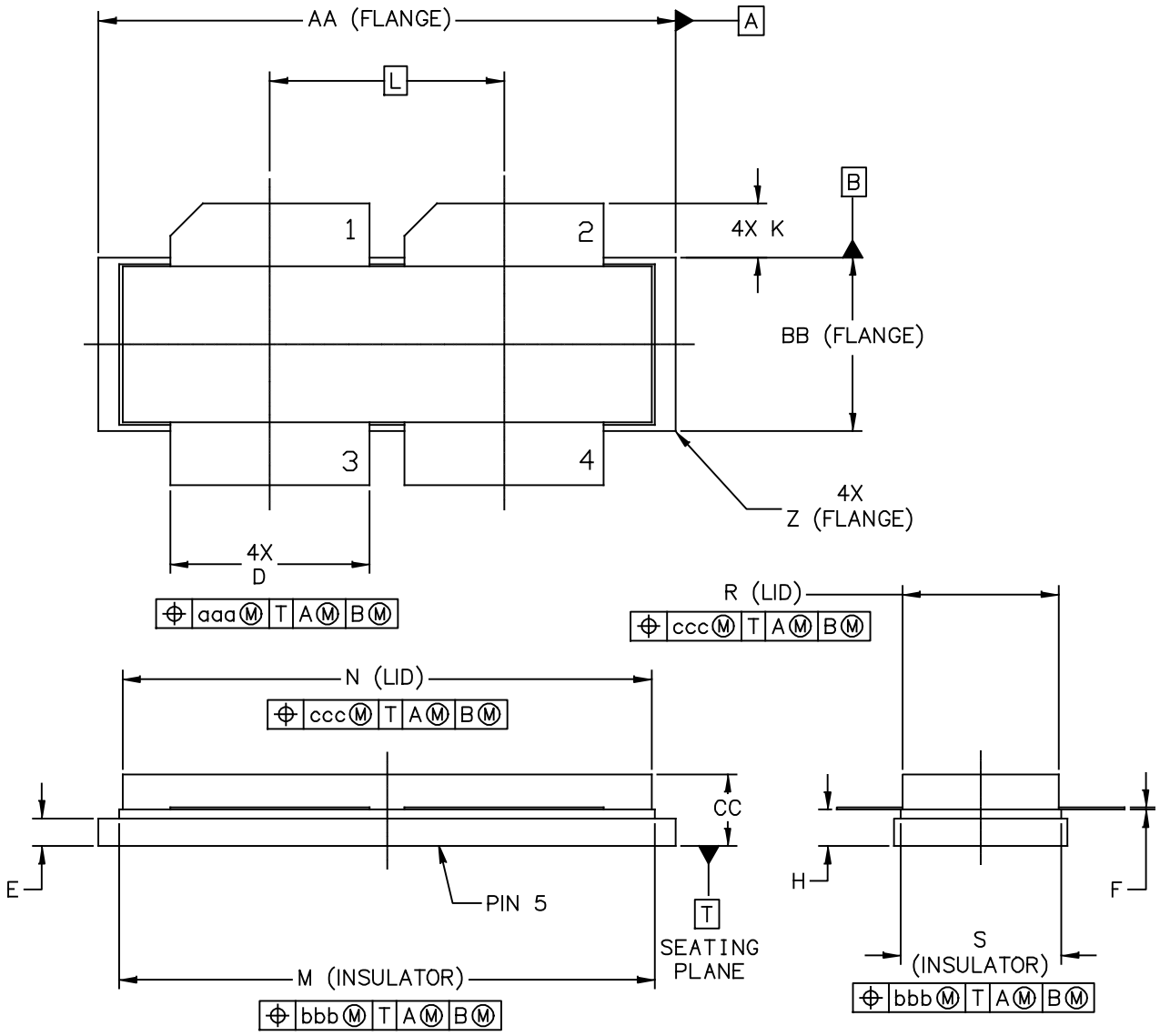
MECHANICAL OUTLINE | PRINT VERSION NOT TO SCALE

TITLE: NI–1230–4H

DOCUMENT NO: 98ASB16977C REV: F

STANDARD: NON–JEDEC

28 FEB 2013

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|---|---|---|
| TITLE: NI-1230-4S | DOCUMENT NO: 98ARB18247C | REV: G |
| | STANDARD: NON-JEDEC | |
| | 01 MAR 2013 | |

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

| DIM | INCHES MIN | INCHES MAX | MILLIMETERS MIN | MILLIMETERS MAX | DIM | INCHES MIN | INCHES MAX | MILLIMETERS MIN | MILLIMETERS MAX |
|---|---|---|---|---|---|---|---|---|---|
| AA | 1.265 | 1.275 | 32.13 | 32.39 | R | .355 | .365 | 9.02 | 9.27 |
| BB | .395 | .405 | 10.03 | 10.29 | S | .365 | .375 | 9.27 | 9.53 |
| CC | .170 | .190 | 4.32 | 4.83 | Z | R.000 | R.040 | R0.00 | R1.02 |
| D | .455 | .465 | 11.56 | 11.81 | | | | | |
| E | .062 | .066 | 1.57 | 1.68 | aaa | .013 | | 0.33 | |
| F | .004 | .007 | 0.10 | 0.18 | bbb | .010 | | 0.25 | |
| H | .082 | .090 | 2.08 | 2.29 | ccc | .020 | | 0.51 | |
| K | .117 | .137 | 2.97 | 3.48 | | | | | |
| L | .540 BSC | | 13.72 BSC | | | | | | |
| M | 1.219 | 1.241 | 30.96 | 31.52 | | | | | |
| N | 1.218 | 1.242 | 30.94 | 31.55 | | | | | |



MECHANICAL OUTLINE | PRINT VERSION NOT TO SCALE

TITLE: NI–1230–4S

DOCUMENT NO: 98ARB18247C REV: G

STANDARD: NON–JEDEC

01 MAR 2013

## PRODUCT DOCUMENTATION

Refer to the following documents 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

## REVISION HISTORY

The following table summarizes revisions to this document.

| Revision | Date | Description |
|---|---|---|
| 0 | Dec. 2013 | • Initial Release of Data Sheet |

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Стандарт Электрон Связь

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Благодаря сотрудничеству с мировыми поставщиками мы осуществляем комплексные и плановые поставки широчайшего спектра электронных компонентов.

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