

# RF LDMOS Wideband Integrated Power Amplifier

The MW4IC001N wideband integrated circuit is designed for use as a distortion signature device in analog predistortion systems. It uses Freescale's newest High Voltage (26 to 28 Volts) LDMOS IC technology. Its wideband On Chip design makes it usable from 800 MHz to 2170 MHz. The linearity performances cover all modulations for cellular applications: GSM EDGE, TDMA, CDMA and W-CDMA.

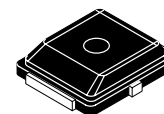
- Typical CW Performance at 2170 MHz, 28 Volts,  $I_{DQ} = 12 \text{ mA}$   
Output Power — 900 mW PEP  
Power Gain — 13 dB  
Efficiency — 38%

## Features

- High Gain, High Efficiency and High Linearity
- Designed for Maximum Gain and Insertion Phase Flatness
- Excellent Thermal Stability
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- N Suffix Indicates Lead-Free Terminations. RoHS Compliant.
- In Tape and Reel. R4 Suffix = 100 Units per 12 mm, 7 inch Reel.

**MW4IC001NR4**

**800-2170 MHz, 900 mW, 28 V  
W-CDMA  
RF LDMOS WIDEBAND  
INTEGRATED POWER AMPLIFIER**



**CASE 466-03, STYLE 1  
PLD-1.5  
PLASTIC**

**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 Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above $25^\circ\text{C}$	$P_D$	4.58 0.037	W W/ $^\circ\text{C}$
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	Unit
Thermal Resistance, Junction to Case @ $85^\circ\text{C}$	$R_{\theta JC}$	27.3	$^\circ\text{C}/\text{W}$

**Table 3. ESD Protection Characteristics**

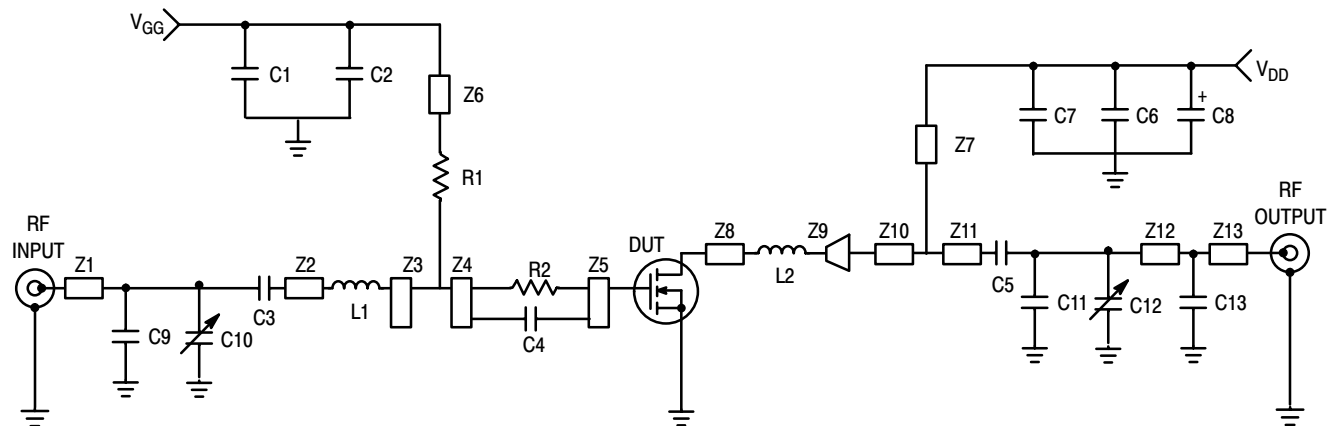
Test Conditions	Class
Human Body Model	0 (Minimum)
Machine Model	M1 (Minimum)
Charge Device Model	C2 (Minimum)

**Table 4. Moisture Sensitivity Level**

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

**Table 5. Electrical Characteristics** ( $T_C = 25^\circ\text{C}$  unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
<b>Off Characteristics</b>					
Zero Gate Voltage Drain Current ( $V_{DS} = 65\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ )	$I_{DSS}$	—	—	10	$\mu\text{Adc}$
Zero Gate Voltage Drain Current ( $V_{DS} = 28\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ )	$I_{DSS}$	—	—	10	$\mu\text{Adc}$
Gate-Source Leakage Current ( $V_{GS} = 5\text{ Vdc}$ , $V_{DS} = 0\text{ Vdc}$ )	$I_{GSS}$	—	—	1	$\mu\text{Adc}$
<b>On Characteristics</b>					
Gate Threshold Voltage ( $V_{DS} = 10\text{ V}$ , $I_D = 50\ \mu\text{A}$ )	$V_{GS(th)}$	2	3	5	Vdc
Gate Quiescent Voltage ( $V_{DS} = 28\text{ V}$ , $I_D = 10\text{ mA}$ )	$V_{GS(Q)}$	2	3.7	5	Vdc
Drain-Source On-Voltage ( $V_{GS} = 10\text{ V}$ , $I_D = 0.05\text{ A}$ )	$V_{DS(on)}$	—	0.48	0.9	Vdc
Forward Transconductance ( $V_{DS} = 10\text{ V}$ , $I_D = 0.1\text{ A}$ )	$g_{fs}$	—	0.05	—	S
<b>Dynamic Characteristics</b>					
Output Capacitance ( $V_{DS} = 28\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$ )	$C_{oss}$	—	45	—	pF
Reverse Transfer Capacitance ( $V_{DS} = 28\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$ )	$C_{rss}$	—	0.62	—	pF
<b>Functional Tests</b> (In Freescale Test Fixture, 50 ohm system)					
Two-Tone Common Source Amplifier Power Gain ( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 0.9\text{ W PEP}$ , $I_{DQ} = 12\text{ mA}$ , $f = 2170\text{ MHz}$ , Tone Spacing = 100 kHz)	$G_{ps}$	—	13	—	dB
Two-Tone Drain Efficiency ( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 0.9\text{ W PEP}$ , $I_{DQ} = 12\text{ mA}$ , $f = 2170\text{ MHz}$ , Tone Spacing = 100 kHz)	$\eta_D$	—	29	—	%
Third Order Intermodulation Distortion ( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 0.9\text{ W PEP}$ , $I_{DQ} = 12\text{ mA}$ , $f = 2170\text{ MHz}$ , Tone Spacing = 100 kHz)	IMD	—	-28	—	dBc
Input Return Loss ( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 0.9\text{ W PEP}$ , $I_{DQ} = 12\text{ mA}$ , $f = 2170\text{ MHz}$ , Tone Spacing = 100 kHz)	IRL	—	-18	—	dB
Output Power, 1 dB Compression Point, CW ( $V_{DD} = 28\text{ Vdc}$ , $I_{DQ} = 12\text{ mA}$ , $f = 2170\text{ MHz}$ )	P1dB	—	0.85	—	W
Common-Source Amplifier Power Gain ( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 0.9\text{ W CW}$ , $I_{DQ} = 12\text{ mA}$ , $f = 2170\text{ MHz}$ )	$G_{ps}$	12	13	—	dB
Drain Efficiency ( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 0.9\text{ W CW}$ , $I_{DQ} = 12\text{ mA}$ , $f = 2170\text{ MHz}$ )	$\eta_D$	35	38	—	%
Input Return Loss ( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 0.9\text{ W CW}$ , $I_{DQ} = 12\text{ mA}$ , $f = 2170\text{ MHz}$ )	IRL	-10	-16	—	dB

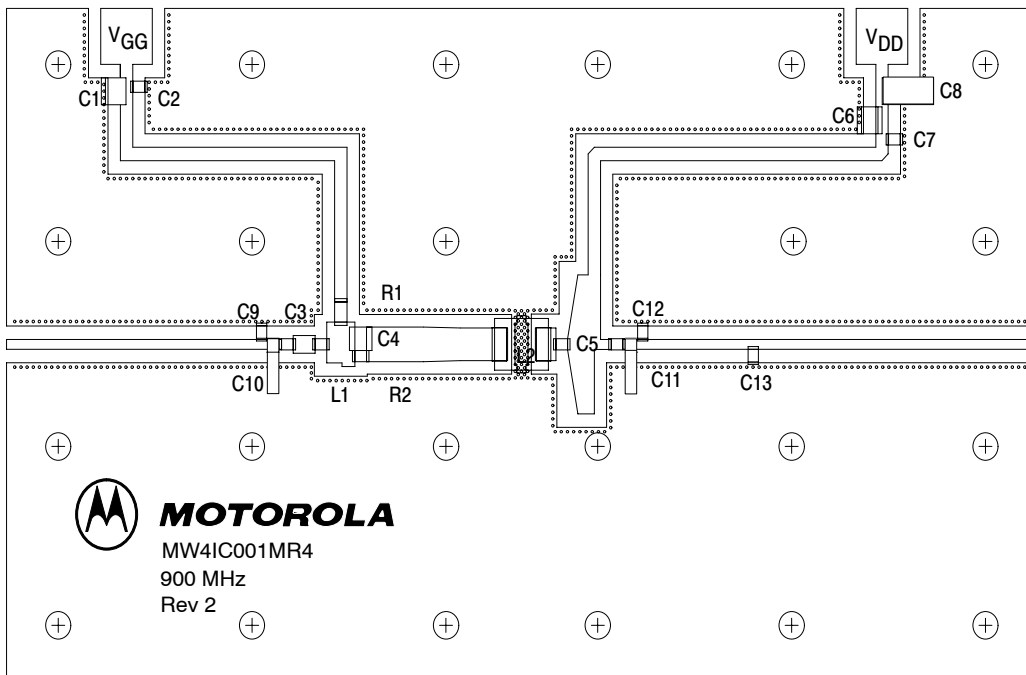


Z1	1.331" x 0.044" Microstrip	Z9	0.062" x 0.044" to 0.615" Taper
Z2	0.126" x 0.076" Microstrip	Z10	0.082" x 0.615" Microstrip
Z3	0.065" x 0.175" Microstrip	Z11	0.075" x 0.044" Microstrip
Z4	0.065" x 0.195" Microstrip	Z12	0.625" x 0.044" Microstrip
Z5	0.680" x 0.145" Microstrip	Z13	1.375" x 0.044" Microstrip
Z6, Z7	1.915" x 0.055" Microstrip	PCB	Rogers RO4350, 0.020", $\epsilon_r = 3.5$
Z8	0.120" x 0.141" Microstrip		

**Figure 1. MW4IC001NR4 900 MHz Test Circuit Schematic**

**Table 6. MW4IC001NR4 900 MHz Test Circuit Component Designations and Values**

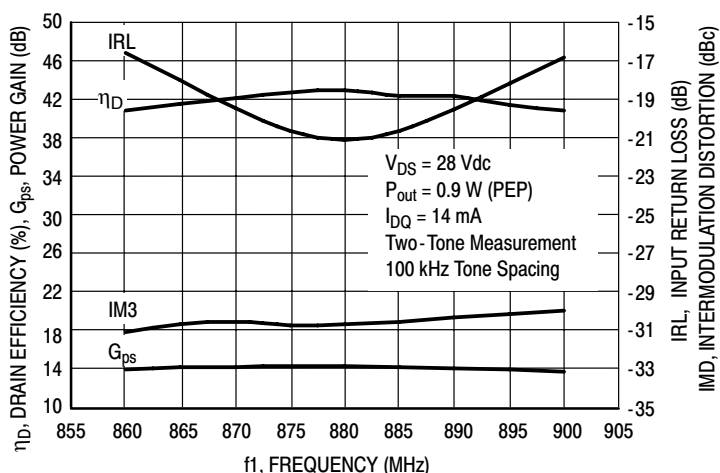
Part	Description	Part Number	Manufacturer
C1, C6	0.1 $\mu$ F, 100 V Chip Capacitors	C1210C104K5RACTR	Kemet
C2, C3, C5, C7	43 pF, 500 V Chip Capacitors	100B430JP500X	ATC
C4	12 pF, 500 V Chip Capacitor	100B120JP500X	ATC
C8	22 $\mu$ F, 35 V Tantalum Chip Capacitor	T491X226K035AS	Kemet
C9	4.7 pF, 500 V Chip Capacitor	100B4R7CP500X	ATC
C10, C11	0.6-4.5 pF, 500 V Variable Capacitors	27271SL	Johanson
C12	2.7 pF, 500 V Chip Capacitor	100B2R7CP500X	ATC
C13	3.3 pF, 500 V Chip Capacitor	100B3R3CP500X	ATC
L1	5.6 nH Chip Inductor	0805 Series	AVX
L2	10 nH Chip Inductor	1008 Series	ATC
R1	100 $\Omega$ Chip Resistor	CRCW12061001F100	Dale
R2	20 $\Omega$ Chip Resistor	CRCW120620R0F100	Dale



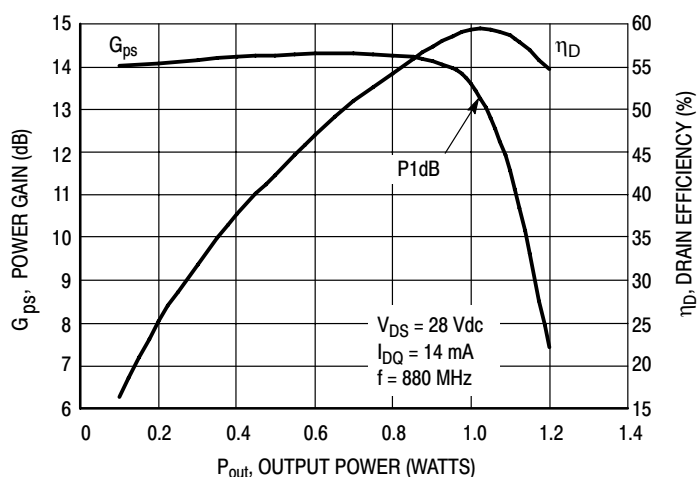
Freescall has begun the transition of marking Printed Circuit Boards (PCBs) with the Freescall Semiconductor signature/logo. PCBs may have either Motorola or Freescall markings during the transition period. These changes will have no impact on form, fit or function of the current product.

**Figure 2. MW4IC001NR4 900 MHz Test Circuit Component Layout**

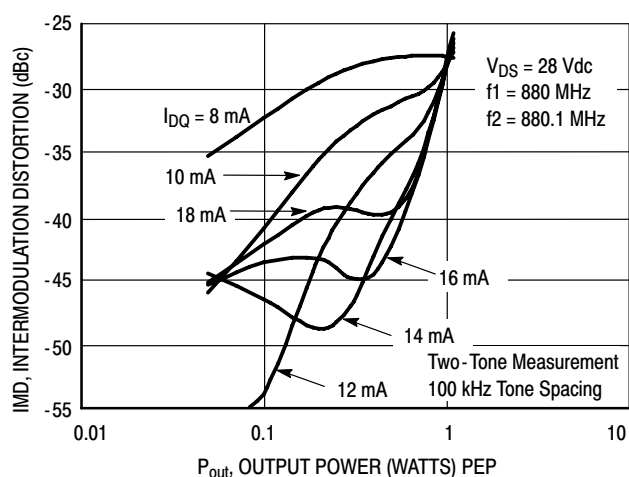
### TYPICAL CHARACTERISTICS - 900 MHz



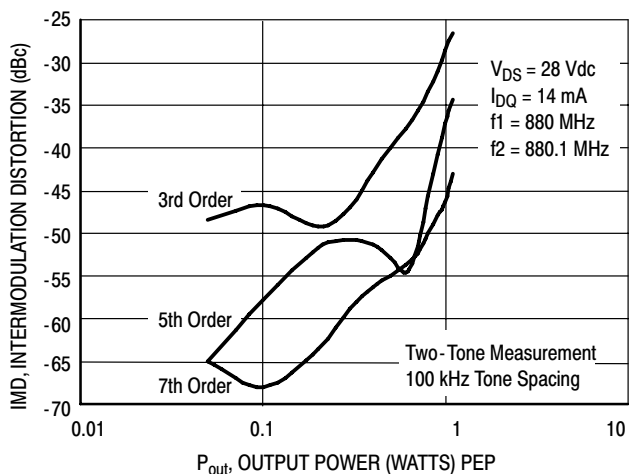
**Figure 3. Two-Tone Performance versus Frequency**



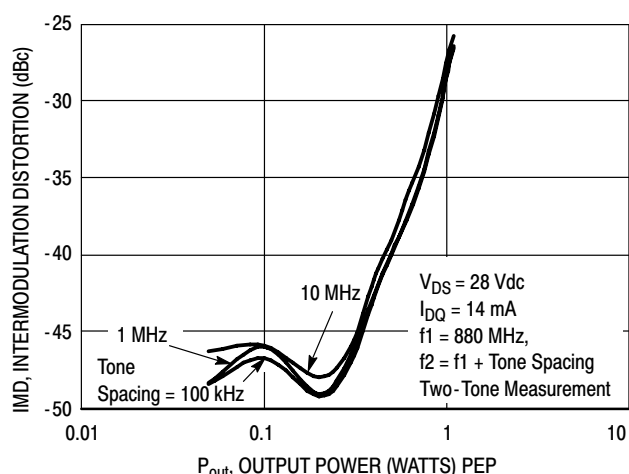
**Figure 4. CW Performance versus Output Power**



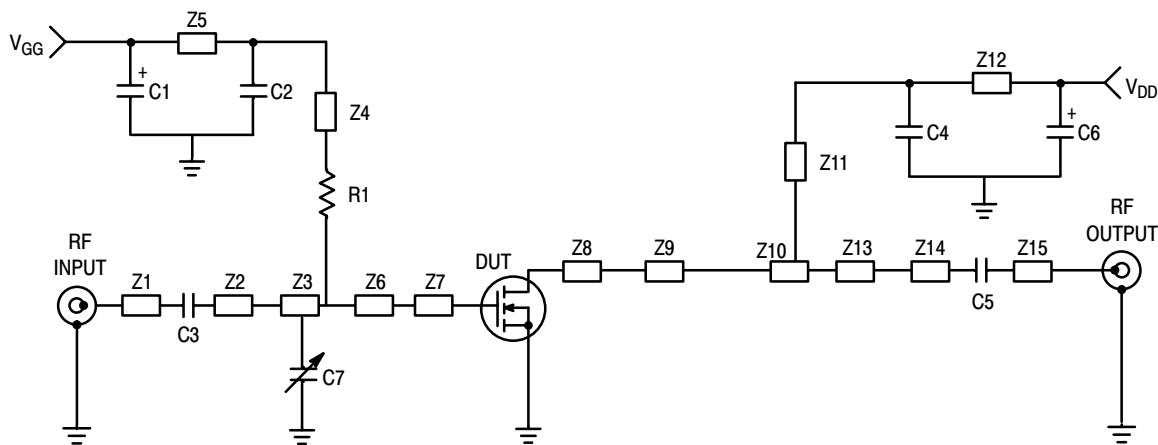
**Figure 5. Intermodulation Distortion versus Output Power**



**Figure 6. Intermodulation Distortion Products versus Output Power**



**Figure 7. Third Order Intermodulation Distortion versus Output Power**

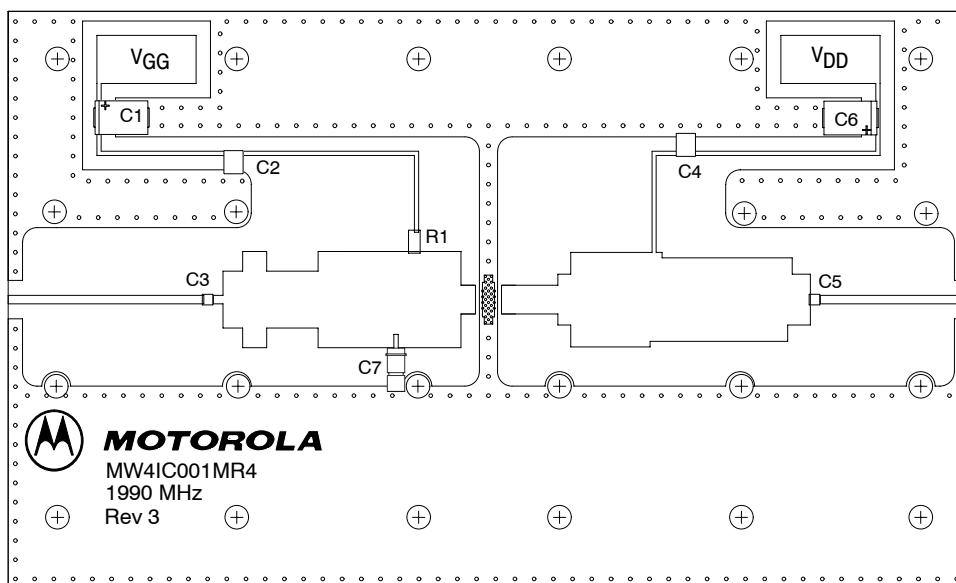


Z1	1.018" x 0.044" Microstrip	Z9	0.067" x 0.264" Microstrip
Z2	0.495" x 0.296" Microstrip	Z10	0.457" x 0.492" Microstrip
Z3	0.893" x 0.500" Microstrip	Z11	0.719" x 0.022" Microstrip
Z4	1.340" x 0.022" Microstrip	Z12	1.149" x 0.022" Microstrip
Z5	0.912" x 0.022" Microstrip	Z13	0.677" x 0.434" Microstrip
Z6	0.241" x 0.500" Microstrip	Z14	0.095" x 0.264" Microstrip
Z7	0.076" x 0.150" Microstrip	Z15	0.772" x 0.044" Microstrip
Z8	0.294" x 0.150" Microstrip	PCB	Rogers RO4350, 0.020", $\epsilon_r = 3.5$

**Figure 8. MW4IC001NR4 1990 MHz Test Circuit Schematic**

**Table 7. MW4IC001NR4 1990 MHz Test Circuit Component Designations and Values**

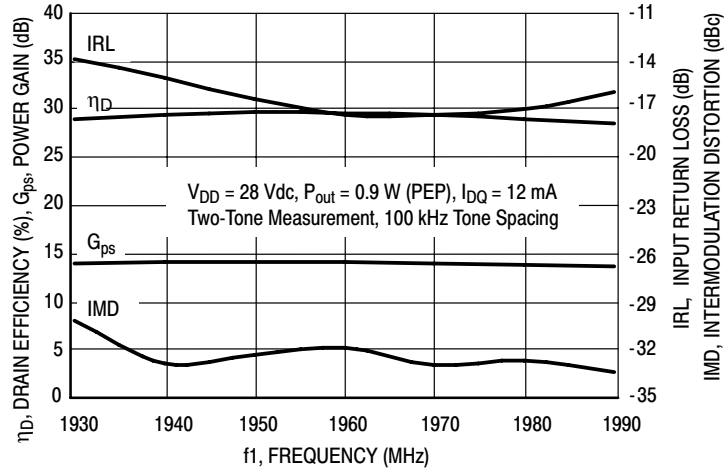
Part	Description	Part Number	Manufacturer
C1, C6	22 $\mu$ F, 35 V Tantalum Capacitors	T491X226K035AS	Kemet
C2, C4	10 pF, 500 V Chip Capacitors	100B100JCA500X	ATC
C3, C5	10 pF, 500 V Chip Capacitor	600S100JW	ATC
C7	0.6-4.5 pF, 500 V Variable Capacitor	27271SL	Johanson
R1	1 k $\Omega$ Chip Resistor	CRCW12061021F100	Dale



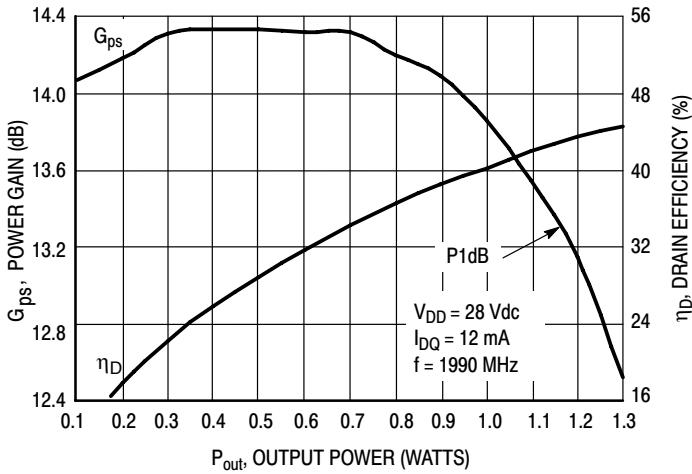
Freescale has begun the transition of marking Printed Circuit Boards (PCBs) with the Freescale Semiconductor signature/logo. PCBs may have either Motorola or Freescale markings during the transition period. These changes will have no impact on form, fit or function of the current product.

**Figure 9. MW4IC001NR4 1990 MHz Test Circuit Component Layout**

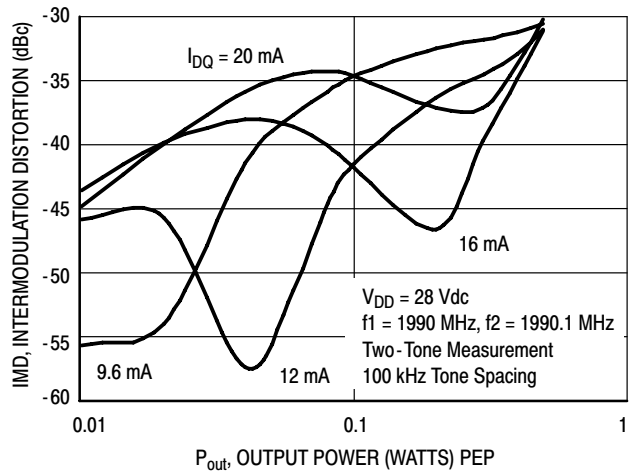
### TYPICAL CHARACTERISTICS - 1990 MHz



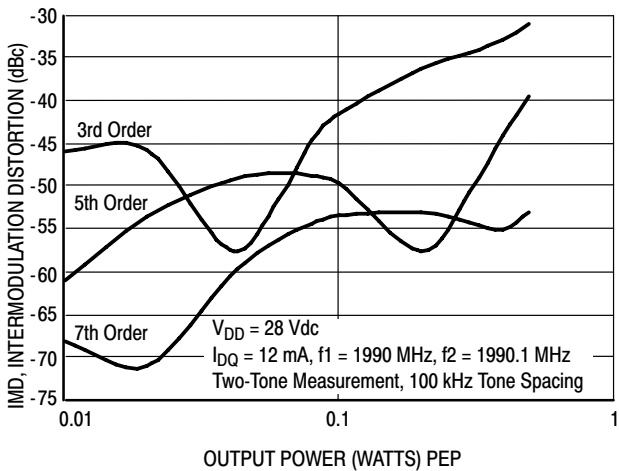
**Figure 10. Two-Tone Performance versus Frequency**



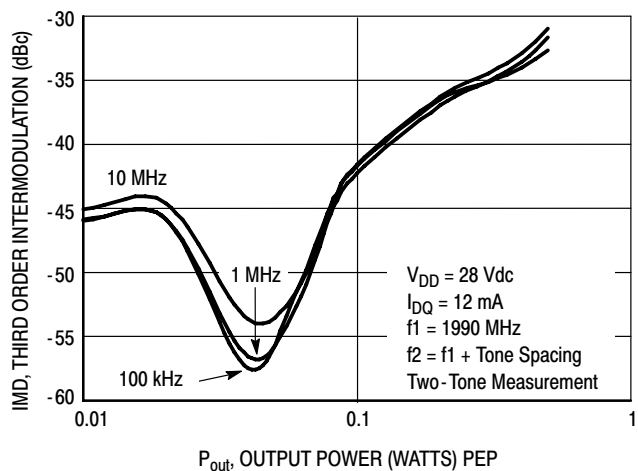
**Figure 11. CW Performance versus Output Power**



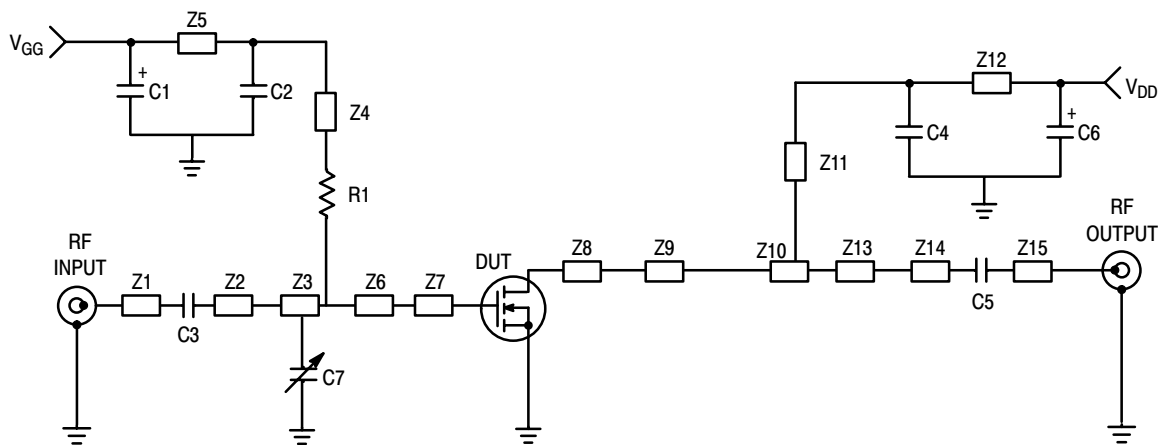
**Figure 12. Intermodulation Distortion versus Output Power**



**Figure 13. Intermodulation Distortion Products versus Output Power**



**Figure 14. Third Order Intermodulation Distortion versus Output Power**

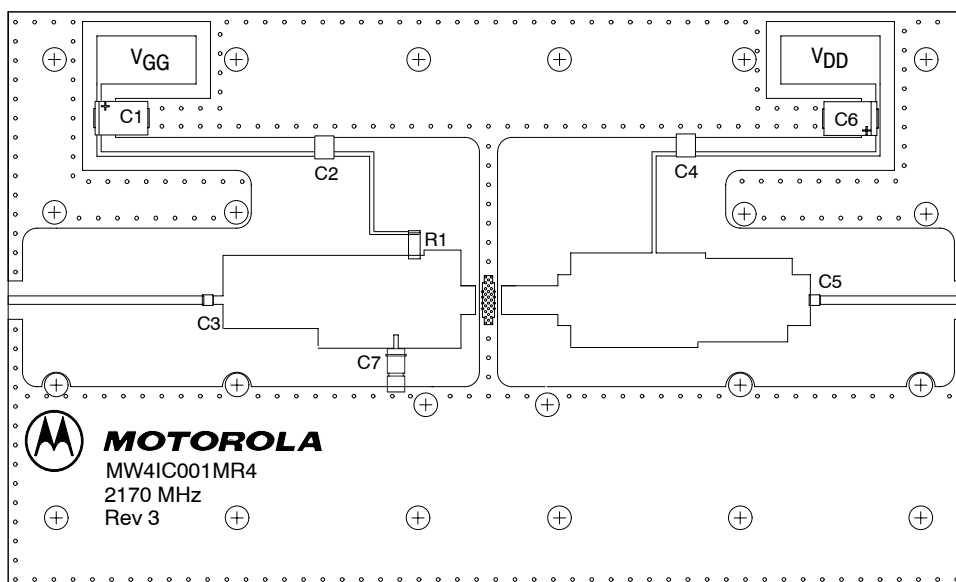


Z1	1.267" x 0.044" Microstrip	Z9	0.106" x 0.344" Microstrip
Z2	0.058" x 0.044" Microstrip	Z10	0.783" x 0.500" Microstrip
Z3	0.758" x 0.256" Microstrip	Z11	0.847" x 0.022" Microstrip
Z4	1.073" x 0.022" Microstrip	Z12	1.055" x 0.022" Microstrip
Z5	1.361" x 0.022" Microstrip	Z13	0.291" x 0.387" Microstrip
Z6	0.205" x 0.332" Microstrip	Z14	0.050" x 0.287" Microstrip
Z7	0.109" x 0.150" Microstrip	Z15	0.950" x 0.044" Microstrip
Z8	0.210" x 0.150" Microstrip	PCB	Rogers RO4350, 0.020", $\epsilon_r = 3.5$

Figure 15. MW4IC001NR4 2170 MHz Test Circuit Schematic

Table 8. MW4IC001NR4 2170 MHz Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C6	22 $\mu$ F, 35 V Tantalum Capacitors	T491X226K035AS	Kemet
C2, C4	10 pF, 500 V Chip Capacitors	100B100JCA500X	ATC
C3, C5	10 pF, 500 V Chip Capacitor	600S100JW	ATC
C7	0.6-4.5 pF, 500 V Variable Capacitor	27271SL	Johanson
R1	1 k $\Omega$ Chip Resistor	CRCW12061021F100	Dale

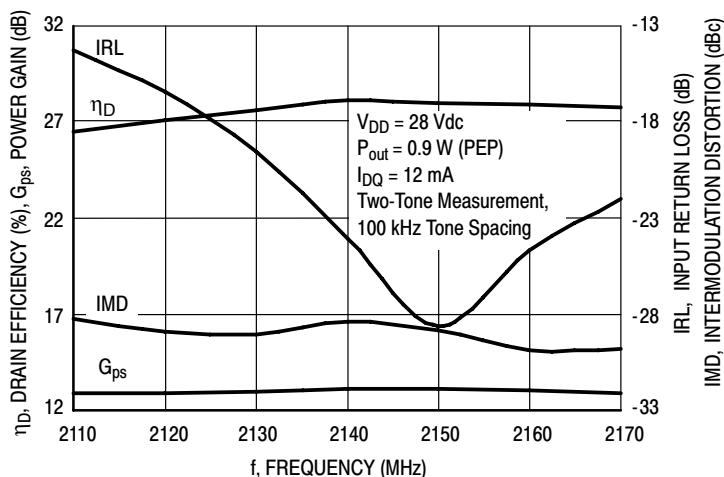


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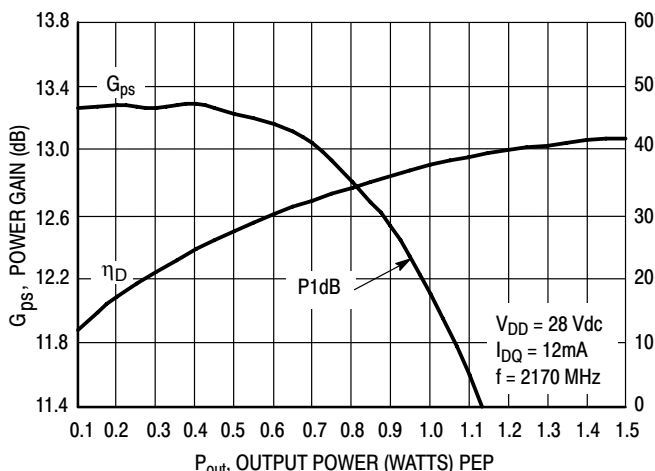
Figure 16. MW4IC001NR4 2170 MHz Test Circuit Component Layout



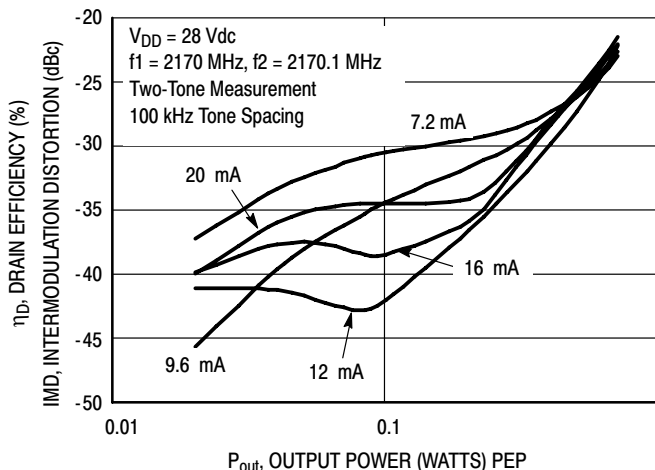
### TYPICAL CHARACTERISTICS - 2170 MHz



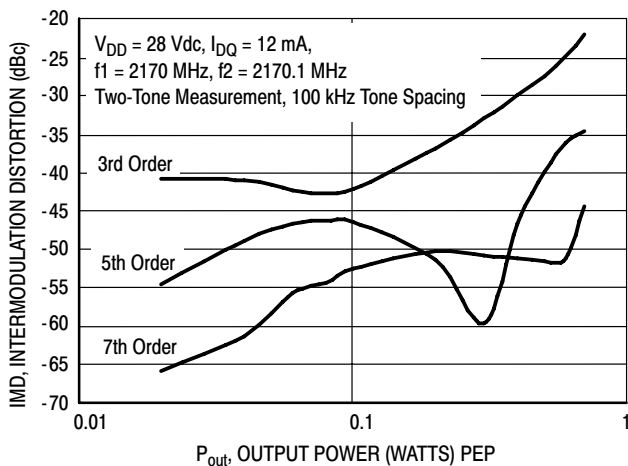
**Figure 17. Two-Tone Performance versus Frequency**



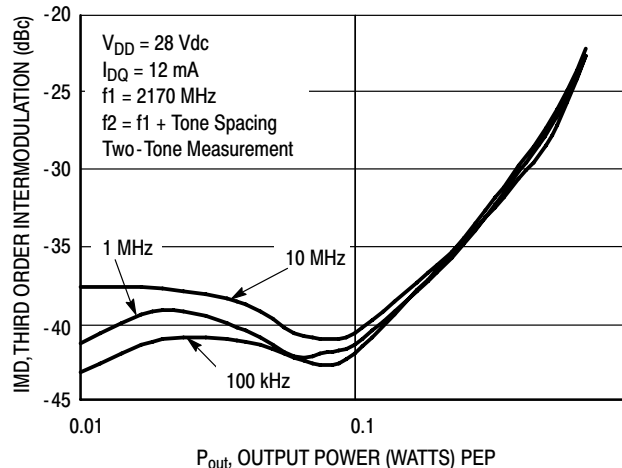
**Figure 18. CW Performance versus Output Power**



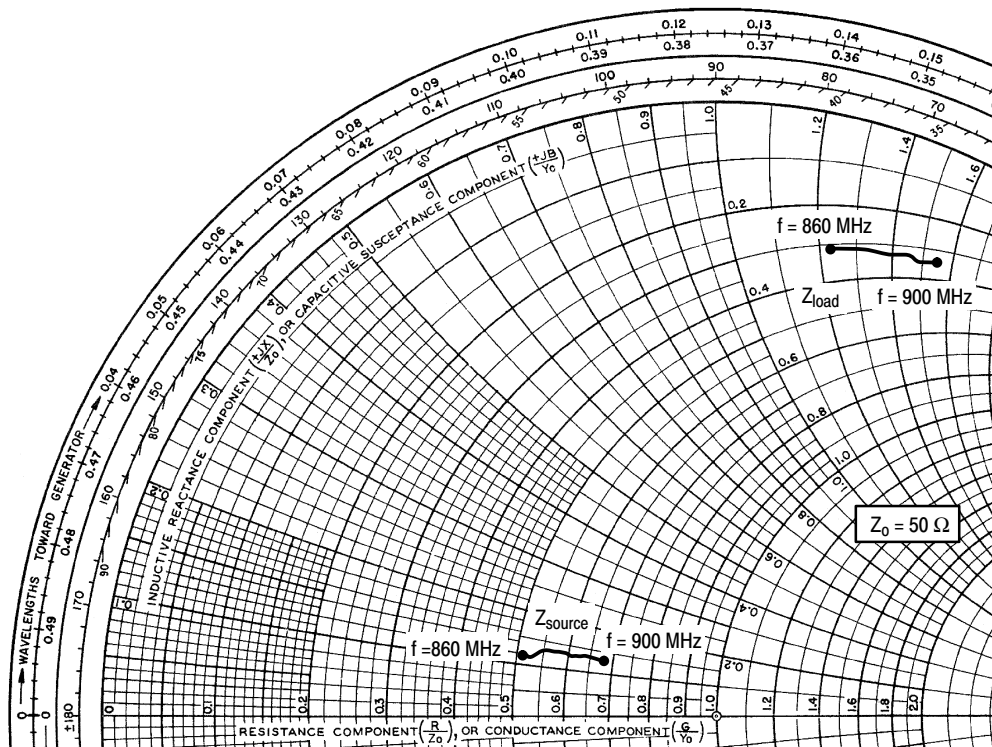
**Figure 19. Intermodulation Distortion versus Output Power**



**Figure 20. Intermodulation Distortion Products versus Output Power**



**Figure 21. Third Order Intermodulation Distortion versus Output Power**



$V_{DD} = 28\text{ V}$ ,  $I_{DQ} = 14\text{ mA}$ ,  $P_{out} = 0.9\text{ W PEP}$

f MHz	$Z_{source}$ $\Omega$	$Z_{load}$ $\Omega$
860	$27.853 + j5.908$	$15.492 + j63.669$
865	$28.617 + j6.078$	$15.592 + j68.687$
870	$29.458 + j6.285$	$15.788 + j69.799$
875	$30.306 + j6.422$	$15.835 + j70.863$
880	$31.223 + j6.567$	$15.975 + j71.920$
885	$32.194 + j6.660$	$16.094 + j73.091$
890	$33.228 + j6.656$	$16.286 + j74.159$
895	$34.293 + j6.624$	$16.344 + j75.236$
900	$35.424 + j6.508$	$16.628 + j76.283$

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

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

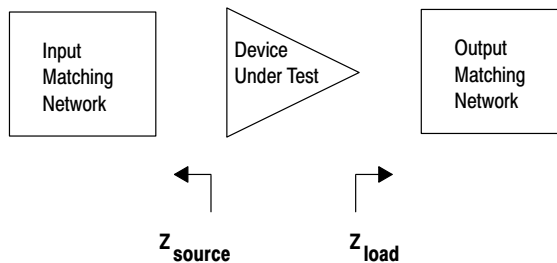
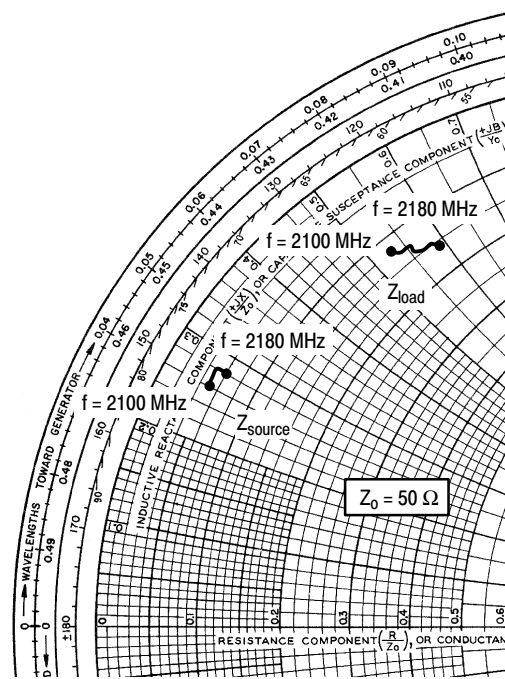
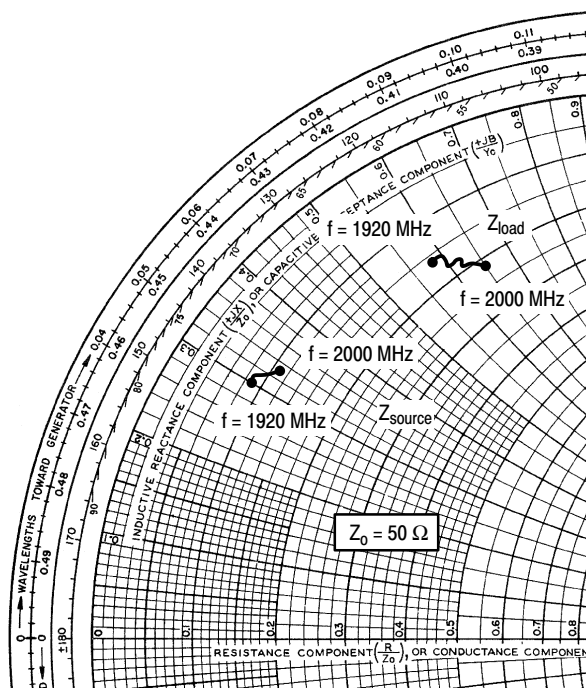


Figure 22. Series Equivalent Source and Load Impedance

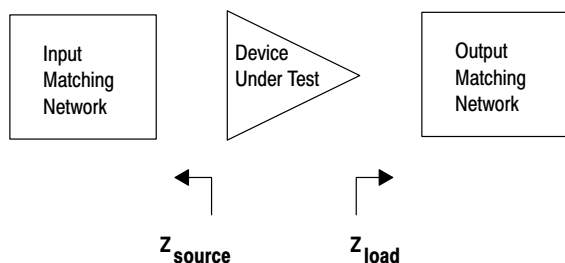


$V_{DD} = 28 \text{ V}$ ,  $I_{DQ} = 12 \text{ mA}$ ,  $P_{out} = 0.9 \text{ W PEP}$

f MHz	$Z_{source} \Omega$	$Z_{load} \Omega$
1920	$4.238 + j15.142$	$7.764 + j28.829$
1930	$4.322 + j15.362$	$8.056 + j29.352$
1940	$4.490 + j15.466$	$8.436 + j29.727$
1950	$4.605 + j15.711$	$8.809 + j30.249$
1960	$4.752 + j15.904$	$9.183 + j30.763$
1970	$4.905 + j16.050$	$9.598 + j31.213$
1980	$5.071 + j16.236$	$10.030 + j31.690$
1990	$5.262 + j16.446$	$10.546 + j32.237$
2000	$5.487 + j16.632$	$11.054 + j32.726$

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

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



$V_{DD} = 28 \text{ V}$ ,  $I_{DQ} = 12 \text{ mA}$ ,  $P_{out} = 0.9 \text{ W PEP}$

f MHz	$Z_{source} \Omega$	$Z_{load} \Omega$
2100	$2.667 + j12.903$	$5.892 + j26.374$
2110	$2.671 + j13.070$	$6.092 + j26.739$
2120	$2.664 + j13.224$	$6.281 + j27.094$
2130	$2.694 + j13.431$	$6.540 + j27.510$
2140	$2.703 + j13.511$	$6.748 + j27.795$
2150	$2.702 + j13.700$	$6.996 + j28.182$
2160	$2.745 + j13.952$	$7.300 + j28.678$
2170	$2.754 + j14.026$	$7.562 + j28.987$
2180	$2.784 + j14.206$	$7.862 + j29.411$

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

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

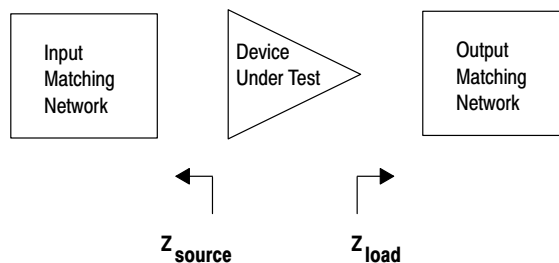


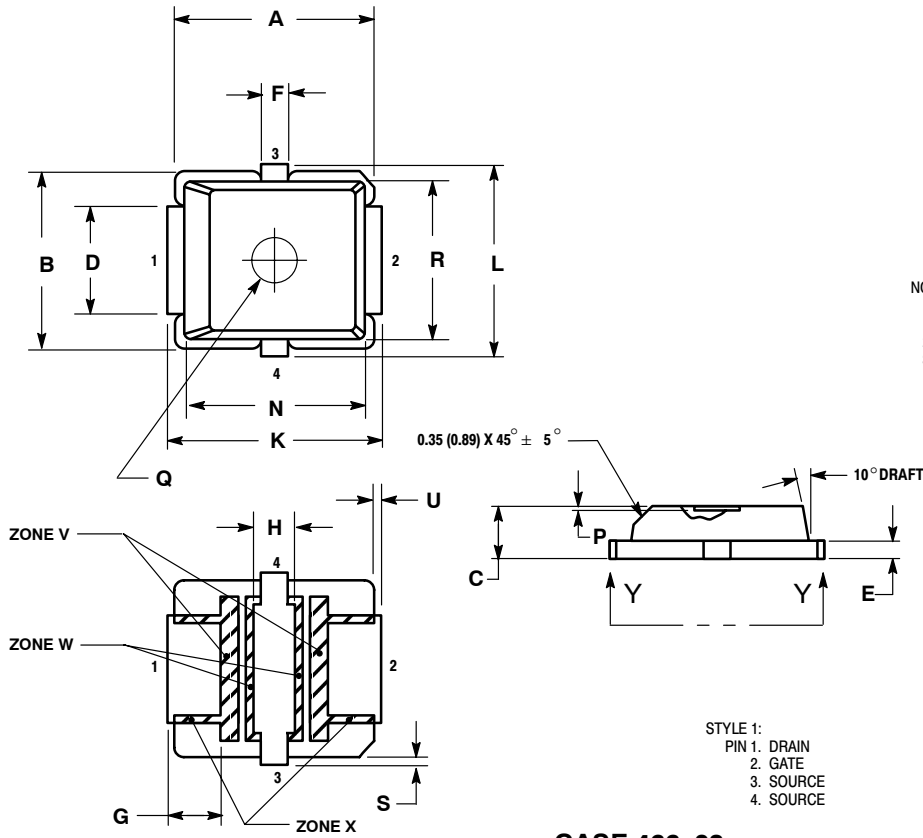
Figure 23. Series Equivalent Source and Load Impedance

# NOTES

# NOTES

# NOTES

## PACKAGE DIMENSIONS



- NOTES:
1. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1984.
  2. CONTROLLING DIMENSION: INCH
  3. RESIN BLEED/FLASH ALLOWABLE IN ZONE V, W, AND X.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.255	0.265	6.48	6.73
B	0.225	0.235	5.72	5.97
C	0.065	0.072	1.65	1.83
D	0.130	0.150	3.30	3.81
E	0.021	0.026	0.53	0.66
F	0.026	0.044	0.66	1.12
G	0.050	0.070	1.27	1.78
H	0.045	0.063	1.14	1.60
J	0.160	0.180	4.06	4.57
K	0.273	0.285	6.93	7.24
L	0.245	0.255	6.22	6.48
N	0.230	0.240	5.84	6.10
P	0.000	0.008	0.00	0.20
Q	0.055	0.063	1.40	1.60
R	0.200	0.210	5.08	5.33
S	0.006	0.012	0.15	0.31
U	0.006	0.012	0.15	0.31
ZONE V	0.000	0.021	0.00	0.53
ZONE W	0.000	0.010	0.00	0.25
ZONE X	0.000	0.010	0.00	0.25

STYLE 1:  
 PIN 1. DRAIN  
 2. GATE  
 3. SOURCE  
 4. SOURCE

**CASE 466-03  
 ISSUE D  
 PLD-1.5  
 PLASTIC**

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support@freescale.com

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Freescale Semiconductor  
Technical Information Center, CH370  
1300 N. Alma School Road  
Chandler, Arizona 85224  
+1-800-521-6274 or +1-480-768-2130  
support@freescale.com

**Europe, Middle East, and Africa:**  
Freescale Halbleiter Deutschland GmbH  
Technical Information Center  
Schatzbogen 7  
81829 Muenchen, Germany  
+44 1296 380 456 (English)  
+46 8 52200080 (English)  
+49 89 92103 559 (German)  
+33 1 69 35 48 48 (French)  
support@freescale.com

**Japan:**  
Freescale Semiconductor Japan Ltd.  
Headquarters  
ARCO Tower 15F  
1-8-1, Shimo-Meguro, Meguro-ku,  
Tokyo 153-0064  
Japan  
0120 191014 or +81 3 5437 9125  
support.japan@freescale.com

**Asia/Pacific:**  
Freescale Semiconductor Hong Kong Ltd.  
Technical Information Center  
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Tai Po Industrial Estate  
Tai Po, N.T., Hong Kong  
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