

# The Wideband IC Line

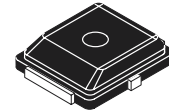
## RF LDMOS Wideband Integrated Power Amplifier

The MW4IC001MR4 wideband integrated circuit is designed for use as a distortion signature device in analog predistortion systems. It uses Motorola's newest High Voltage (26 to 28 Volts) LDMOS IC technology. Its wideband On Chip design makes it usable from 800 MHz to 2.2 GHz. 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
- In Tape and Reel. R4 Suffix = 100 Units per 12 mm, 7 inch Reel.

**MW4IC001MR4**

**W-CDMA**  
**0.8-2.17 GHz, 900 mW, 28 V**  
**RF LDMOS WIDEBAND**  
**INTEGRATED POWER AMPLIFIER**



**CASE 466-02, STYLE 1**  
**PLD-1.5**  
**PLASTIC**

### MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	$V_{DSS}$	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	$^\circ\text{C}$

### THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case @ $85^\circ\text{C}$	$R_{\theta JC}$	27.3	$^\circ\text{C}/\text{W}$

### ESD PROTECTION CHARACTERISTICS

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

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

**ELECTRICAL CHARACTERISTICS** ( $T_C = 25^\circ\text{C}$  unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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**OFF CHARACTERISTICS**

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	$\mu\text{Adc}$

**ON CHARACTERISTICS**

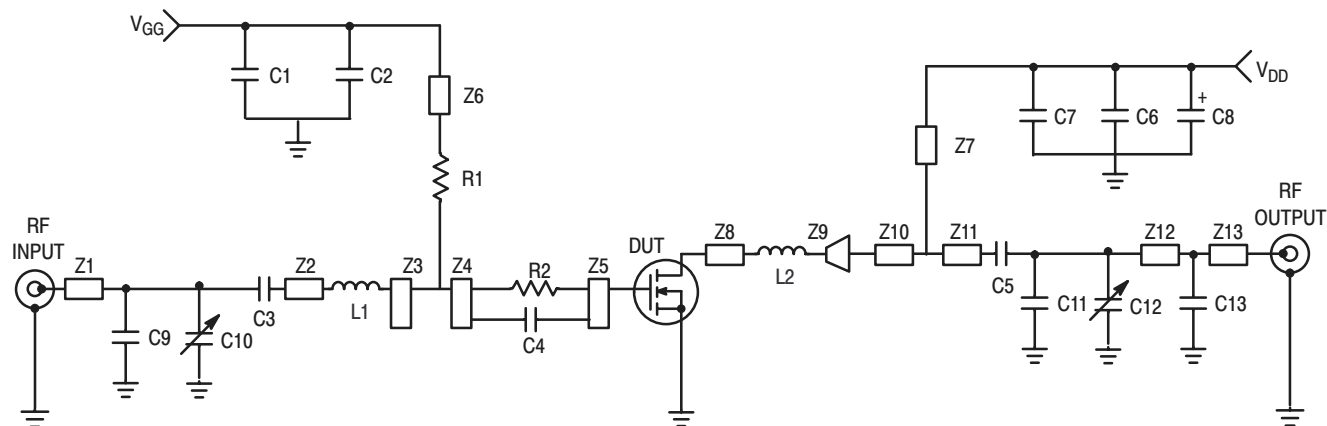
Gate Threshold Voltage ( $V_{DS} = 10\text{ V}$ , $I_D = 50\ \mu\text{A}$ )	$V_{GS(th)}$	2	3	5	Vdc
Gate Quiescent Voltage ( $V_{DS} = 28\text{ V}$ , $I_D = 10\text{ mA}$ )	$V_{GS(Q)}$	2	3.7	5	Vdc
Drain–Source On–Voltage ( $V_{GS} = 10\text{ V}$ , $I_D = 0.05\text{ A}$ )	$V_{DS(on)}$	—	0.48	0.9	Vdc
Forward Transconductance ( $V_{DS} = 10\text{ V}$ , $I_D = 0.1\text{ A}$ )	$g_{fs}$	—	0.05	—	S

**DYNAMIC CHARACTERISTICS**

Output Capacitance ( $V_{DS} = 26\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$ )	$C_{oss}$	—	45	—	pF
Reverse Transfer Capacitance ( $V_{DS} = 26\text{ Vdc} \pm 30\text{ mV(rms)ac}$ @ 1 MHz, $V_{GS} = 0\text{ Vdc}$ )	$C_{rss}$	—	0.62	—	pF

**FUNCTIONAL TESTS** (In Motorola 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)	$\eta$	—	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 ( $V_{DD} = 28\text{ Vdc}$ , $P_{out} = 0.9\text{ W CW}$ , $I_{DQ} = 12\text{ mA}$ , $f = 2170\text{ MHz}$ )	$\eta$	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. MW4IC001MR4 900 MHz Test Circuit Schematic**

**Table 1. MW4IC001MR4 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

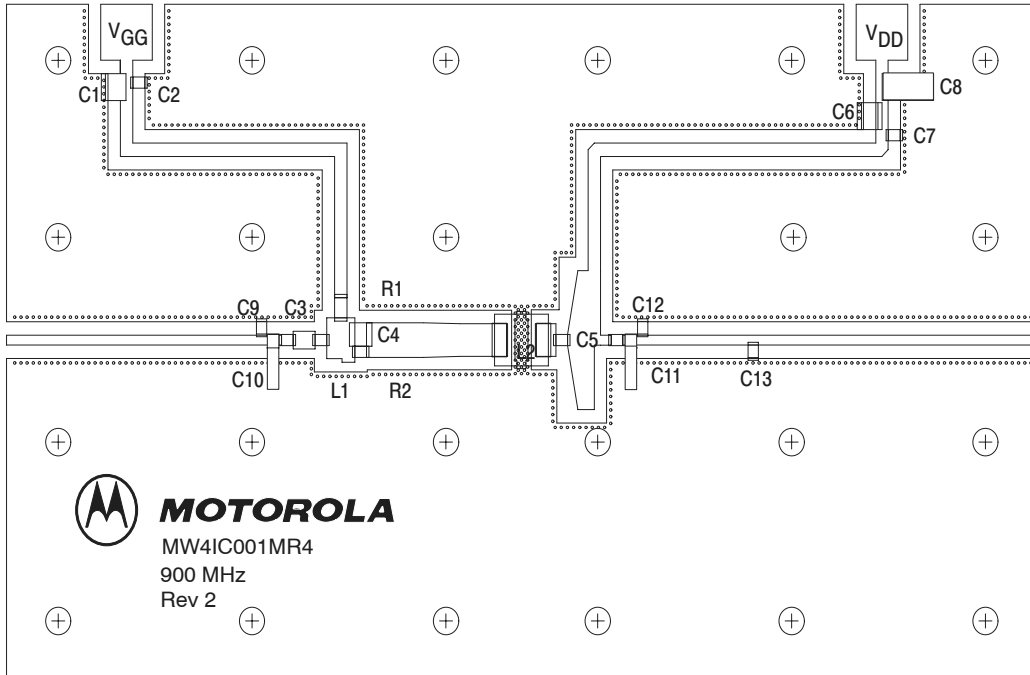


Figure 2. MW4IC001MR4 900 MHz Test Circuit Component Layout

## TYPICAL CHARACTERISTICS – 900 MHz

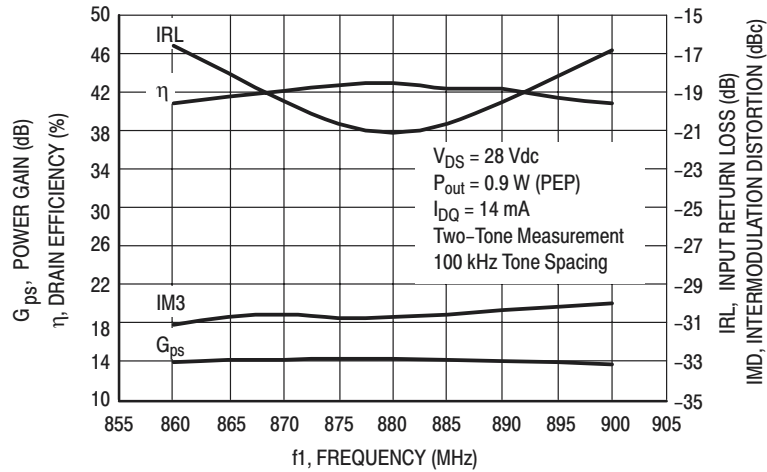


Figure 3. Two-Tone Performance versus Frequency

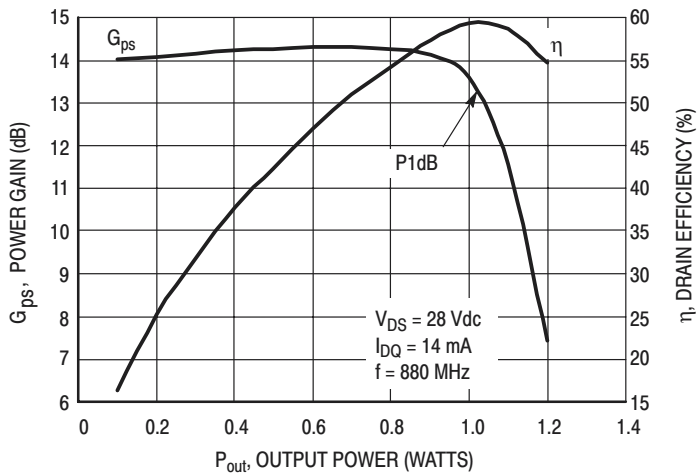


Figure 4. CW Performance versus Output Power

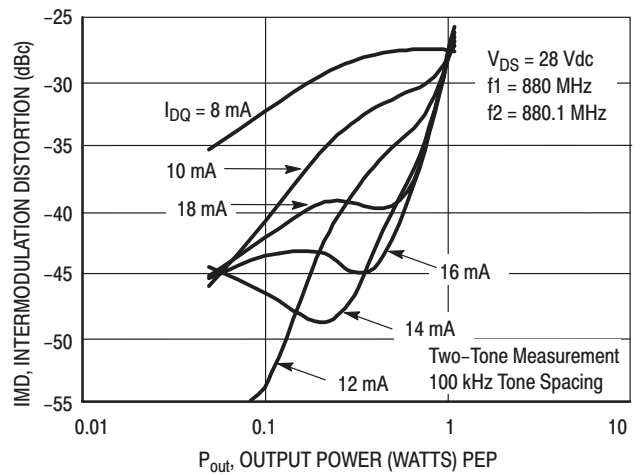


Figure 5. Intermodulation Distortion versus Output Power

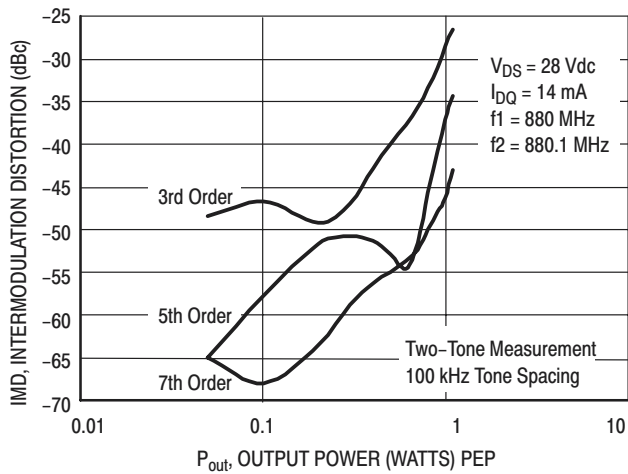


Figure 6. Intermodulation Distortion Products versus Output Power

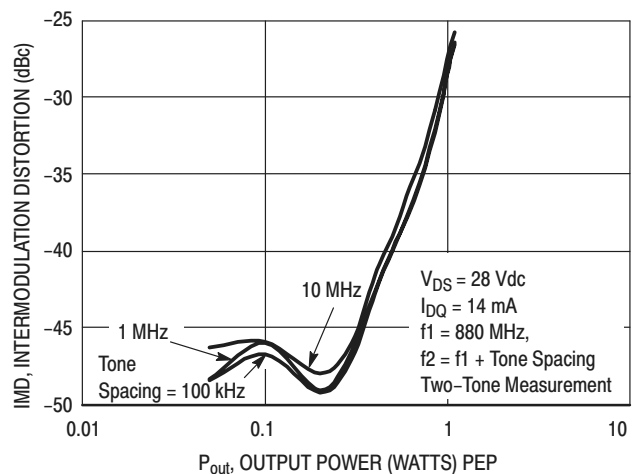
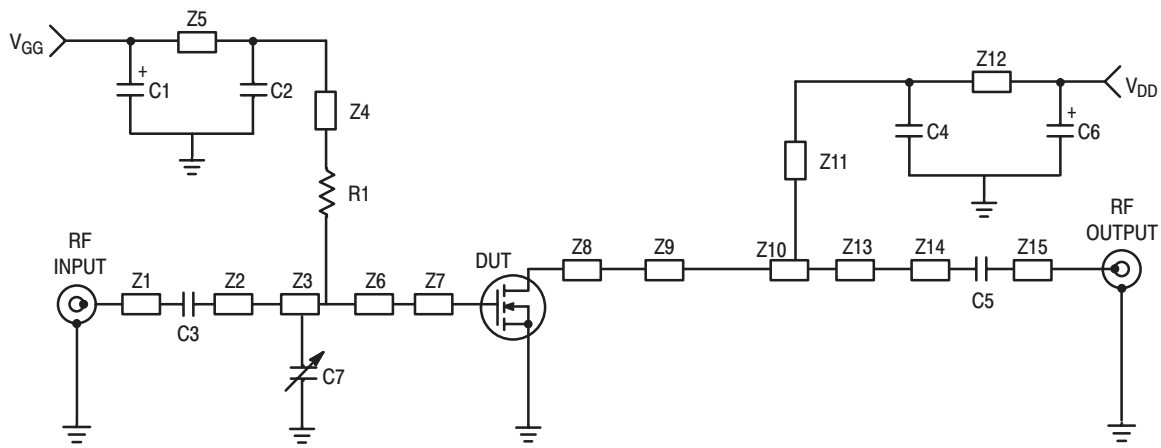


Figure 7. Third Order Intermodulation Distortion versus Output Power



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. MW4IC001MR4 1.99 GHz Test Circuit Schematic

Table 2. MW4IC001MR4 1.99 GHz 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

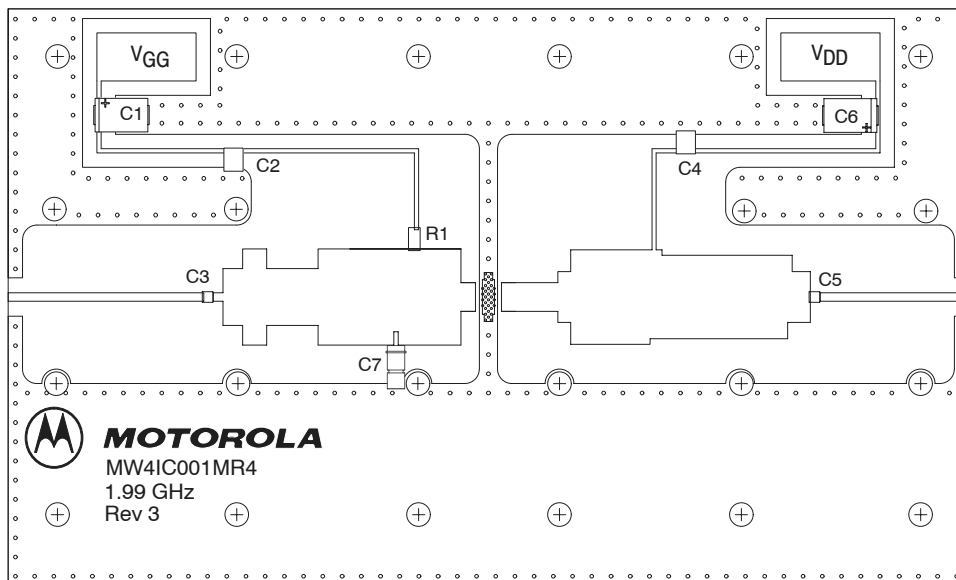
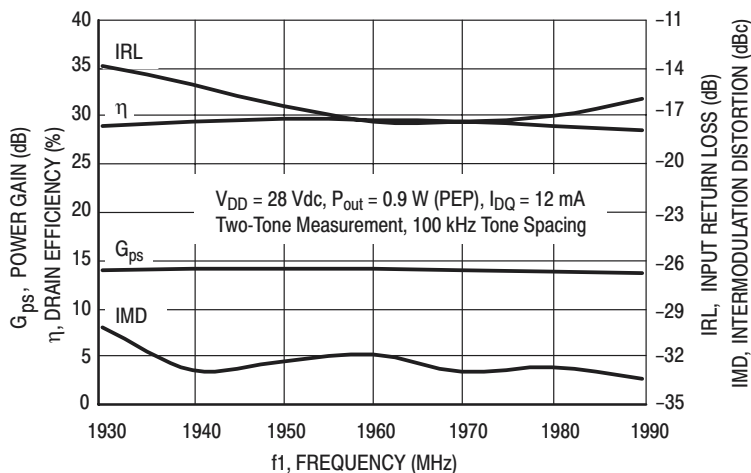
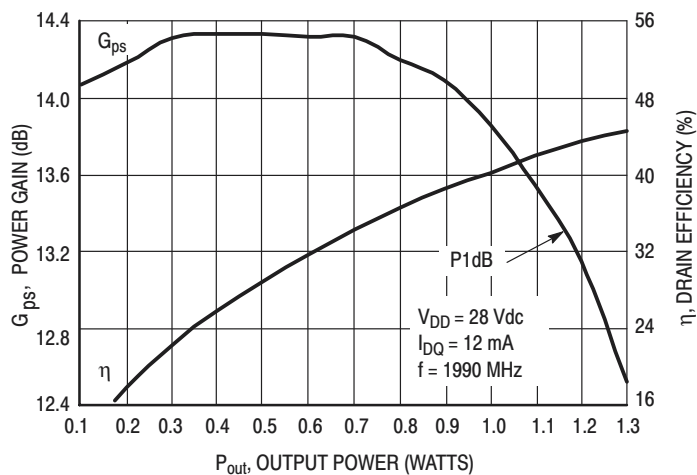


Figure 9. MW4IC001MR4 1.99 GHz Test Circuit Component Layout

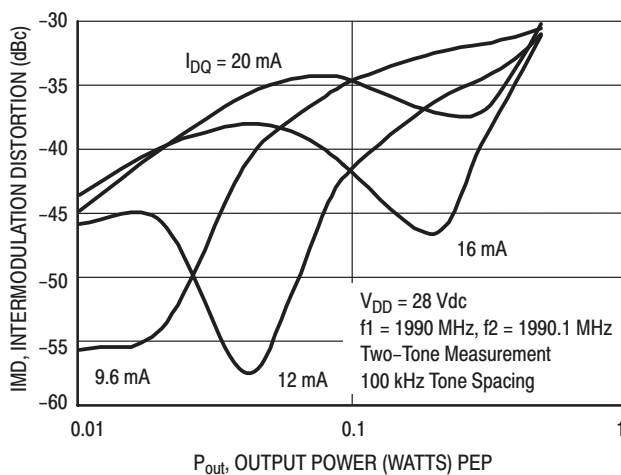
### TYPICAL CHARACTERISTICS – 1.99 GHz



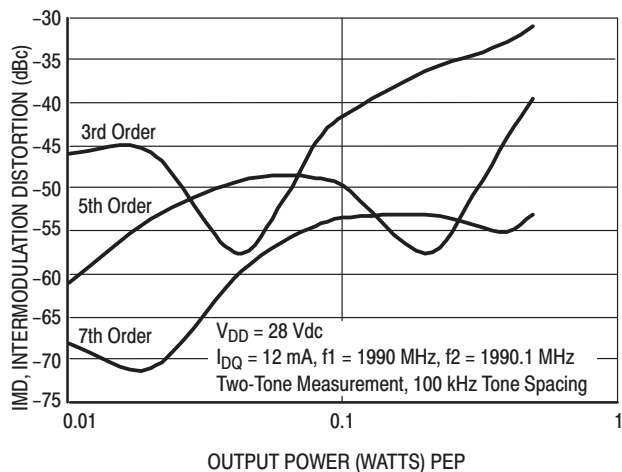
**Figure 10. Two-Tone Performance versus Frequency**



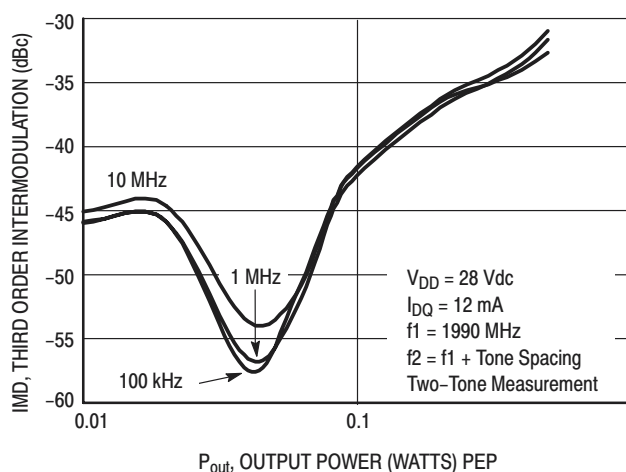
**Figure 11. CW Performance versus Output Power**



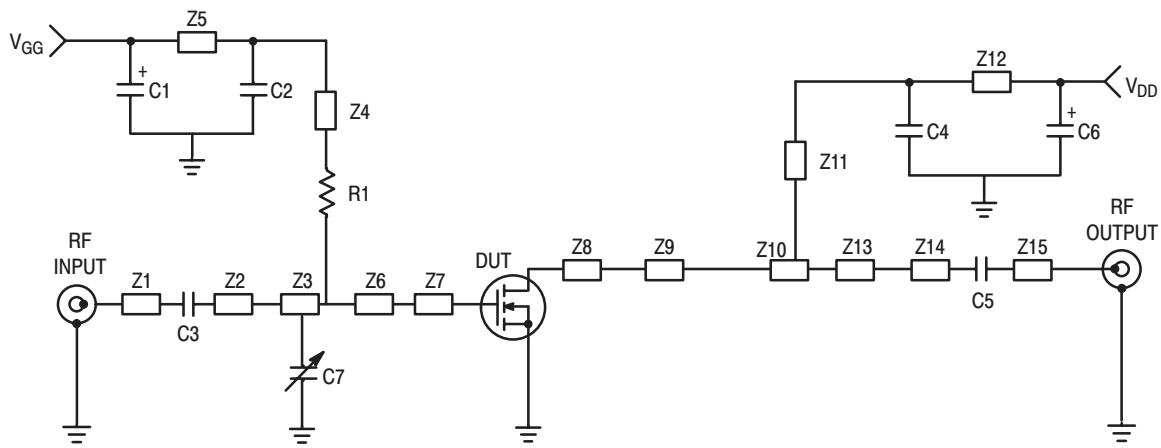
**Figure 12. Intermodulation Distortion versus Output Power**



**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. MW4IC001MR4 2.17 GHz Test Circuit Schematic

Table 3. MW4IC001MR4 2.17 GHz 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

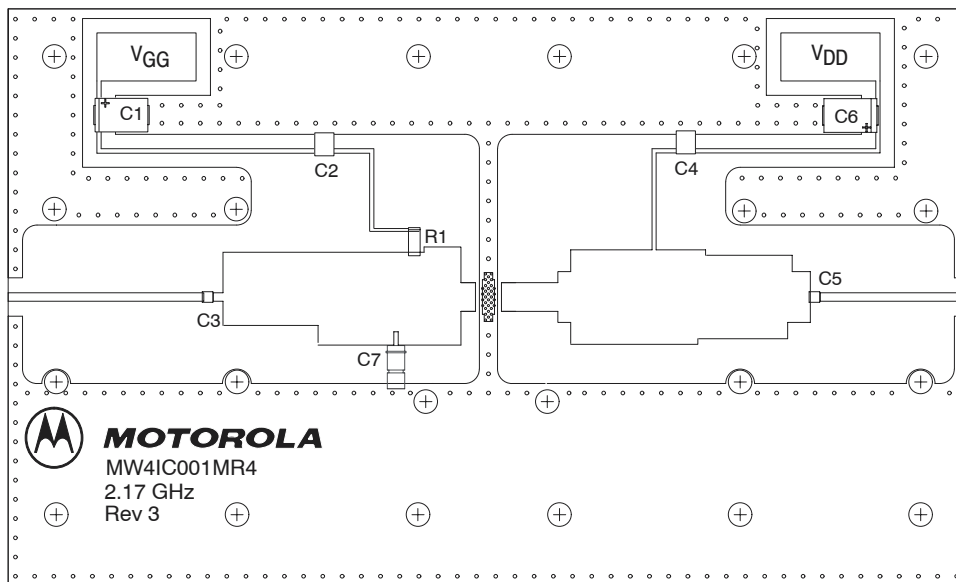


Figure 16. MW4IC001MR4 2.17 GHz Test Circuit Component Layout



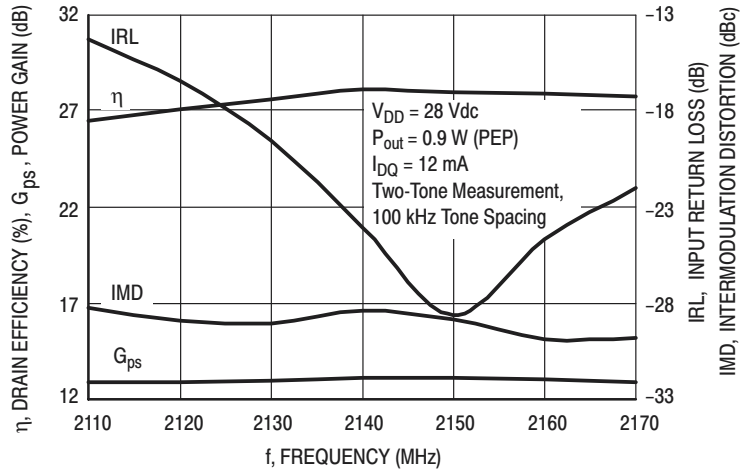


Figure 17. Two-Tone Performance versus Frequency

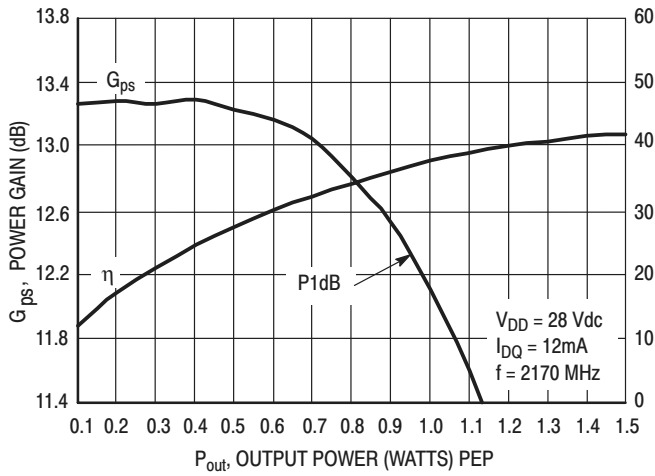


Figure 18. CW Performance versus Output Power

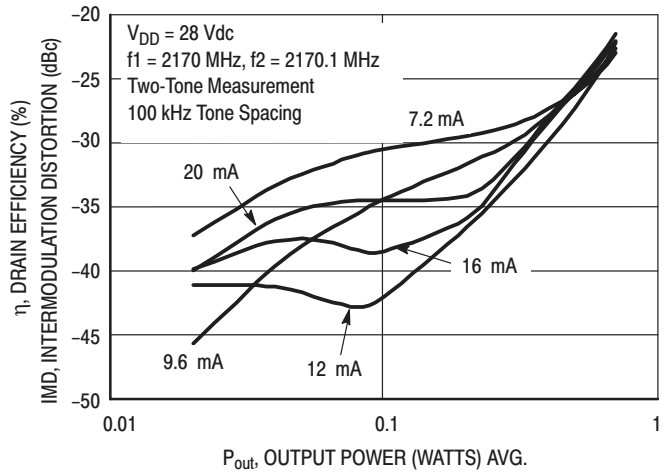


Figure 19. Intermodulation Distortion versus Output Power

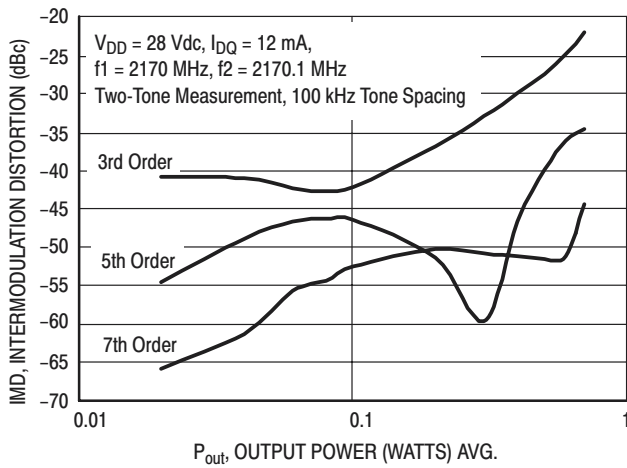


Figure 20. Intermodulation Distortion Products versus Output Power

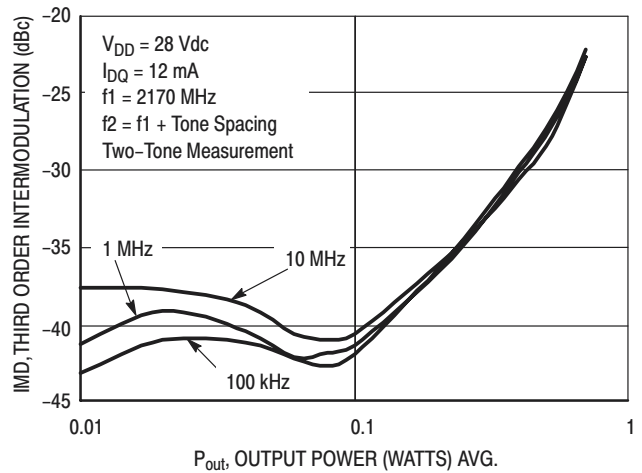


Figure 21. Third Order Intermodulation Distortion versus Output Power

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

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

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

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

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

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.

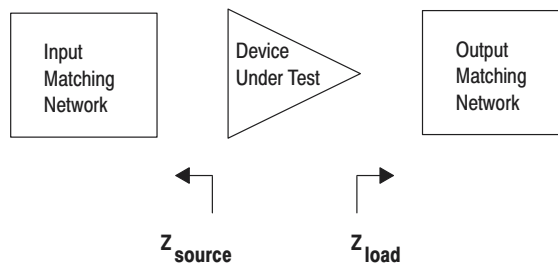
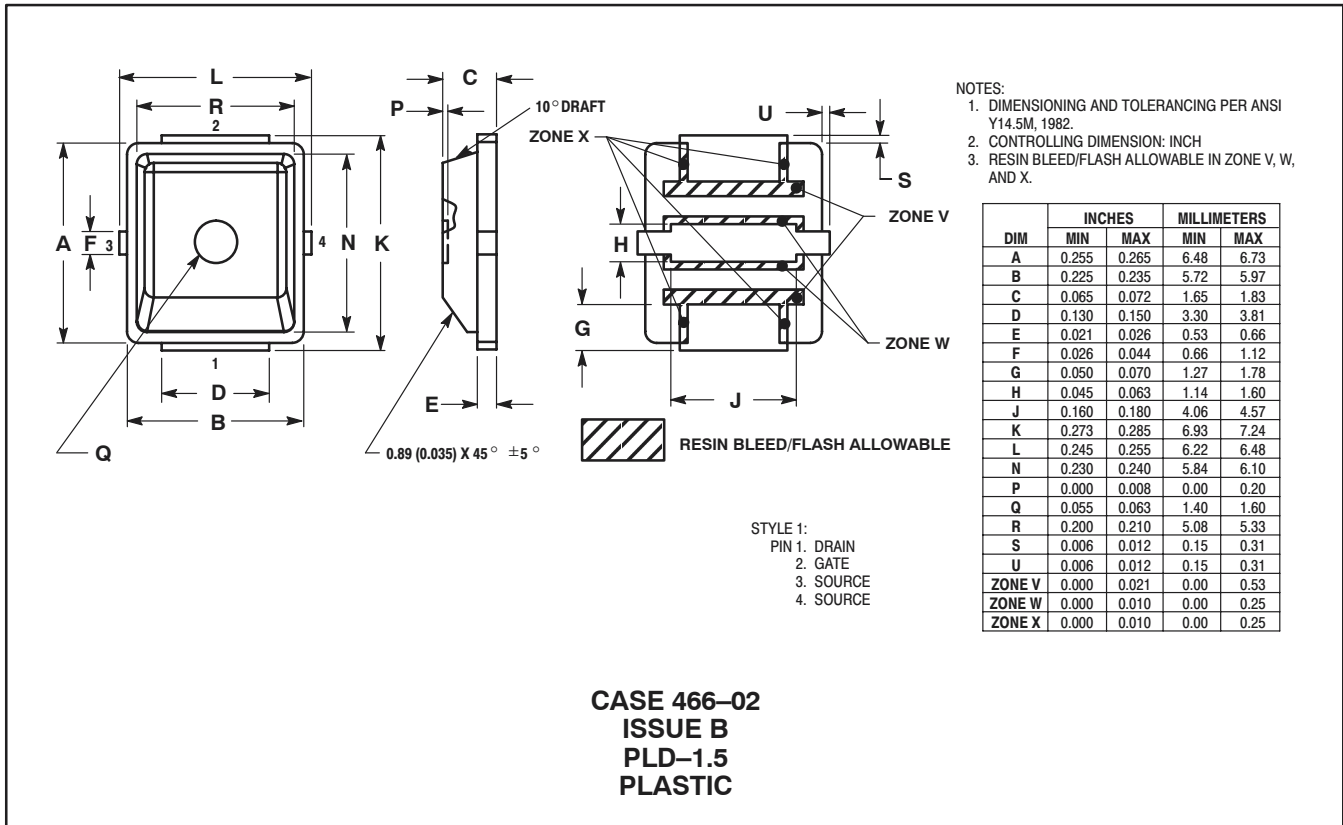


Figure 22. Series Equivalent Source and Load Impedance

# NOTES

## PACKAGE DIMENSIONS



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