

RF LDMOS Wideband Integrated Power Amplifiers

The MW4IC001 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, $I_{DQ} = 12$ mA
 Output Power — 900 mW PEP
 Power Gain — 13 dB
 Efficiency — 38%
- 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
- In Tape and Reel. R4 Suffix = 100 Units per 12 mm, 7 inch Reel.

MW4IC001NR4
MW4IC001MR4

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

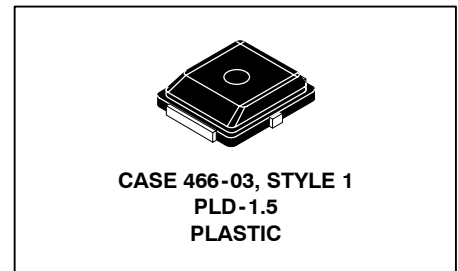


Table 1. Maximum Ratings

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°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°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)

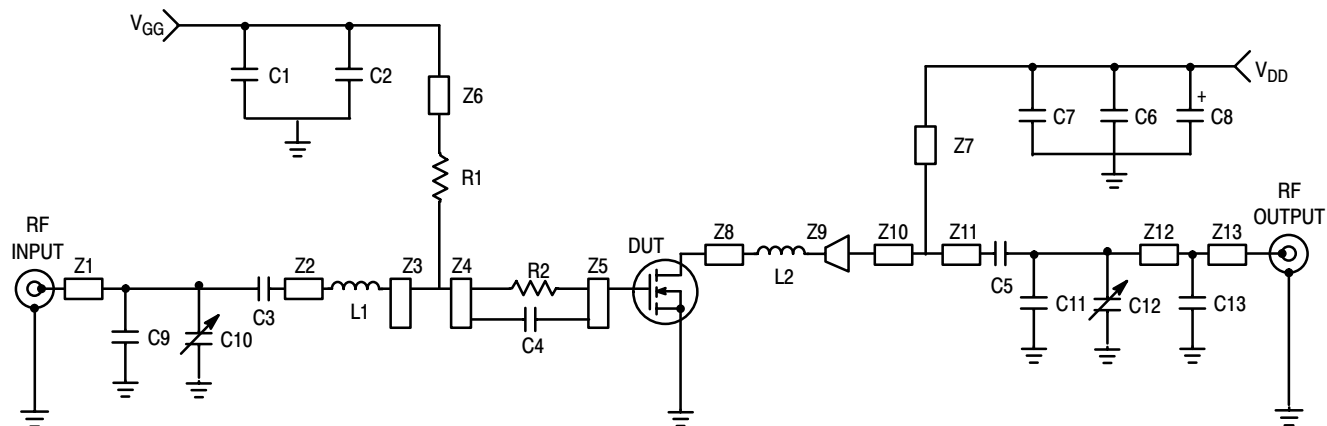
Table 4. Moisture Sensitivity Level

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

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

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

Characteristic	Symbol	Min	Typ	Max	Unit
Off Characteristics					
Zero Gate Voltage Drain Current ($V_{DS} = 65\text{ Vdc}$, $V_{GS} = 0\text{ Vdc}$)	I_{DSS}	—	—	10	μA
Zero Gate Voltage Drain Current ($V_{DS} = 28\text{ Vdc}$, $V_{GS} = 0\text{ Vdc}$)	I_{DSS}	—	—	10	μA
Gate-Source Leakage Current ($V_{GS} = 5\text{ Vdc}$, $V_{DS} = 0\text{ Vdc}$)	I_{GSS}	—	—	1	μA
On Characteristics					
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
Dynamic Characteristics					
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
Functional Tests (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)	η_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 ($V_{DD} = 28\text{ Vdc}$, $P_{out} = 0.9\text{ W CW}$, $I_{DQ} = 12\text{ mA}$, $f = 2170\text{ MHz}$)	η_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

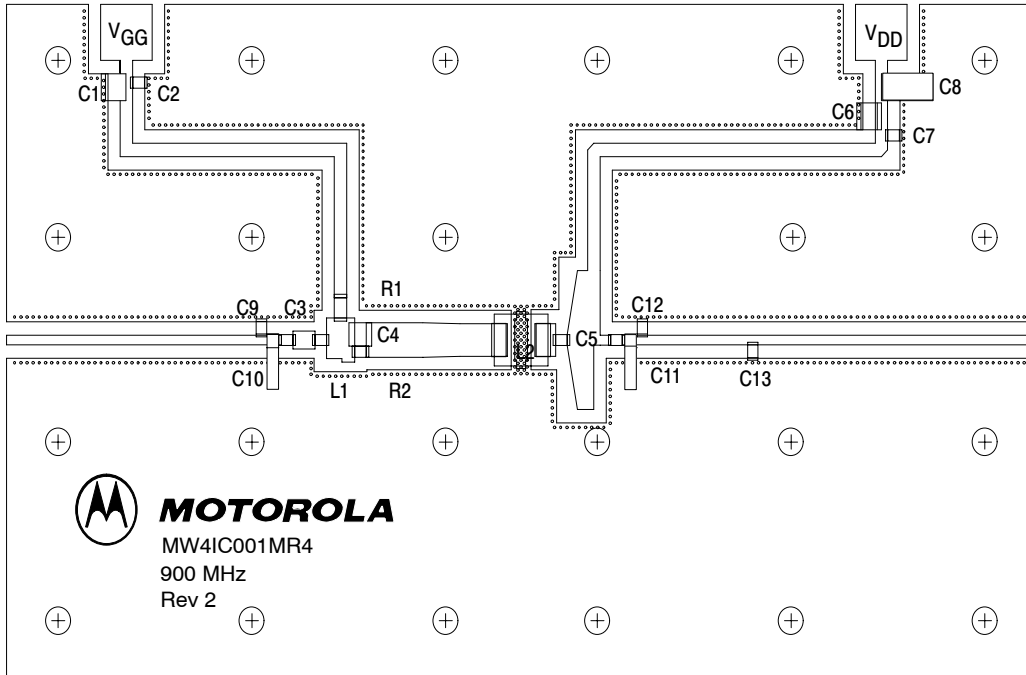


Z1	1.331" x 0.044" Microstrip	Z9	0.062" x 0.044" to 0.615" Taper
Z2	0.126" x 0.076" Microstrip	Z10	0.082" x 0.615" Microstrip
Z3	0.065" x 0.175" Microstrip	Z11	0.075" x 0.044" Microstrip
Z4	0.065" x 0.195" Microstrip	Z12	0.625" x 0.044" Microstrip
Z5	0.680" x 0.145" Microstrip	Z13	1.375" x 0.044" Microstrip
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(MR4) 900 MHz Test Circuit Schematic

Table 6. MW4IC001NR4(MR4) 900 MHz Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C6	0.1 μ 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 μ 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 Ω Chip Resistor	CRCW12061001F100	Dale
R2	20 Ω Chip Resistor	CRCW120620R0F100	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 2. MW4IC001NR4(MR4) 900 MHz Test Circuit Component Layout

TYPICAL CHARACTERISTICS - 900 MHz

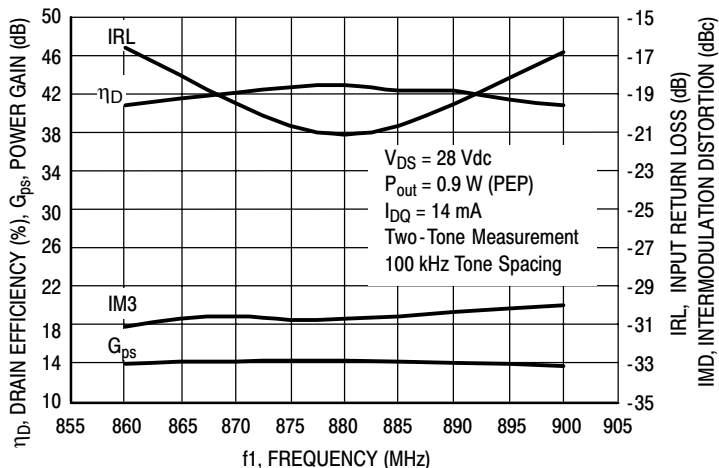


Figure 3. Two-Tone Performance versus Frequency

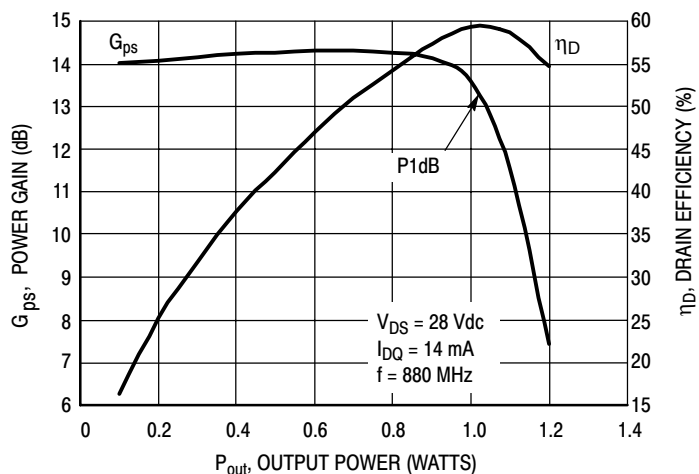


Figure 4. CW Performance versus Output Power

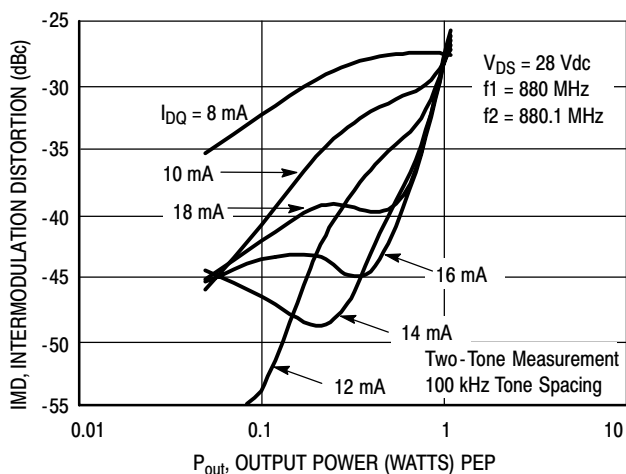


Figure 5. Intermodulation Distortion versus Output Power

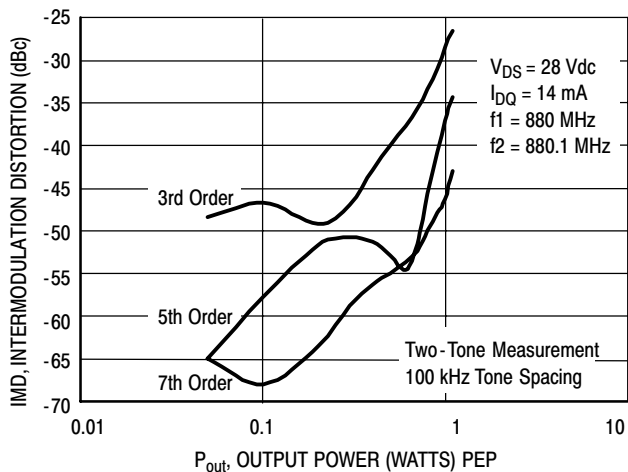


Figure 6. Intermodulation Distortion Products versus Output Power

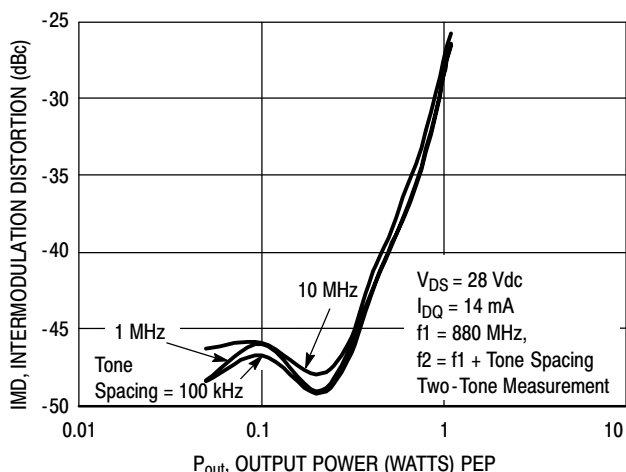
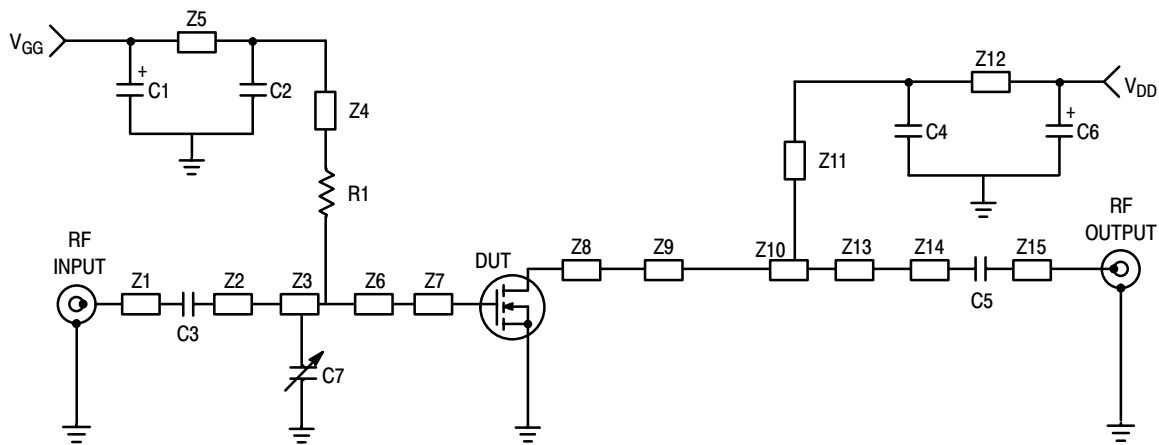


Figure 7. Third Order Intermodulation Distortion versus Output Power

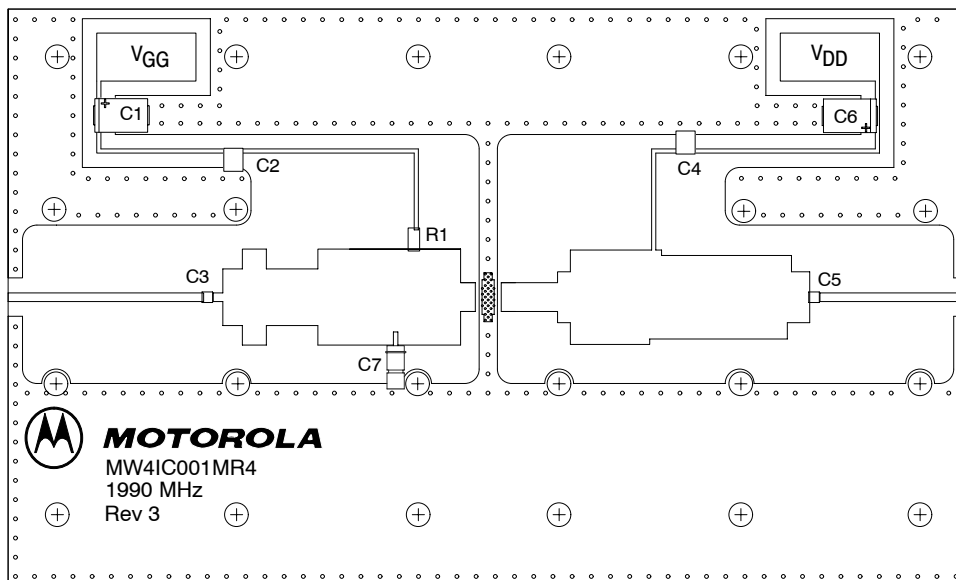


Z1	1.018" x 0.044" Microstrip	Z9	0.067" x 0.264" Microstrip
Z2	0.495" x 0.296" Microstrip	Z10	0.457" x 0.492" Microstrip
Z3	0.893" x 0.500" Microstrip	Z11	0.719" x 0.022" Microstrip
Z4	1.340" x 0.022" Microstrip	Z12	1.149" x 0.022" Microstrip
Z5	0.912" x 0.022" Microstrip	Z13	0.677" x 0.434" Microstrip
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(MR4) 1990 MHz Test Circuit Schematic

Table 7. MW4IC001NR4(MR4) 1990 MHz Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C6	22 μ 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 Ω Chip Resistor	CRCW12061021F100	Dale



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Figure 9. MW4IC001NR4(MR4) 1990 MHz Test Circuit Component Layout

TYPICAL CHARACTERISTICS - 1990 MHz

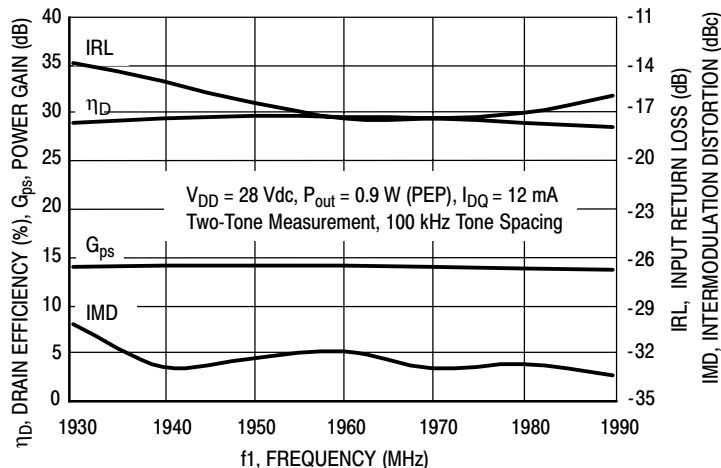


Figure 10. Two-Tone Performance versus Frequency

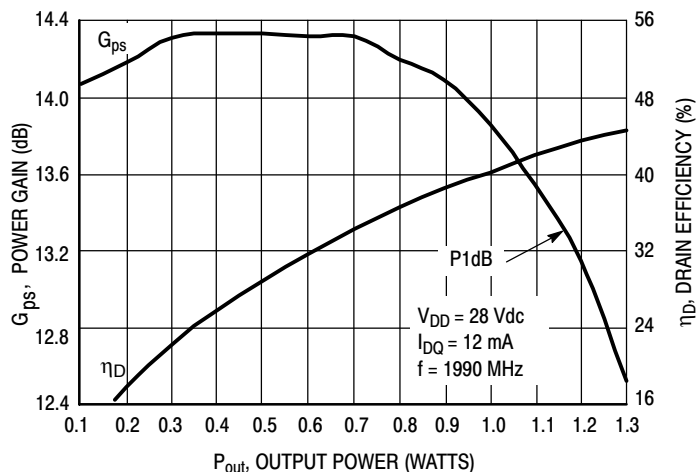


Figure 11. CW Performance versus Output Power

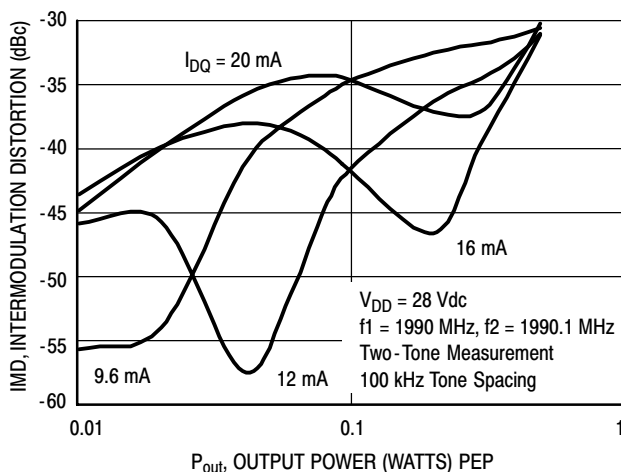


Figure 12. Intermodulation Distortion versus Output Power

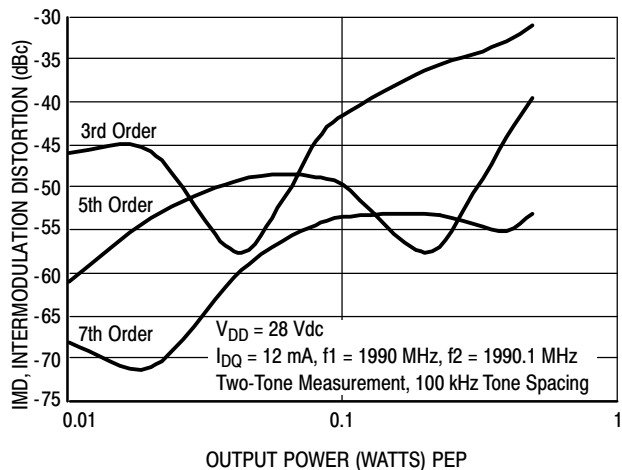


Figure 13. Intermodulation Distortion Products versus Output Power

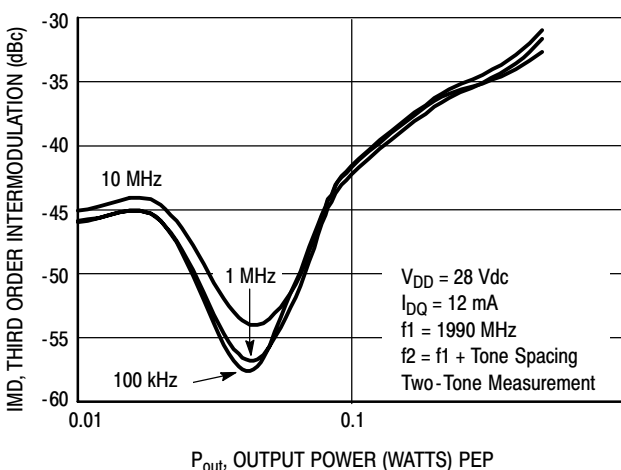
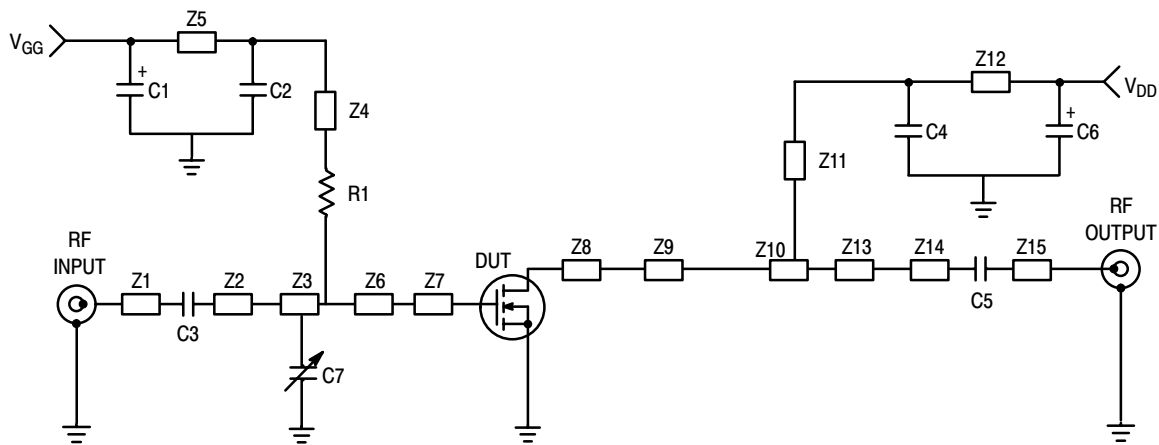


Figure 14. Third Order Intermodulation Distortion versus Output Power

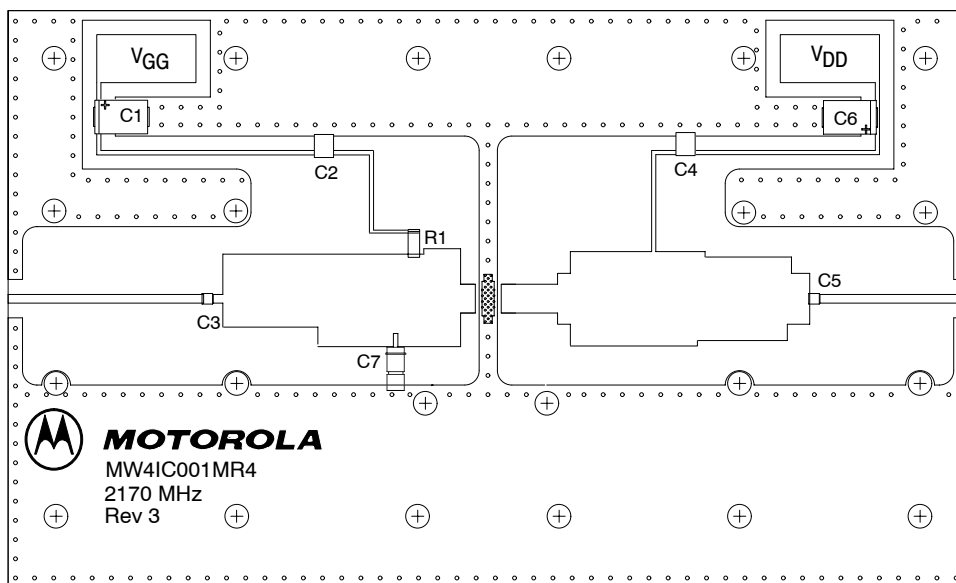


Z1	1.267" x 0.044" Microstrip	Z9	0.106" x 0.344" Microstrip
Z2	0.058" x 0.044" Microstrip	Z10	0.783" x 0.500" Microstrip
Z3	0.758" x 0.256" Microstrip	Z11	0.847" x 0.022" Microstrip
Z4	1.073" x 0.022" Microstrip	Z12	1.055" x 0.022" Microstrip
Z5	1.361" x 0.022" Microstrip	Z13	0.291" x 0.387" Microstrip
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(MR4) 2170 MHz Test Circuit Schematic

Table 8. MW4IC001NR4(MR4) 2170 MHz Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C6	22 μ 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 Ω Chip Resistor	CRCW12061021F100	Dale



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Figure 16. MW4IC001NR4(MR4) 2170 MHz Test Circuit Component Layout

TYPICAL CHARACTERISTICS - 2170 MHz

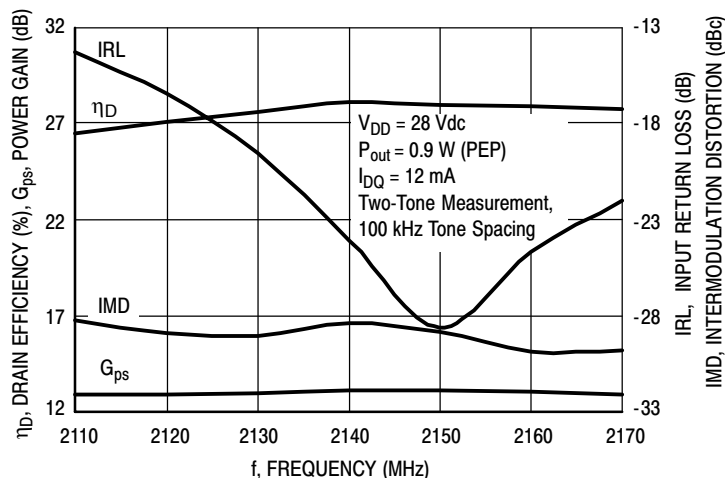


Figure 17. Two-Tone Performance versus Frequency

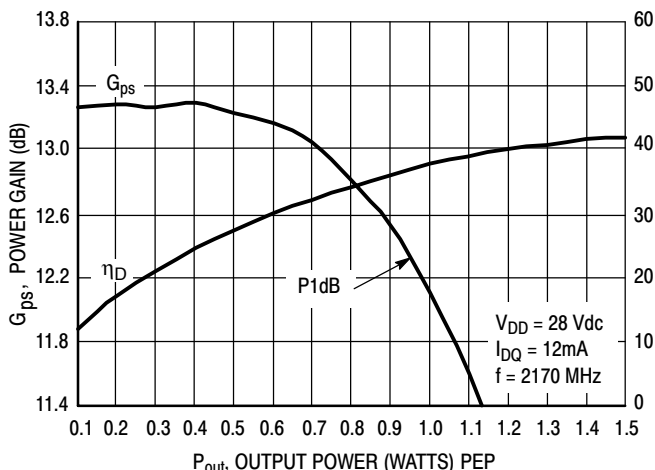


Figure 18. CW Performance versus Output Power

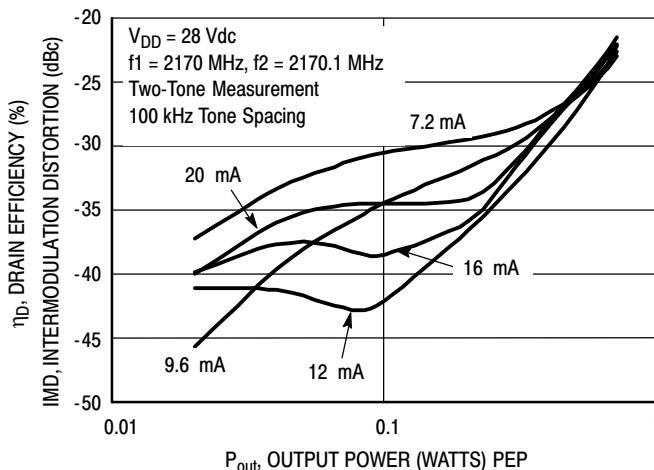


Figure 19. Intermodulation Distortion versus Output Power

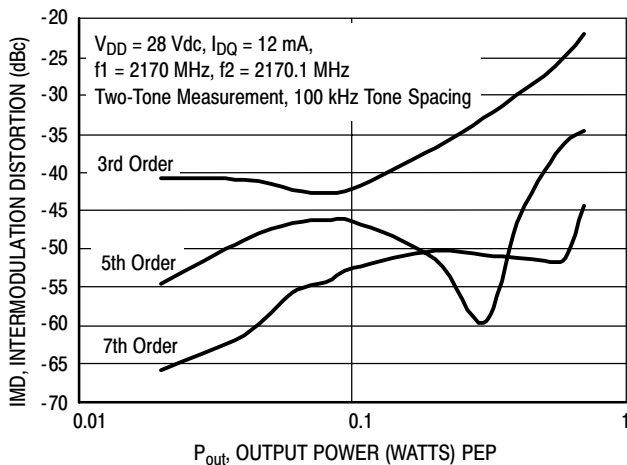


Figure 20. Intermodulation Distortion Products versus Output Power

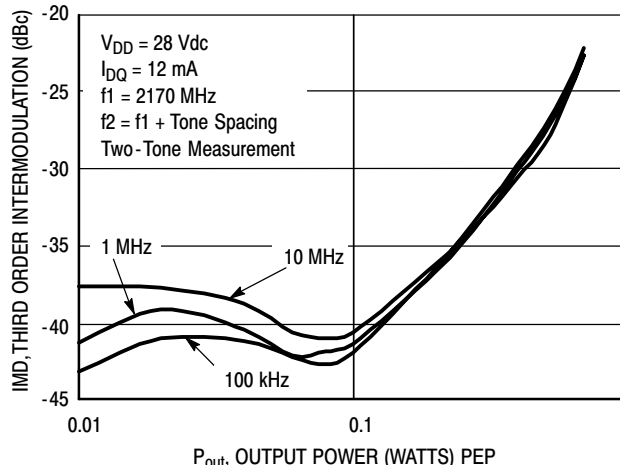
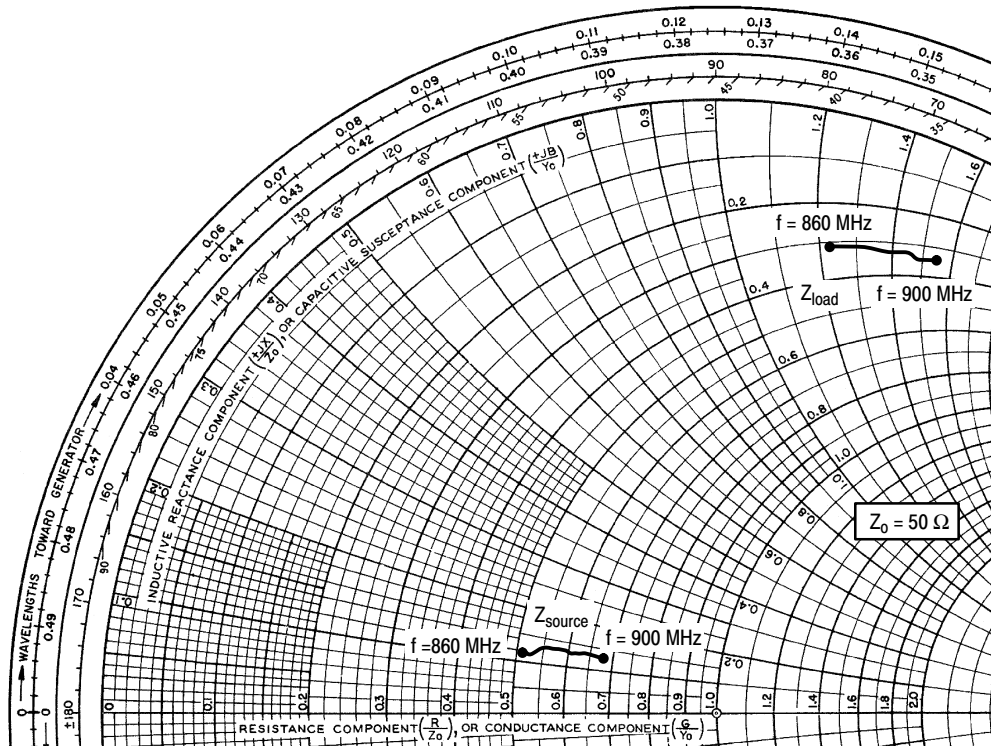


Figure 21. Third Order Intermodulation Distortion versus Output Power

MW4IC001NR4 MW4IC001MR4



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

f MHz	Z_{source} Ω	Z_{load} Ω
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.

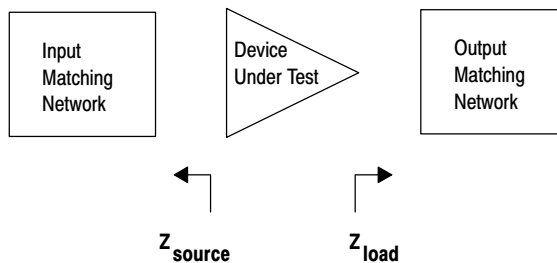
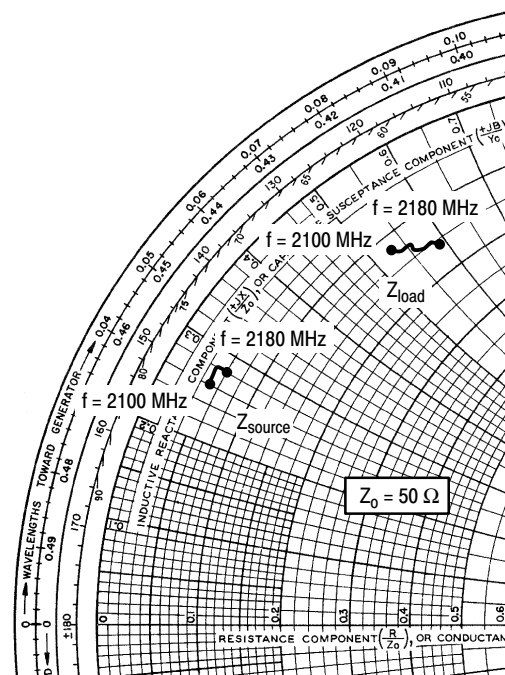
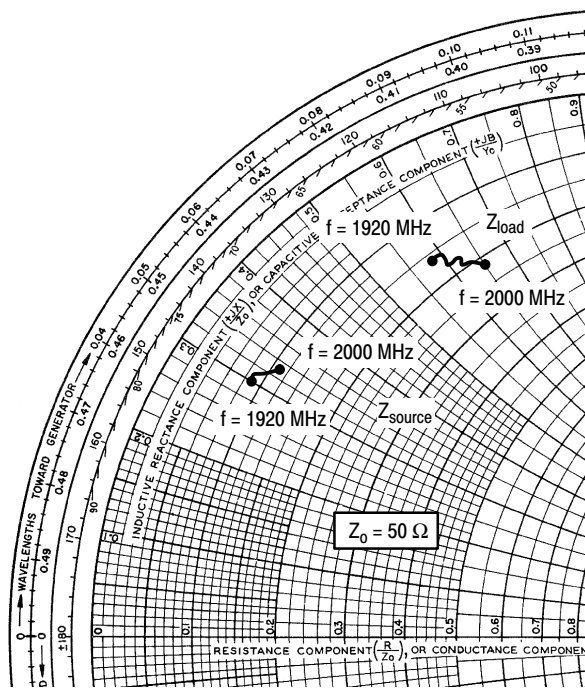


Figure 22. Series Equivalent Source and Load Impedance

MW4IC001NR4 MW4IC001MR4

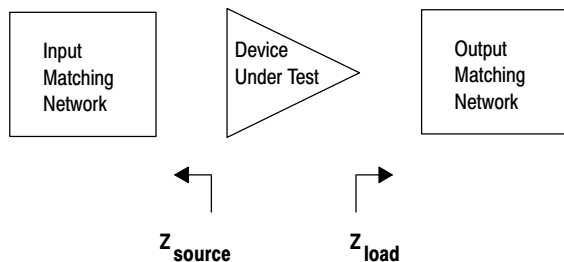


$V_{DD} = 28\text{ V}$, $I_{DQ} = 12\text{ mA}$, $P_{out} = 0.9\text{ W PEP}$

f MHz	Z_{source} Ω	Z_{load} Ω
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} Ω	Z_{load} Ω
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.

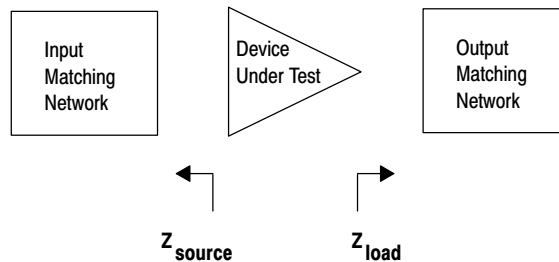


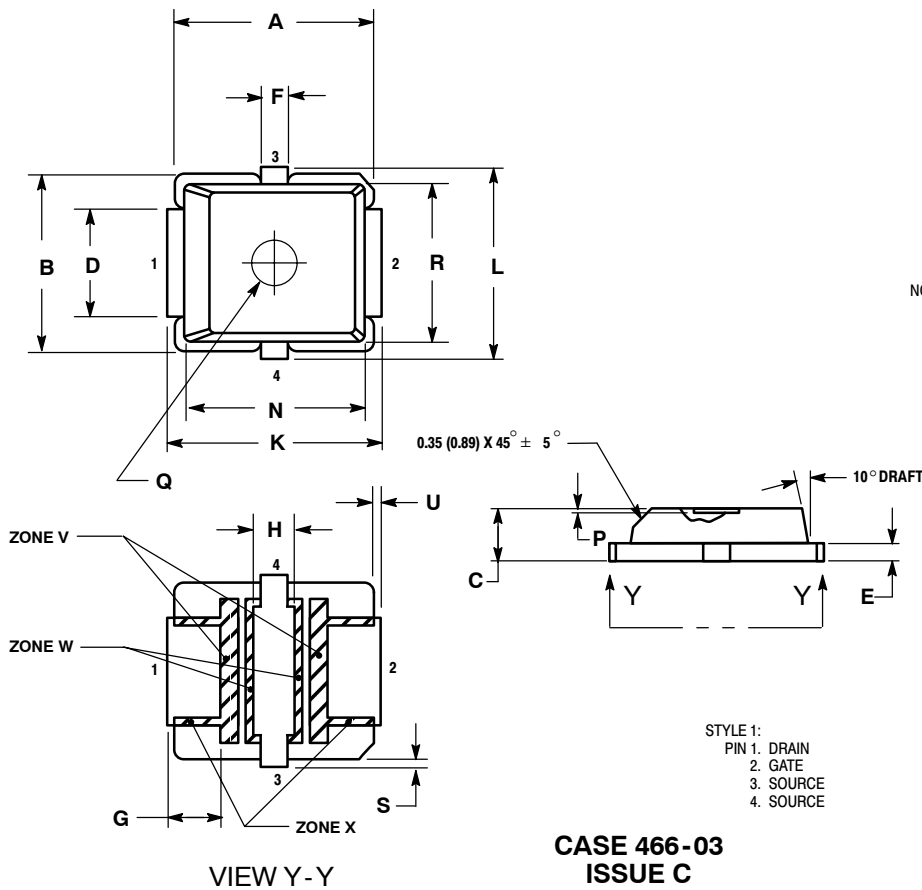
Figure 23. Series Equivalent Source and Load Impedance

NOTES

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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

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

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