



# 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.

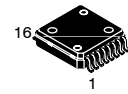
- Typical Performance at 960 MHz, 26 Volts  
 Output Power — 2 Watts Per Transistor  
 Power Gain — 18 dB  
 Efficiency — 50%
- Capable of Handling 10:1 VSWR, @ 26 Vdc, 960 MHz, 2 Watts CW Output Power

### Features

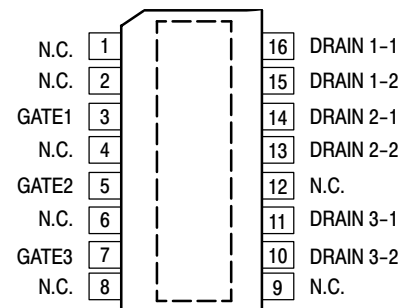
- Designed for Maximum Gain and Insertion Phase Flatness
- Excellent Thermal Stability
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- RoHS Compliant
- In Tape and Reel. R2 Suffix = 1,500 Units per 16 mm, 13 inch Reel.

**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 <sup>(1)</sup>	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/rf>. 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
<b>On Characteristics</b>					
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
<b>Functional Tests</b> (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 ( $V_{DD} = 26\text{ Vdc}$ , $I_{DQ} = 25\text{ mA}$ , $f = 960.0\text{ MHz}$ )	$\eta$	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

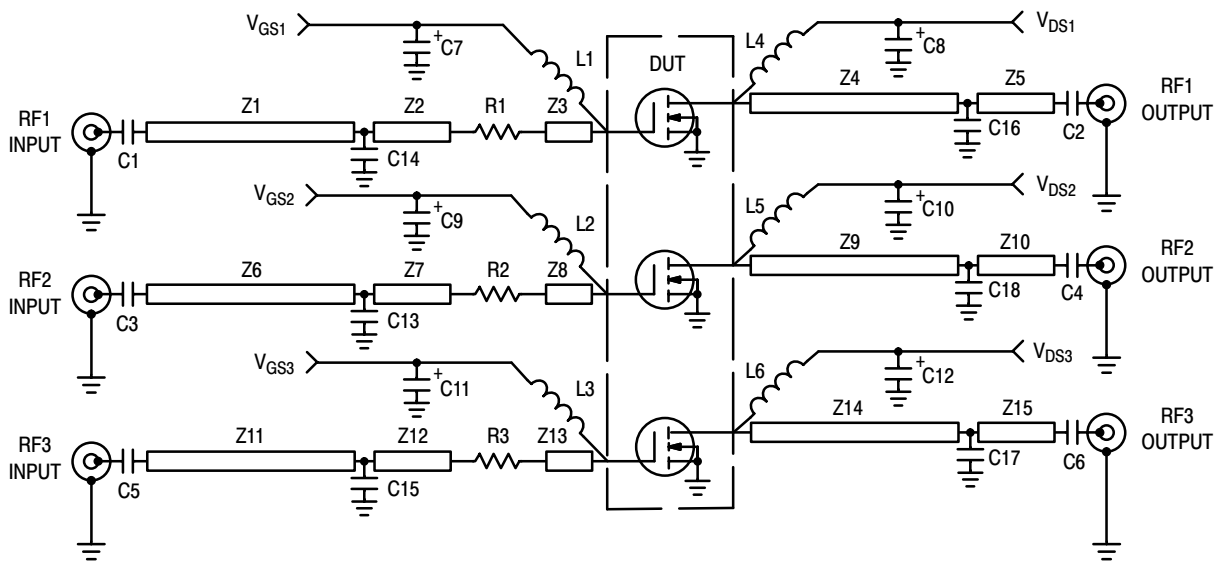
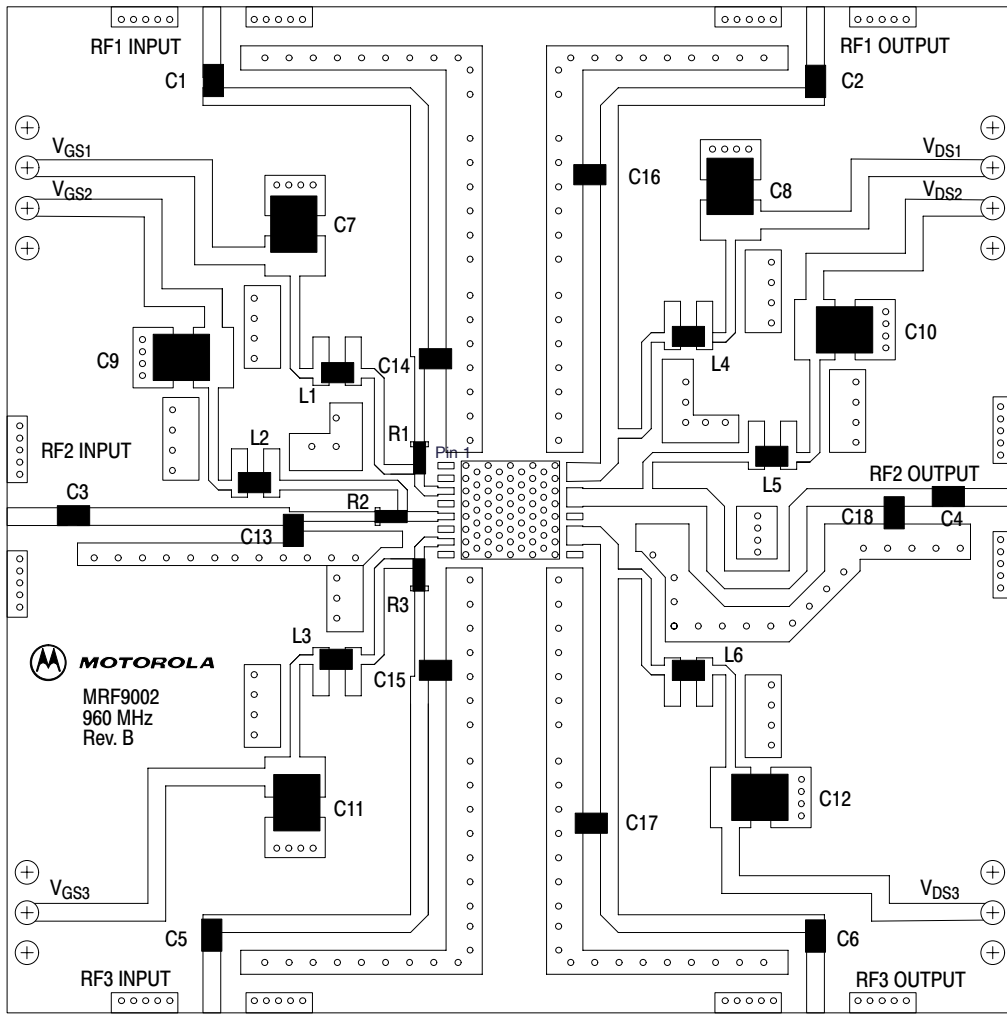


Figure 2. MRF9002NR2 Broadband Test Circuit Schematic

Table 5. MRF9002NR2 Broadband Test Circuit Component Designations and Values

Designators	Description
C1 - C6	33 pF Chip Capacitors (0805)
C7 - C12	1.0 $\mu$ 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 $\Omega$ 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



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**Figure 3. MRF9002NR2 Broadband Test Circuit Component Layout**

## TYPICAL CHARACTERISTICS

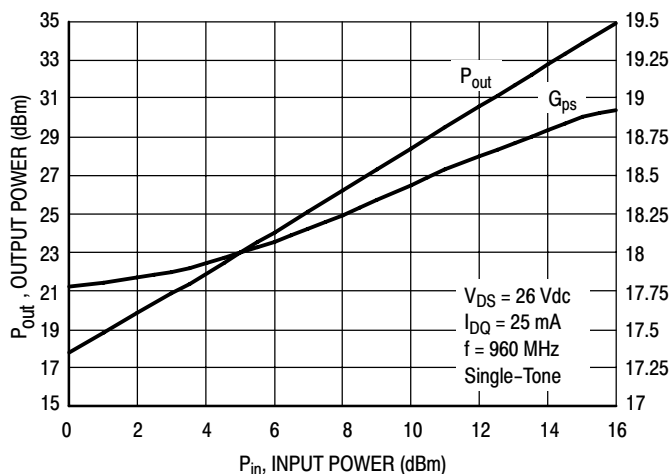


Figure 4. Output Power and Power Gain versus Input Power

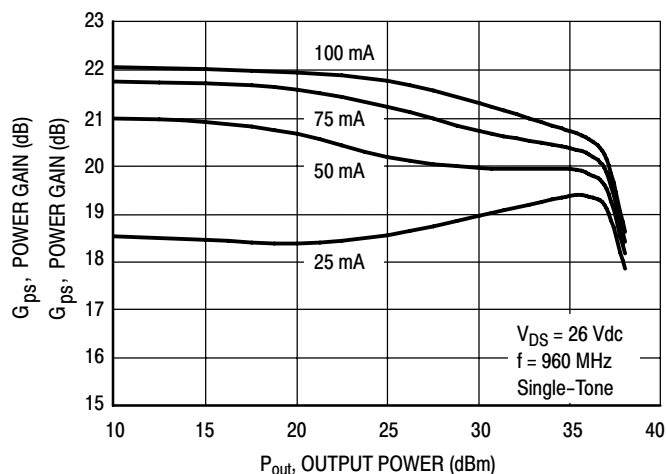


Figure 5. Power Gain versus Output Power

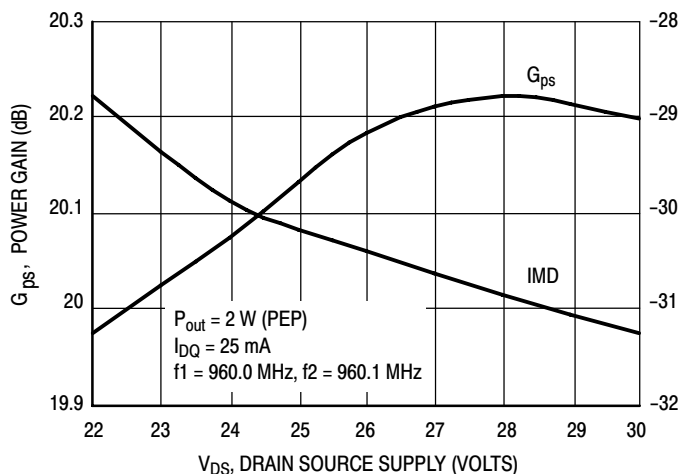


Figure 6. Power Gain and Intermodulation Distortion versus Supply Voltage

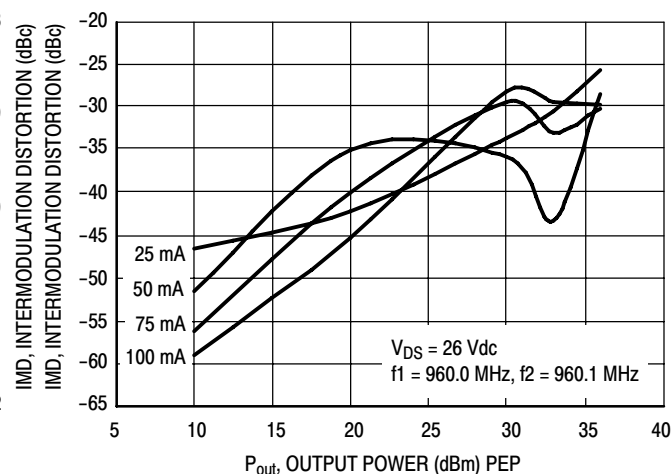


Figure 7. Intermodulation Distortion versus Output Power

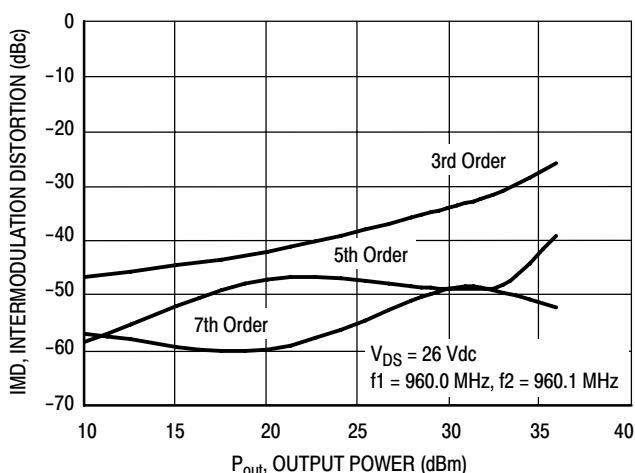


Figure 8. Intermodulation Distortion Products versus Output Power

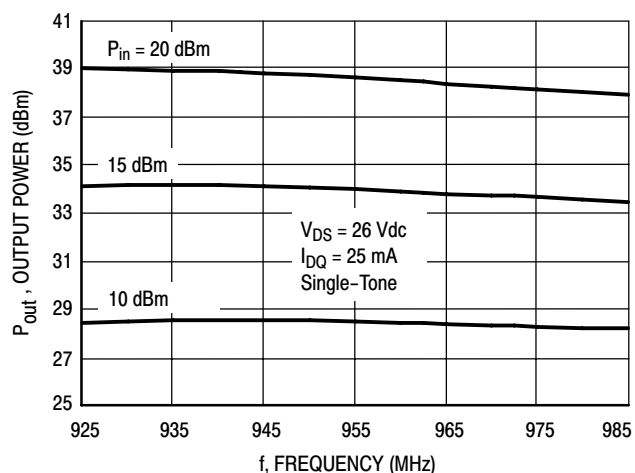
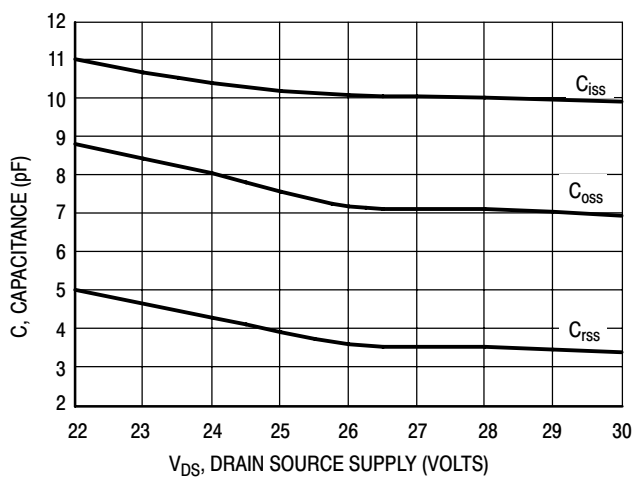
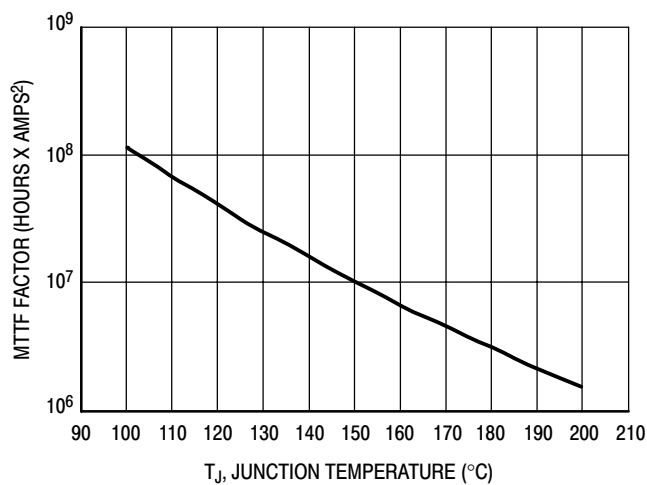


Figure 9. Output Power versus Frequency

## TYPICAL CHARACTERISTICS

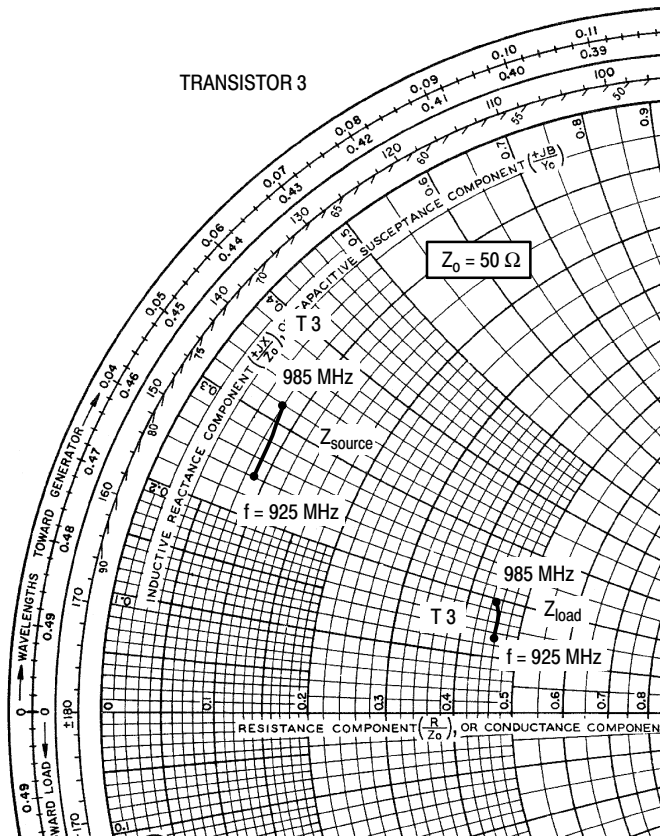
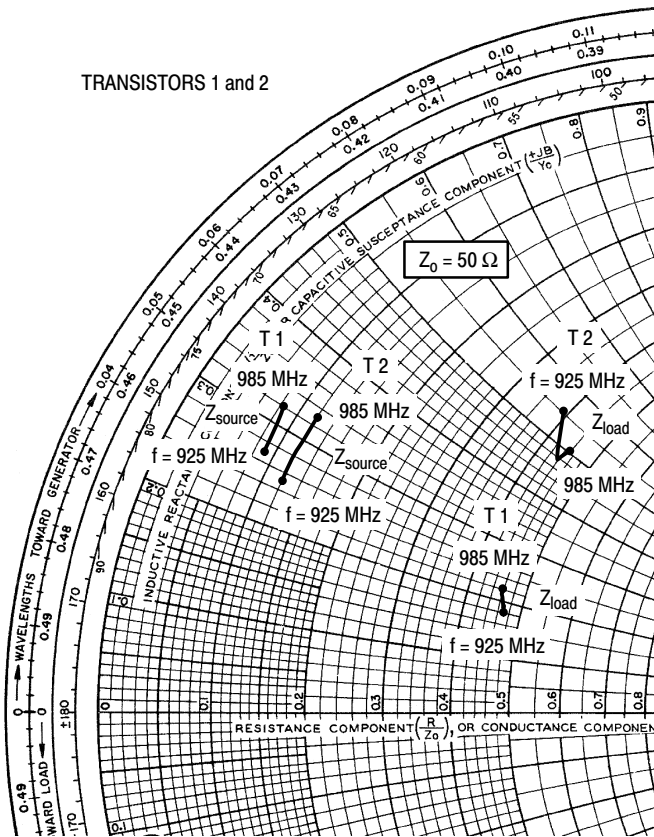


**Figure 10. Capacitance versus Drain Source Voltage**



This above graph displays calculated MTTF in hours x ampere<sup>2</sup> 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	$Z_{source}$ $\Omega$	$Z_{load}$ $\Omega$
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	$Z_{source}$ $\Omega$	$Z_{load}$ $\Omega$
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**

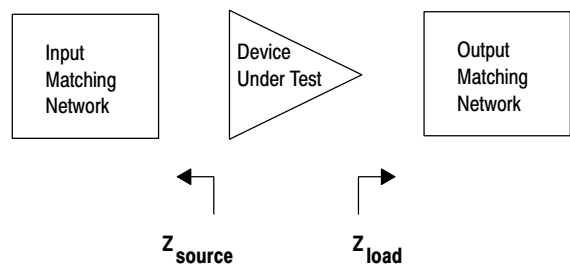
$V_{DD} = 26 \text{ V}$ ,  $I_{DQ} = 25 \text{ mA}$ ,  $P_{out} = 2 \text{ W PEP}$

f MHz	$Z_{source}$ $\Omega$	$Z_{load}$ $\Omega$
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**



## NOTES



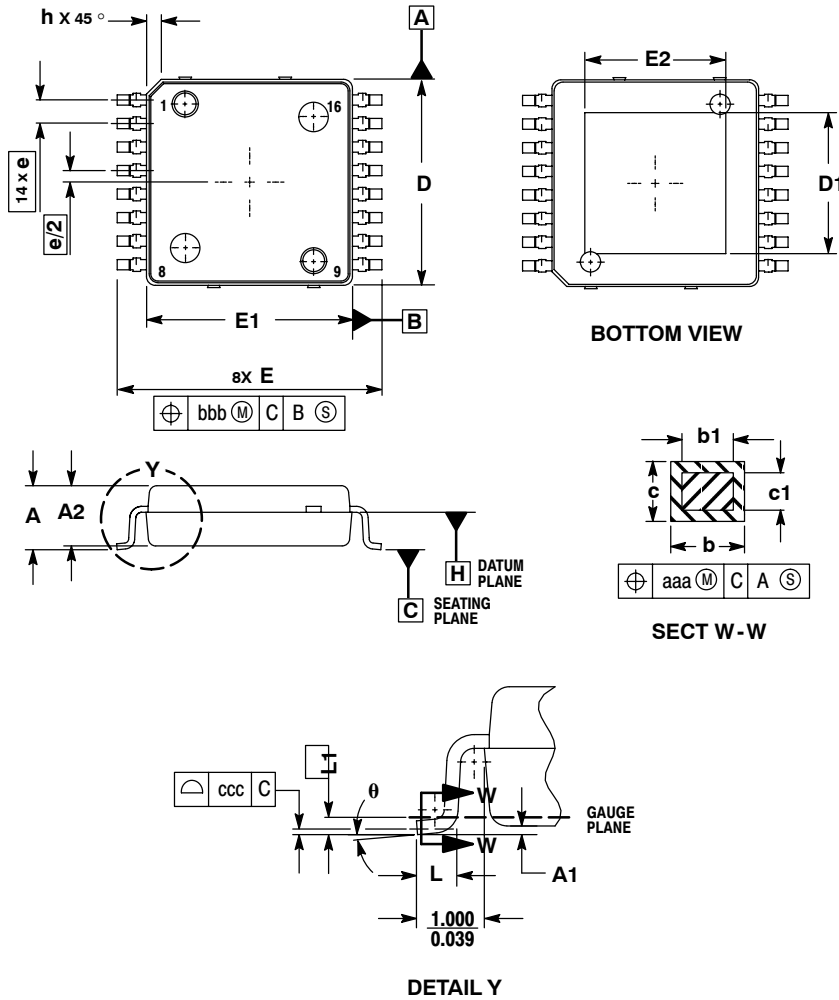


## NOTES



## NOTES

## PACKAGE DIMENSIONS



**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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