



RF Power Field Effect Transistor Array

N-Channel Enhancement-Mode Lateral MOSFET

Designed for broadband commercial and industrial applications with frequencies to 1000 MHz. The high gain and broadband performance of this device make it ideal for large-signal, common-source amplifier applications in 26 volt base station equipment. The device is in a PFP-16 Power Flat Pack package which gives excellent thermal performances through a solderable backside contact.

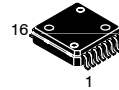
- Typical Performance at 960 MHz, 26 Volts
 Output Power — 2 Watts Per Transistor
 Power Gain — 18 dB
 Efficiency — 50%
- Capable of Handling 10:1 VSWR, @ 26 Vdc, 960 MHz, 2 Watts CW
 Output Power

Features

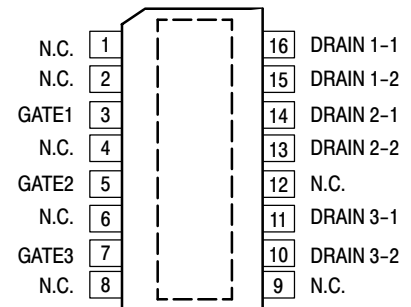
- Designed for Maximum Gain and Insertion Phase Flatness
- Excellent Thermal Stability
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- RoHS Compliant
- In Tape and Reel. R2 Suffix = 1,500 Units per 16 mm, 13 inch Reel.

MRF9002NR2

**1000 MHz, 2 W, 26 V
 LATERAL N-CHANNEL
 BROADBAND
 RF POWER MOSFET**



**CASE 978-03
 PLASTIC
 PFP-16**



(Top View)

Note: Exposed backside flag is source terminal for transistors.

Figure 1. Pin Connections

Table 1. Maximum Ratings

| Rating | Symbol | Value | Unit |
|---|-----------|--------------|------------------|
| Drain-Source Voltage | V_{DSS} | - 0.5, +65 | Vdc |
| Gate-Source Voltage | V_{GS} | - 0.5, + 15 | Vdc |
| Total Dissipation Per Transistor @ $T_C = 25^\circ\text{C}$ | P_D | 4 | W |
| Storage Temperature Range | T_{stg} | - 65 to +150 | $^\circ\text{C}$ |
| Operating Junction Temperature | T_J | 150 | $^\circ\text{C}$ |

Table 2. Thermal Characteristics

| Characteristic | Symbol | Value (1) | Unit |
|---|-----------------|-----------|---------------------------|
| Thermal Resistance, Junction to Case, Single Transistor | $R_{\theta JC}$ | 12 | $^\circ\text{C}/\text{W}$ |

Table 3. Moisture Sensitivity Level

| Test Methodology | Rating | Package Peak Temperature | Unit |
|---------------------------------------|--------|--------------------------|------------------|
| Per JESD 22-A113, IPC/JEDEC J-STD-020 | 3 | 260 | $^\circ\text{C}$ |

1. MTTF calculator available at <http://www.freescale.com/rtf>. Select Tools/Software/Application Software/Calculators to access the MTTF calculators by product.

NOTE - CAUTION - MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

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

| Characteristic | Symbol | Min | Typ | Max | Unit |
|--|--------------|-----|------|-----|------|
| On Characteristics | | | | | |
| Gate Threshold Voltage ($V_{DS} = 10\text{ Vdc}$, $I_D = 20\ \mu\text{Adc}$) | $V_{GS(th)}$ | 2.4 | — | 4 | Vdc |
| Gate Quiescent Voltage ($V_{DS} = 26\text{ Vdc}$, $I_D = 25\text{ mAdc}$) | $V_{GS(Q)}$ | 3 | — | 5 | Vdc |
| Drain-Source On-Voltage ($V_{GS} = 10\text{ Vdc}$, $I_D = 0.1\text{ Adc}$) | $V_{DS(on)}$ | — | 0.3 | — | Vdc |
| Functional Tests (Per Transistor in Freescale Test Fixture, 50 ohm system) | | | | | |
| Common-Source Amplifier Power Gain @ P1dB ($V_{DD} = 26\text{ Vdc}$, $I_{DQ} = 25\text{ mA}$, $f = 960.0\text{ MHz}$) | G_{ps} | 15 | 18 | — | dB |
| Drain Efficiency @ P1dB ($V_{DD} = 26\text{ Vdc}$, $I_{DQ} = 25\text{ mA}$, $f = 960.0\text{ MHz}$) | η | 35 | 50 | — | % |
| Input Return Loss @ P1dB ($V_{DD} = 26\text{ Vdc}$, $I_{DQ} = 25\text{ mA}$, $f = 960.0\text{ MHz}$) | IRL | — | - 15 | - 9 | dB |
| Power Output, 1 dB Compression Point ($V_{DD} = 26\text{ Vdc}$, $I_{DQ} = 25\text{ mA}$, $f = 960.0\text{ MHz}$) | P_{1dB} | 34 | 37 | — | dBm |

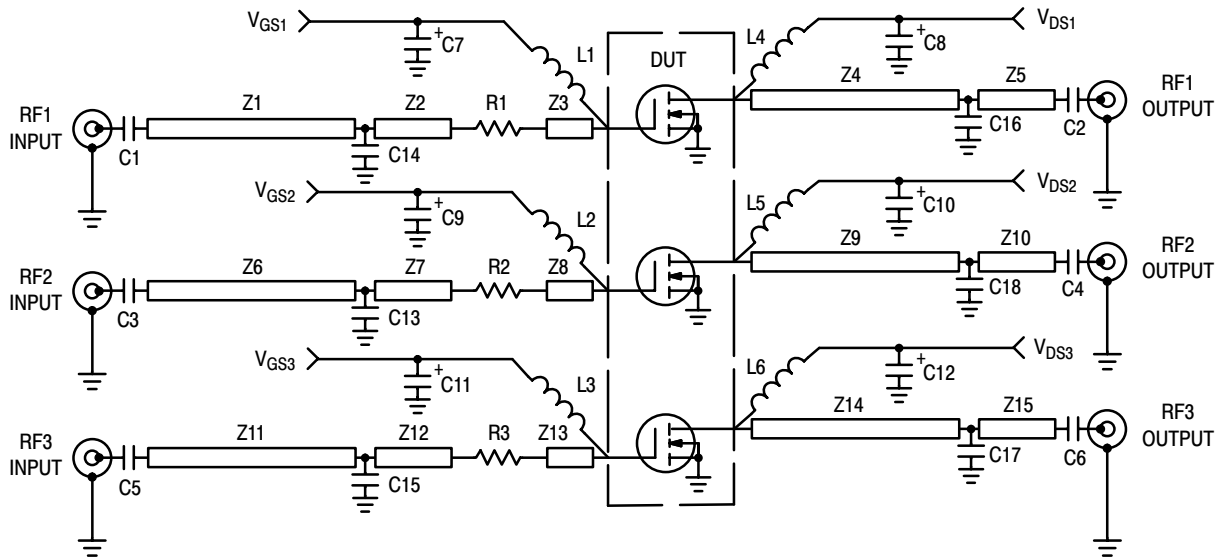
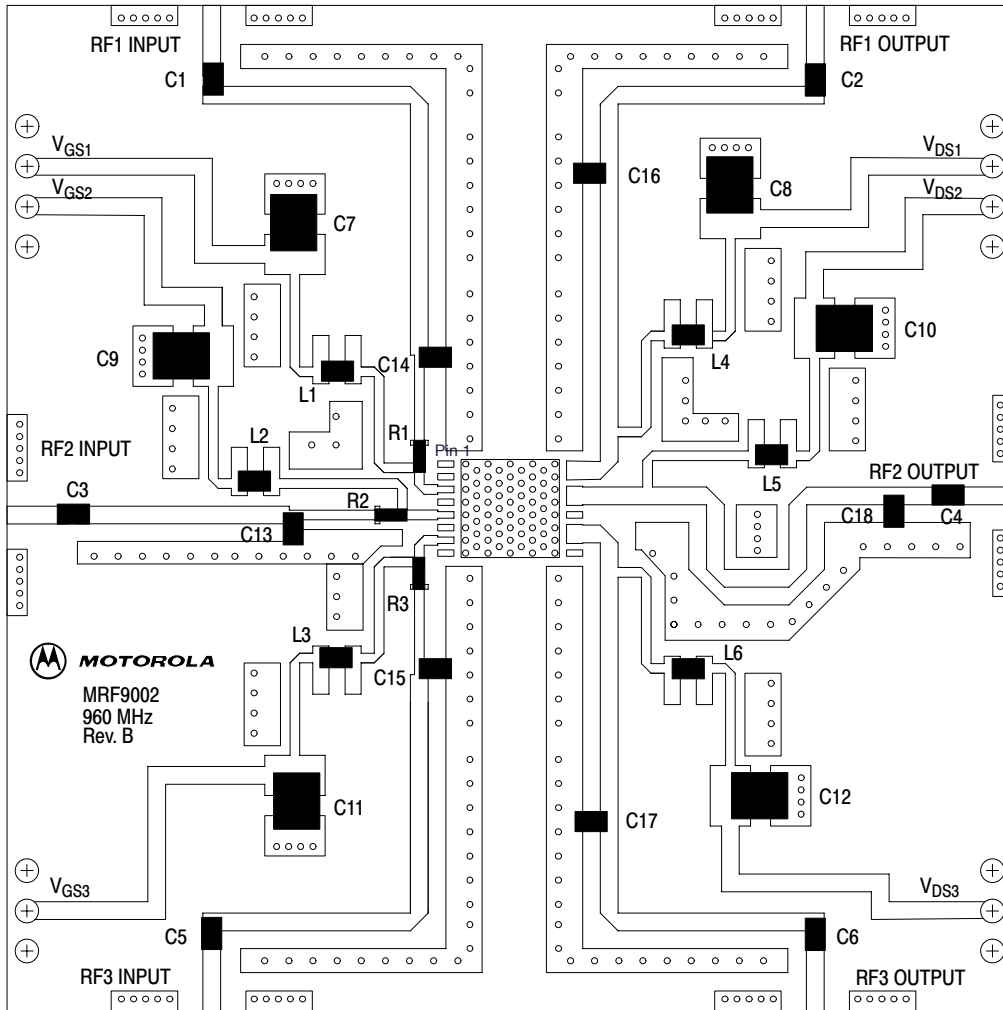


Figure 2. MRF9002NR2 Broadband Test Circuit Schematic

Table 5. MRF9002NR2 Broadband Test Circuit Component Designations and Values

| Designators | Description |
|------------------|---|
| C1 - C6 | 33 pF Chip Capacitors (0805) |
| C7 - C12 | 1.0 μ F, 35 V Tantalum Capacitors, B Case, Kemet |
| C13 | 8.2 pF Chip Capacitor (0805) |
| C14, C15 | 10 pF Chip Capacitors (0805) |
| C16, C17 | 2.7 pF Chip Capacitors (0805) |
| C18 | 3.3 pF Chip Capacitor (0805) |
| L1 - L6 | 12 nH Chip Inductors (0805) |
| R1 - R3 | 0 Ω Chip Resistors (0805) |
| Z1, Z11 | 1.16 x 28.5 mm Microstrip |
| Z2, Z7, Z12 | 0.65 x 5.6 mm Microstrip |
| Z3, Z8, Z13 | 0.65 x 2.6 mm Microstrip |
| Z4, Z14 | 1.16 x 19.5 mm Microstrip |
| Z5, Z15 | 1.16 x 17.5 mm Microstrip |
| Z6 | 1.16 x 12.9 mm Microstrip |
| Z9 | 1.16 x 27.2 mm Microstrip |
| Z10 | 1.16 x 4.3 mm Microstrip |
| PCB | Etched Circuit Board |
| Raw PCB Material | Rogers RO4350, 0.020", 2.5", x 2.5", $\epsilon_r = 3.5$ |
| Bedstead | Copper Heatsink |



Freescale has begun the transition of marking Printed Circuit Boards (PCBs) with the Freescale Semiconductor signature/logo. PCBs may have either Motorola or Freescale markings during the transition period. These changes will have no impact on form, fit or function of the current product.

Figure 3. MRF9002NR2 Broadband Test Circuit Component Layout

TYPICAL CHARACTERISTICS

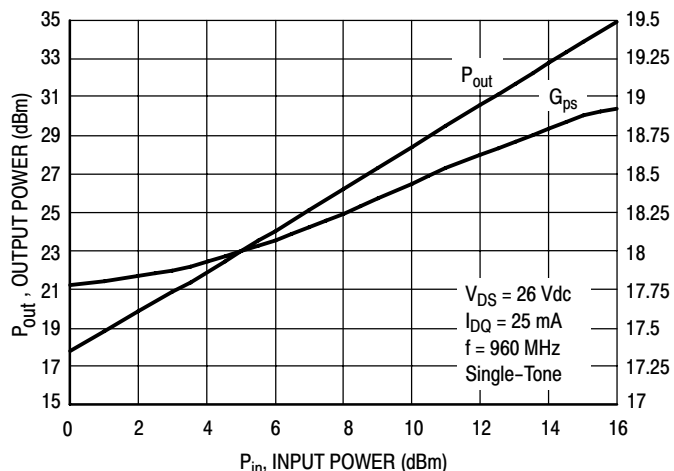


Figure 4. Output Power and Power Gain versus Input Power

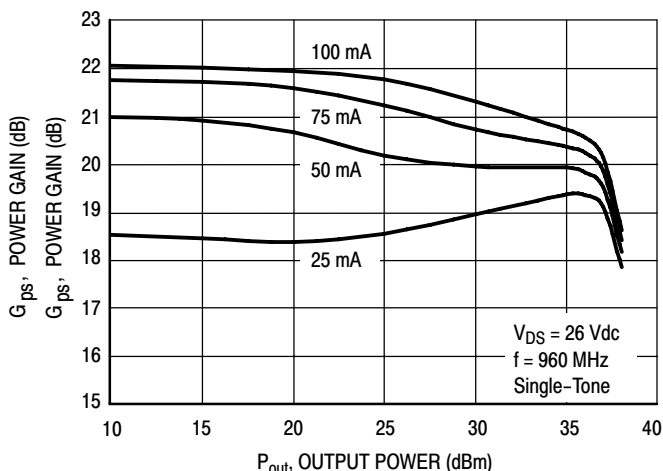


Figure 5. Power Gain versus Output Power

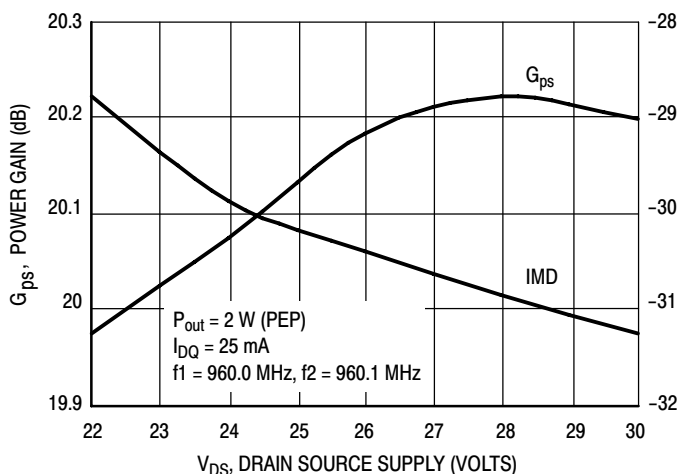


Figure 6. Power Gain and Intermodulation Distortion versus Supply Voltage

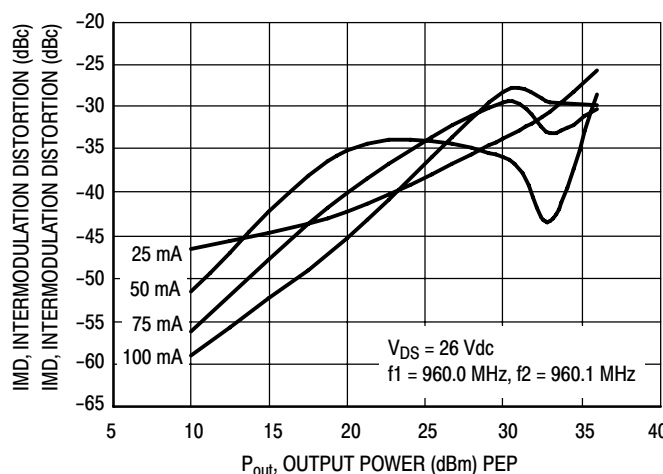


Figure 7. Intermodulation Distortion versus Output Power

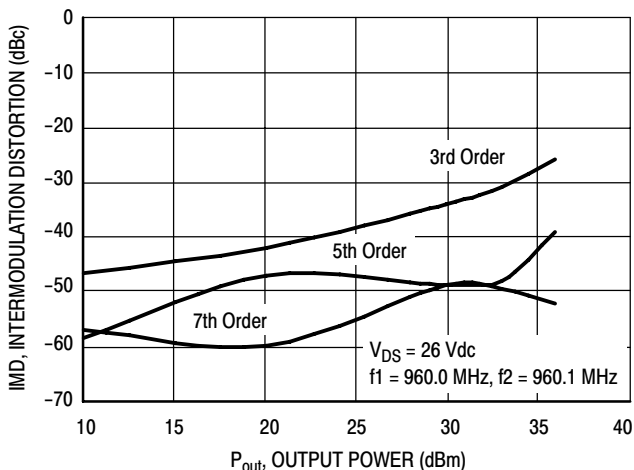


Figure 8. Intermodulation Distortion Products versus Output Power

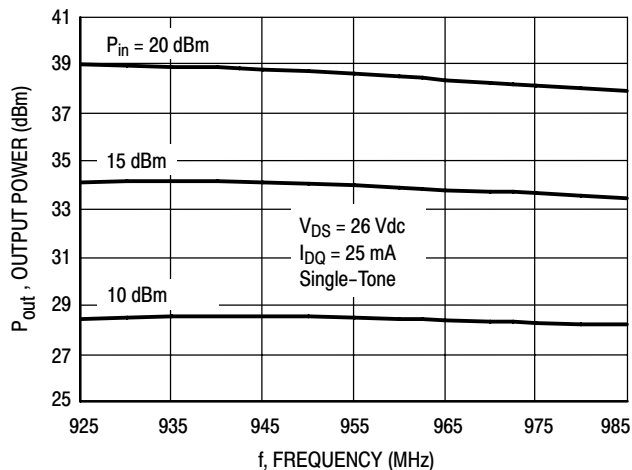


Figure 9. Output Power versus Frequency

TYPICAL CHARACTERISTICS

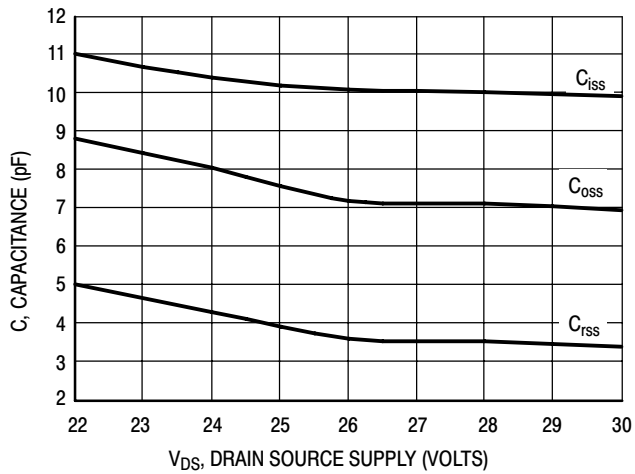
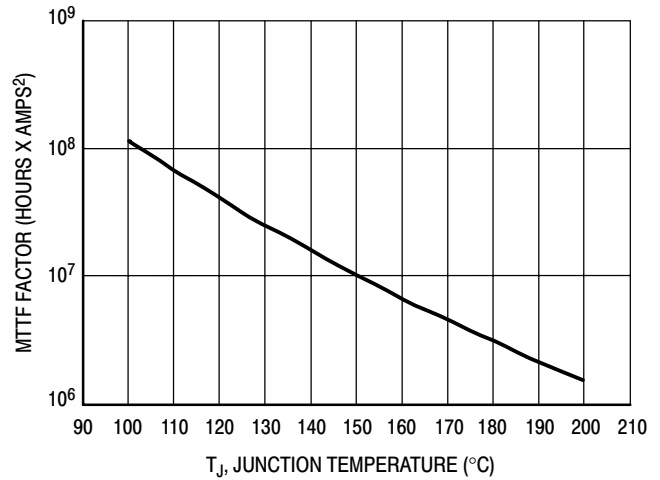
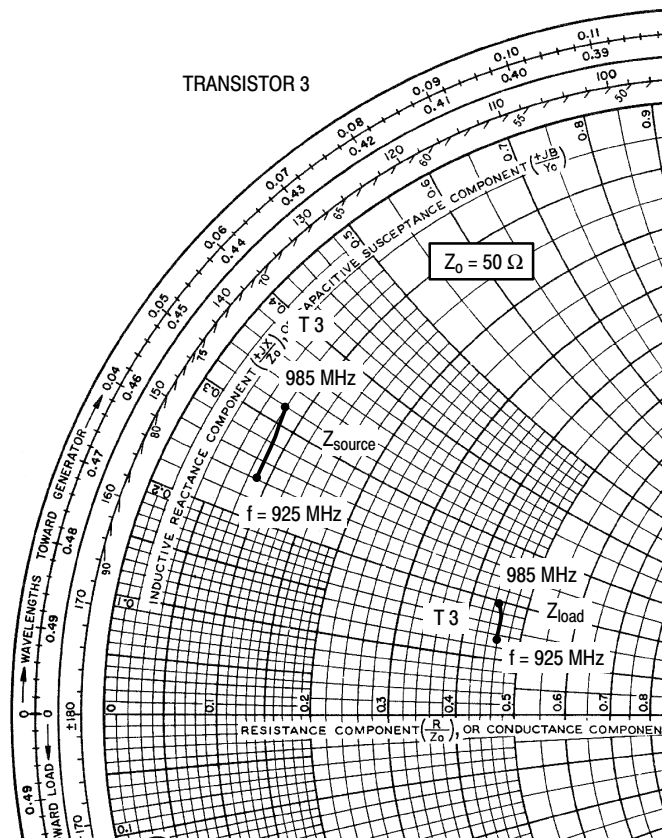
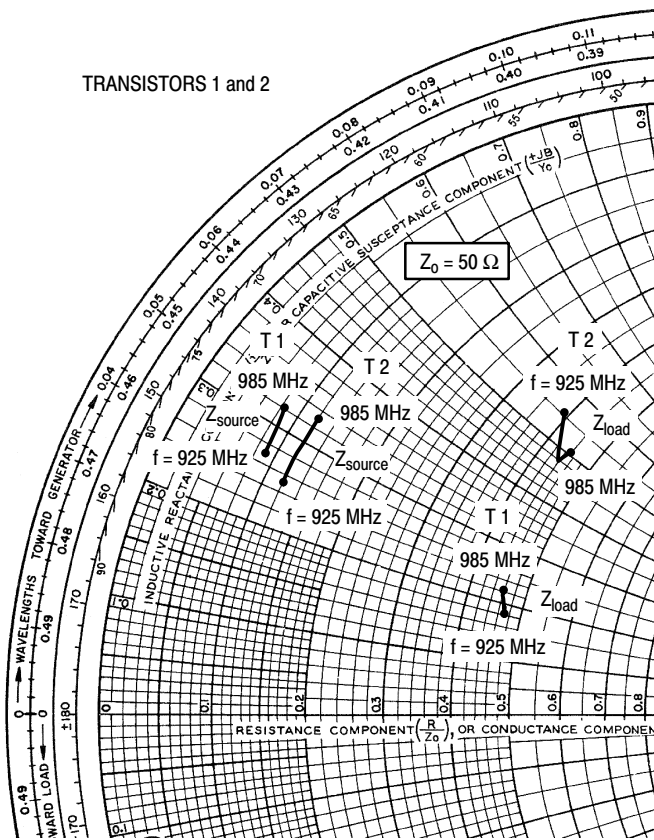


Figure 10. Capacitance versus Drain Source Voltage



This above graph displays calculated MTTF in hours x ampere² drain current. Life tests at elevated temperatures have correlated to better than $\pm 10\%$ of the theoretical prediction for metal failure. Divide MTTF factor by I_D^2 for MTTF in a particular application.

Figure 11. MTTF Factor versus Junction Temperature



$V_{DD} = 26\text{ V}$, $I_{DQ} = 25\text{ mA}$, $P_{out} = 2\text{ W PEP}$

| f MHz | Z_{source} Ω | Z_{load} Ω |
|----------|--------------------------|------------------------|
| 925 | $4.5 + j13.3$ | $23.4 + j9.2$ |
| 960 | $4.3 + j15.3$ | $23.2 + j10.4$ |
| 985 | $4.1 + j15.8$ | $23.0 + j11.1$ |

Transistor 1

$V_{DD} = 26\text{ V}$, $I_{DQ} = 25\text{ mA}$, $P_{out} = 2\text{ W PEP}$

| f MHz | Z_{source} Ω | Z_{load} Ω |
|----------|--------------------------|------------------------|
| 925 | $6.0 + j12.3$ | $19.7 + j27.8$ |
| 960 | $5.9 + j14.3$ | $22.0 + j23.9$ |
| 985 | $5.8 + j16.5$ | $22.5 + j25.4$ |

Transistor 2

$V_{DD} = 26\text{ V}$, $I_{DQ} = 25\text{ mA}$, $P_{out} = 2\text{ W PEP}$

| f MHz | Z_{source} Ω | Z_{load} Ω |
|----------|--------------------------|------------------------|
| 925 | $4.3 + j12.2$ | $23.1 + j6.5$ |
| 960 | $4.3 + j14.0$ | $22.8 + j8.4$ |
| 985 | $3.9 + j15.9$ | $22.6 + j9.3$ |

Transistor 3

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

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

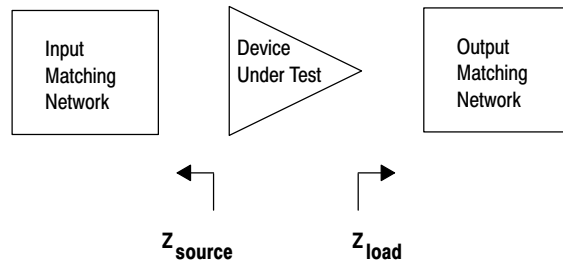


Figure 12. Series Equivalent Source and Load Impedance

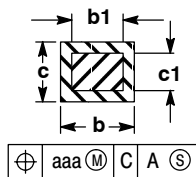
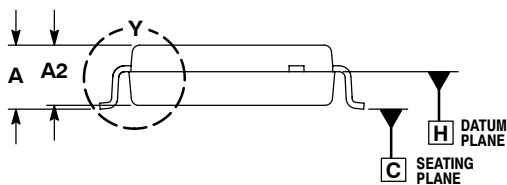
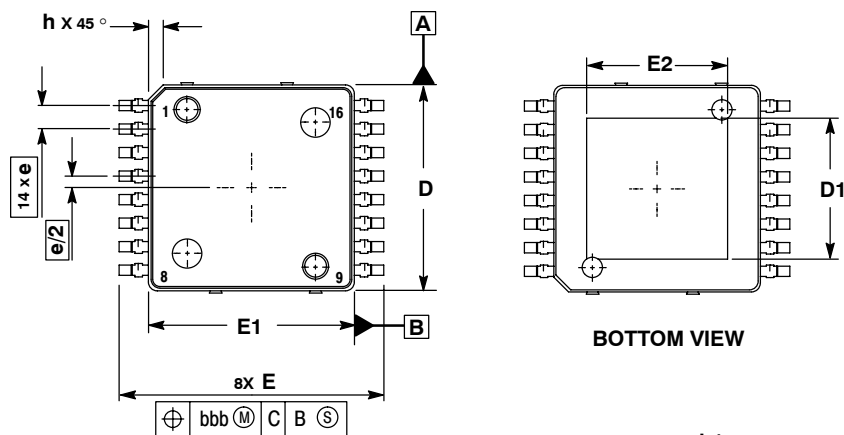
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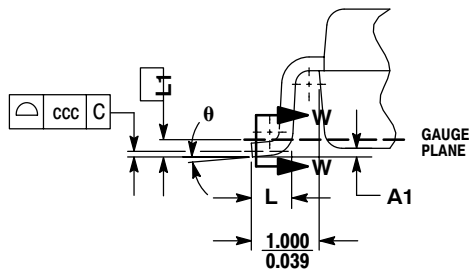
NOTES

NOTES

PACKAGE DIMENSIONS



SECT W-W



DETAIL Y

NOTES:

1. CONTROLLING DIMENSION: MILLIMETER.
2. DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994.
3. DATUM PLANE -H- IS LOCATED AT BOTTOM OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE BOTTOM OF THE PARTING LINE.
4. DIMENSIONS D AND E1 DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS 0.250 PER SIDE. DIMENSIONS D AND E1 DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE -H-.
5. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION IS 0.127 TOTAL IN EXCESS OF THE b DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. DATUMS -A- AND -B- TO BE DETERMINED AT DATUM PLANE -H-.

| DIM | MILLIMETERS | |
|-----|-------------|-------|
| | MIN | MAX |
| A | 2.000 | 2.300 |
| A1 | 0.025 | 0.100 |
| A2 | 1.950 | 2.100 |
| D | 6.950 | 7.100 |
| D1 | 4.372 | 5.180 |
| E | 8.850 | 9.150 |
| E1 | 6.950 | 7.100 |
| E2 | 4.372 | 5.180 |
| L | 0.466 | 0.720 |
| L1 | 0.250 | BSC |
| b | 0.300 | 0.432 |
| b1 | 0.300 | 0.375 |
| c | 0.180 | 0.279 |
| c1 | 0.180 | 0.230 |
| e | 0.800 | BSC |
| h | --- | 0.600 |
| θ | 0° | 7° |
| aaa | 0.200 | |
| bbb | 0.200 | |
| ccc | 0.100 | |

CASE 978-03
 ISSUE C
 PLASTIC
 PFP-16

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