



# RF LDMOS Wideband Integrated Power Amplifier

The MW7IC008N wideband integrated circuit is designed with on-chip matching that makes it usable from 100 to 1000 MHz. This multi-stage structure is rated for 24 to 32 Volt operation and covers all typical radio base station modulation formats.

## Driver Applications

- Typical CW Performance:  $V_{DD} = 28$  Volts,  $I_{DQ1} = 25$  mA,  $I_{DQ2} = 75$  mA

Frequency	$G_{ps}$ (dB)	PAE (%)
100 MHz @ 11 W CW	23.5	55
400 MHz @ 9 W CW	22.5	41
900 MHz @ 6.5 W CW	23.5	34

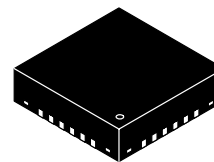
- Capable of Handling 10:1 VSWR, @ 32 Vdc, 900 MHz,  $P_{out} = 6.5$  Watts CW (3 dB Input Overdrive from Rated  $P_{out}$ )
- Stable into a 5:1 VSWR. All Spurs Below -60 dBc @ 1 mW to 8 Watts CW  $P_{out}$  @ 900 MHz
- Typical  $P_{out}$  @ 1 dB Compression Point  $\approx$  11 Watts CW @ 100 MHz, 9 Watts CW @ 400 MHz, 6.5 Watts CW @ 900 MHz

## Features

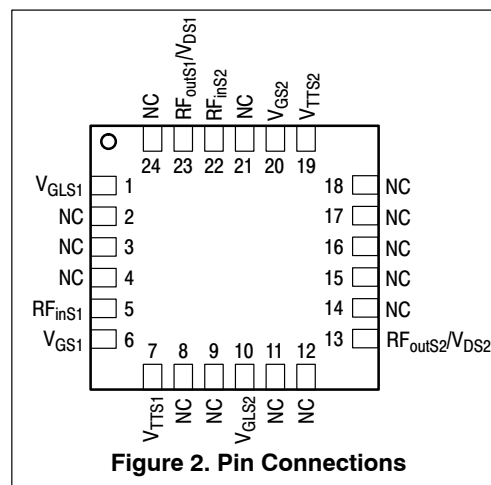
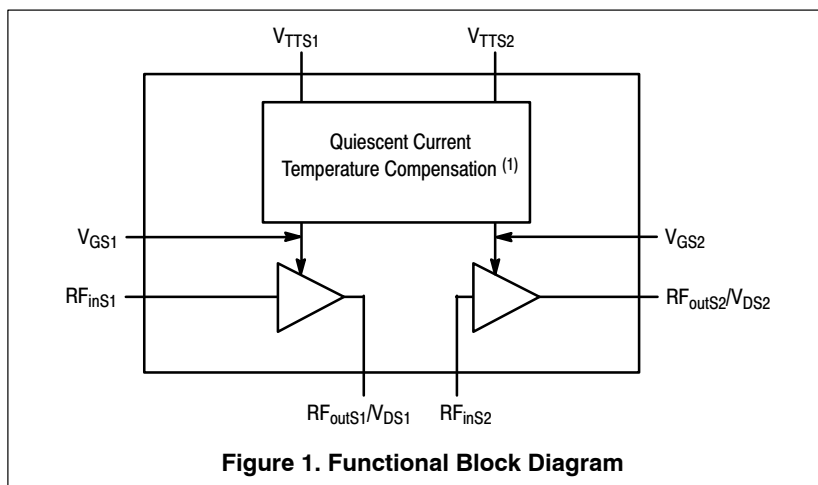
- Broadband, Single Matching Network from 20 to 1000 MHz
- Integrated Quiescent Current Temperature Compensation with Enable/Disable Function (1)
- Integrated ESD Protection
- 225°C Capable Plastic Package
- RoHS Compliant
- In Tape and Reel. T1 Suffix = 1000 Units per 16 mm, 13 inch Reel.

**MW7IC008NT1**

**100-1000 MHz, 8 W PEAK, 28 V  
 RF LDMOS WIDEBAND  
 INTEGRATED POWER AMPLIFIER**



**CASE 1894-01  
 PQFN 8x8  
 PLASTIC**



1. Refer to AN1977, *Quiescent Current Thermal Tracking Circuit in the RF Integrated Circuit Family* and to AN1987, *Quiescent Current Control for the RF Integrated Circuit Device Family*. Go to <http://www.freescale.com/rf>. Select Documentation/Application Notes - AN1977 or AN1987.

**Table 1. Maximum Ratings**

Rating	Symbol	Value	Unit
Drain-Source Voltage	$V_{DSS}$	-0.5, +65	Vdc
Gate-Source Voltage	$V_{GS}$	-6.0, +12	Vdc
Operating Voltage	$V_{DD}$	32, +0	Vdc
Storage Temperature Range	$T_{stg}$	-65 to +150	°C
Operating Junction Temperature	$T_J$	150	°C
100 MHz CW Operation @ $T_A = 25^\circ\text{C}$ (3)	CW	11	W
400 MHz CW Operation @ $T_A = 25^\circ\text{C}$ (3)		6	W
900 MHz CW Operation @ $T_A = 25^\circ\text{C}$ (3)		5	W
Input Power	$P_{in}$	100 MHz 400 MHz 900 MHz	27 23 38
			dBm

**Table 2. Thermal Characteristics**

Characteristic	Symbol	Value (1,2)	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$		°C/W
(CW Signal @ 100 MHz) (Case Temperature 82°C, $P_{out} = 11$ W CW)		Stage 1, 28 Vdc, $I_{DQ1} = 25$ mA Stage 2, 28 Vdc, $I_{DQ2} = 75$ mA	5.3 4.9
(CW Signal @ 400 MHz) (Case Temperature 87°C, $P_{out} = 9$ W CW)		Stage 1, 28 Vdc, $I_{DQ1} = 25$ mA Stage 2, 28 Vdc, $I_{DQ2} = 75$ mA	4.4 2.7
(CW Signal @ 900 MHz) (Case Temperature 86°C, $P_{out} = 6.5$ W CW)		Stage 1, 28 Vdc, $I_{DQ1} = 25$ mA Stage 2, 28 Vdc, $I_{DQ2} = 75$ mA	3.5 3.2

**Table 3. ESD Protection Characteristics**

Test Methodology	Class
Human Body Model (per JESD22-A114)	1B (Minimum)
Machine Model (per EIA/JESD22-A115)	A (Minimum)
Charge Device Model (per JESD22-C101)	III (Minimum)

**Table 4. Moisture Sensitivity Level**

Test Methodology	Rating	Package Peak Temperature	Unit
Per JESD22-A113, IPC/JEDEC J-STD-020	3	260	°C

1. MTTF calculator available at <http://www.freescale.com/rf>. Select Software & Tools/Development Tools/Calculators to access MTTF calculators by product.
2. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers*. Go to <http://www.freescale.com/rf>. Select Documentation/Application Notes - AN1955.
3. CW Ratings at the individual frequencies are limited by a 100 year MTTF requirement. See MTTF calculator (referenced in Note 1).

(continued)

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

Characteristic	Symbol	Min	Typ	Max	Unit
<b>Stage 1 — Off Characteristics</b>					
Zero Gate Voltage Drain Leakage Current ( $V_{DS} = 65\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ )	$I_{DSS}$	—	—	10	$\mu\text{Adc}$
Zero Gate Voltage Drain Leakage Current ( $V_{DS} = 28\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ )	$I_{DSS}$	—	—	1	$\mu\text{Adc}$
Gate-Source Leakage Current ( $V_{GS} = 1.5\text{ Vdc}$ , $V_{DS} = 0\text{ Vdc}$ )	$I_{GSS}$	—	—	10	$\mu\text{Adc}$

**Stage 1 — On Characteristics**

Gate Threshold Voltage ( $V_{DS} = 10\text{ Vdc}$ , $I_D = 5.3\ \mu\text{Adc}$ )	$V_{GS(th)}$	1.3	2	2.8	Vdc
Gate Quiescent Voltage ( $V_{DD} = 28\text{ Vdc}$ , $I_D = 25\text{ mAdc}$ , Measured in Functional Test)	$V_{GS(Q)}$	2	2.8	3.5	Vdc

**Stage 2 — Off Characteristics**

Zero Gate Voltage Drain Leakage Current ( $V_{DS} = 65\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ )	$I_{DSS}$	—	—	10	$\mu\text{Adc}$
Zero Gate Voltage Drain Leakage Current ( $V_{DS} = 28\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ )	$I_{DSS}$	—	—	1	$\mu\text{Adc}$
Gate-Source Leakage Current ( $V_{GS} = 1.5\text{ Vdc}$ , $V_{DS} = 0\text{ Vdc}$ )	$I_{GSS}$	—	—	10	$\mu\text{Adc}$

**Stage 2 — On Characteristics**

Gate Threshold Voltage ( $V_{DS} = 10\text{ Vdc}$ , $I_D = 23\ \mu\text{Adc}$ )	$V_{GS(th)}$	1.3	2	2.8	Vdc
Gate Quiescent Voltage ( $V_{DD} = 28\text{ Vdc}$ , $I_D = 75\text{ mAdc}$ , Measured in Functional Test)	$V_{GS(Q)}$	2	2.7	3.5	Vdc
Drain-Source On-Voltage ( $V_{GS} = 10\text{ Vdc}$ , $I_D = 3.6\text{ Adc}$ )	$V_{DS(on)}$	0.1	0.3	1	Vdc

**Functional Tests** <sup>(1)</sup> (In Freescale Test Fixture, 50 ohm system)  $V_{DD} = 28\text{ Vdc}$ ,  $I_{DQ1} = 25\text{ mA}$ ,  $I_{DQ2} = 75\text{ mA}$ ,  $P_{out} = 6.5\text{ W CW}$ ,  $f = 900\text{ MHz}$ 

Power Gain	$G_{ps}$	21.5	23.5	31.5	dB
Power Added Efficiency	PAE	30	34	—	%
Input Return Loss	IRL	—	-15	-11	dB

**Typical Broadband Performance** (In Freescale Test Fixture, 50 ohm system)  $V_{DD} = 28\text{ Vdc}$ ,  $I_{DQ1} = 25\text{ mA}$ ,  $I_{DQ2} = 75\text{ mA}$ 

Frequency	$G_{ps}$ (dB)	PAE (%)	IRL (dB)
100 MHz @ 11 W CW	23.5	55	-20
400 MHz @ 9 W CW	22.5	41	-17
900 MHz @ 6.5 W CW	23.5	34	-15

1. Part internally matched both on input and output.

(continued)

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

Characteristic	Symbol	Min	Typ	Max	Unit
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**Typical Performances** (In Freescale Test Fixture, 50 ohm system)  $V_{DD} = 28\text{ Vdc}$ ,  $I_{DQ1} = 25\text{ mA}$ ,  $I_{DQ2} = 75\text{ mA}$ , 100-1000 MHz Bandwidth

Characteristic	Symbol	Min	Typ	Max	Unit
IMD Symmetry @ 6.8 W PEP, $P_{out}$ where IMD Third Order Intermodulation $\cong 30\text{ dBc}$ (Delta IMD Third Order Intermodulation between Upper and Lower Sidebands $> 2\text{ dB}$ )	$IMD_{sym}$	—	180	—	MHz
VBW Resonance Point <sup>(1)</sup> (IMD Third Order Intermodulation Inflection Point)	$VBW_{res}$	—	210	—	MHz
Gain Flatness in 500-1000 MHz Bandwidth @ $P_{out} = 6\text{ W Avg.}$	$G_F$	—	1.35	—	dB
Gain Variation over Temperature ( $-30^\circ\text{C}$ to $+85^\circ\text{C}$ )	$\Delta G$	—	0.024	—	dB/ $^\circ\text{C}$
Output Power Variation over Temperature ( $-30^\circ\text{C}$ to $+85^\circ\text{C}$ )	$\Delta P1\text{dB}$	—	0.005	—	dBm/ $^\circ\text{C}$

**Typical CW Performances — 100 MHz** (In Freescale Test Fixture, 50 ohm system)  $V_{DD} = 28\text{ Vdc}$ ,  $I_{DQ1} = 25\text{ mA}$ ,  $I_{DQ2} = 75\text{ mA}$ ,  $P_{out} = 11\text{ W}$  CW,  $f = 100\text{ MHz}$

Power Gain	$G_{ps}$	—	23.5	—	dB
Power Added Efficiency	PAE	—	55	—	%
Input Return Loss	IRL	—	-20	—	dB
$P_{out}$ @ 1 dB Compression Point, CW	P1dB	—	11	—	W

**Typical CW Performances — 400 MHz** (In Freescale Test Fixture, 50 ohm system)  $V_{DD} = 28\text{ Vdc}$ ,  $I_{DQ1} = 25\text{ mA}$ ,  $I_{DQ2} = 75\text{ mA}$ ,  $P_{out} = 9\text{ W}$  CW,  $f = 400\text{ MHz}$

Power Gain	$G_{ps}$	—	22.5	—	dB
Power Added Efficiency	PAE	—	41	—	%
Input Return Loss	IRL	—	-17	—	dB
$P_{out}$ @ 1 dB Compression Point, CW	P1dB	—	9	—	W

**Typical CW Performances — 900 MHz** (In Freescale Test Fixture, 50 ohm system)  $V_{DD} = 28\text{ Vdc}$ ,  $I_{DQ1} = 25\text{ mA}$ ,  $I_{DQ2} = 75\text{ mA}$ ,  $P_{out} = 6.5\text{ W}$  CW,  $f = 900\text{ MHz}$

Power Gain	$G_{ps}$	—	23.5	—	dB
Power Added Efficiency	PAE	—	34	—	%
Input Return Loss	IRL	—	-15	—	dB
$P_{out}$ @ 1 dB Compression Point, CW	P1dB	—	6.5	—	W

1. Estimated data.

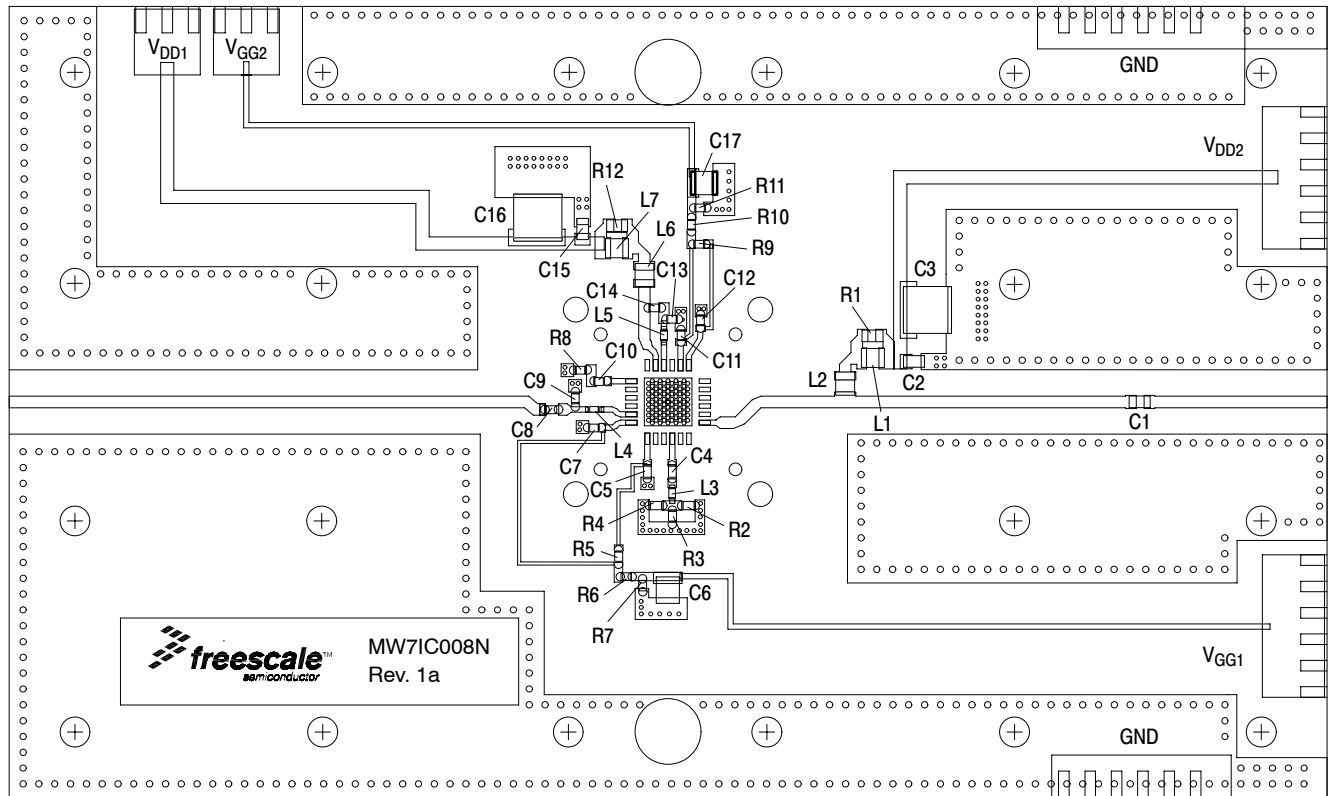


Figure 3. MW7IC008NT1 Test Circuit Component Layout

Table 6. MW7IC008NT1 Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1	0.01 $\mu$ F Chip Capacitor	GRM3195C1E103JA01	Murata
C2, C15	0.1 $\mu$ F Chip Capacitors	GRM219F51H104ZA01	Murata
C3, C16	10 $\mu$ F Chip Capacitors	GRM55DR61H106KA88L	Murata
C4, C5, C7, C8, C10, C11, C12, C14	0.01 $\mu$ F Chip Capacitors	C0805C103K5RAC	Kemet
C6, C17	1 $\mu$ F, 35 V Tantalum Capacitors	TAJA105K035R	AVX
C9	2.2 pF Chip Capacitor	ATC600S2R2CT250XT	ATC
C13	3.3 pF Chip Capacitor	ATC600S3R3BT250XT	ATC
L1, L7	150 nH Ceramic Chip Inductors	LL2012-FHLR15J	Toko
L2, L6	180 nH Ceramic Chip Inductors	LL2012-FHLR18J	Toko
L3	1.6 nH Inductor	0603HC-1N6XJLW	Coilcraft
L4, L5	5.1 nH Inductors	0603HP-5N1XJLW	Coilcraft
R1, R12	510 $\Omega$ , 1/10 W Chip Resistors	RR1220P-511-B-T5	Susumu
R2, R3, R4	91 $\Omega$ , 1/8 W Chip Resistors	CRCW080591R0FKEA	Vishay
R5*, R9*	0 $\Omega$ , 2.5 A Chip Resistors	CRCW08050000Z0EA	Vishay
R6	10 K $\Omega$ , 1/8 W Chip Resistor	CRCW080510K0JNEA	Vishay
R7, R11	12 K $\Omega$ , 1/8 W Chip Resistors	CRCW080512K0JNEA	Vishay
R8	43 $\Omega$ , 1/8 W Chip Resistor	CRCW080543R0FKEA	Vishay
R10	15 K $\Omega$ , 1/8 W Chip Resistor	CRCW080515K0JNEA	Vishay
PCB	0.020", $\epsilon_r = 3.5$	RO4350	Rogers

\*Add for temperature compensation

## TYPICAL CHARACTERISTICS

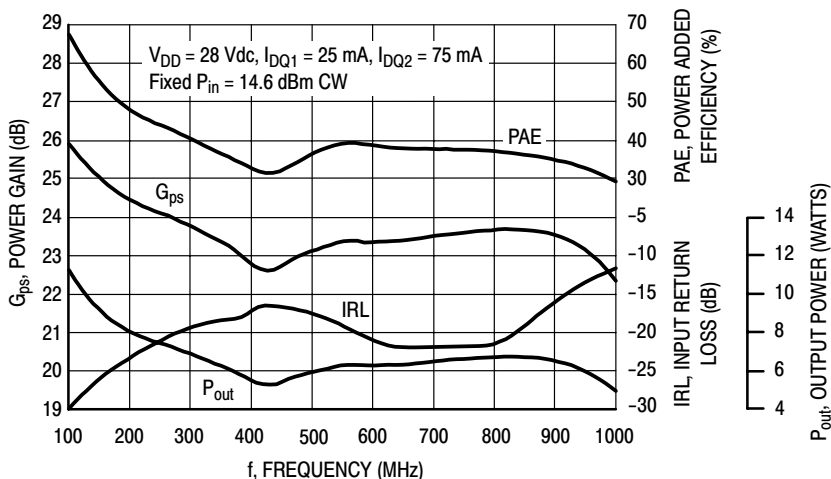


Figure 4. Broadband Performance @  $P_{in} = 14.6$  dBm CW

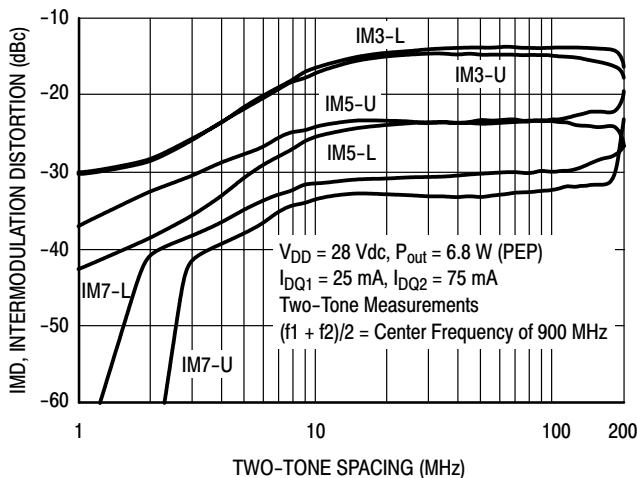


Figure 5. Intermodulation Distortion Products versus Two-Tone Spacing

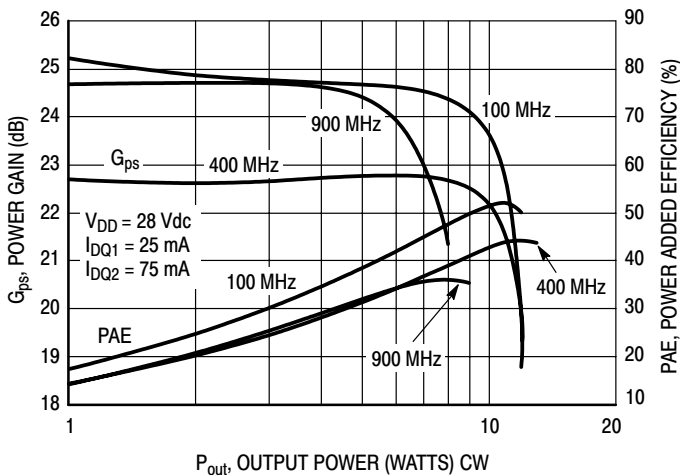


Figure 6. Power Gain and Power Added Efficiency versus Output Power

### TYPICAL CHARACTERISTICS

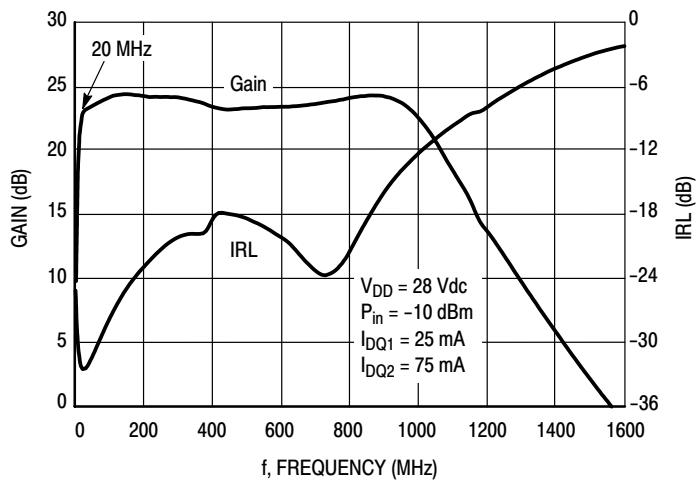


Figure 7. Broadband Frequency Response

$V_{DD} = 28 \text{ Vdc}$ ,  $I_{DQ1} = 25 \text{ mA}$ ,  $I_{DQ2} = 75 \text{ mA}$   
 $P_{out} = 11 \text{ W @ 100 MHz}$ ,  $9 \text{ W @ 400 MHz}$ ,  $6.5 \text{ W @ 900 MHz}$

f MHz	$Z_{in}$ $\Omega$	$Z_{load}$ $\Omega$
100	49.78 + j1.07	47.87 - j9.85
150	48.96 + j1.44	49.12 - j5.44
200	48.00 + j1.54	49.09 - j2.66
250	46.67 + j1.36	48.63 - j0.79
300	45.30 + j0.91	47.73 + j0.49
350	43.93 + j0.11	46.60 + j1.22
400	42.53 - j0.86	45.63 + j1.43
450	41.38 - j2.16	44.97 + j1.13
500	40.30 - j3.71	45.04 + j0.70
550	39.38 - j5.44	45.23 + j0.77
600	38.43 - j7.11	44.80 + j1.29
650	37.94 - j8.71	44.32 + j1.48
700	37.49 - j10.52	43.57 + j1.51
750	37.31 - j12.42	43.19 + j1.32
800	37.00 - j14.03	42.61 + j0.77
850	36.74 - j15.64	42.25 + j0.39
900	36.57 - j17.09	41.90 + j0.03
950	36.37 - j18.59	41.67 - j0.41
1000	36.12 - j20.06	41.77 - j1.10
1050	35.58 - j21.43	41.82 - j1.60
1100	35.00 - j22.79	41.90 - j2.01
1150	34.53 - j24.39	42.26 - j2.43
1200	33.53 - j25.97	42.51 - j2.80
1250	32.67 - j27.84	42.74 - j2.99
1300	31.61 - j29.89	43.10 - j3.11
1350	30.61 - j32.34	43.52 - j3.19
1400	29.55 - j34.81	43.86 - j3.13
1450	28.23 - j37.61	44.03 - j3.03
1500	27.34 - j40.59	44.33 - j2.67

$Z_{in}$  = Device input impedance as measured from gate to ground.

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

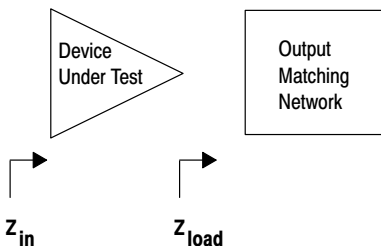
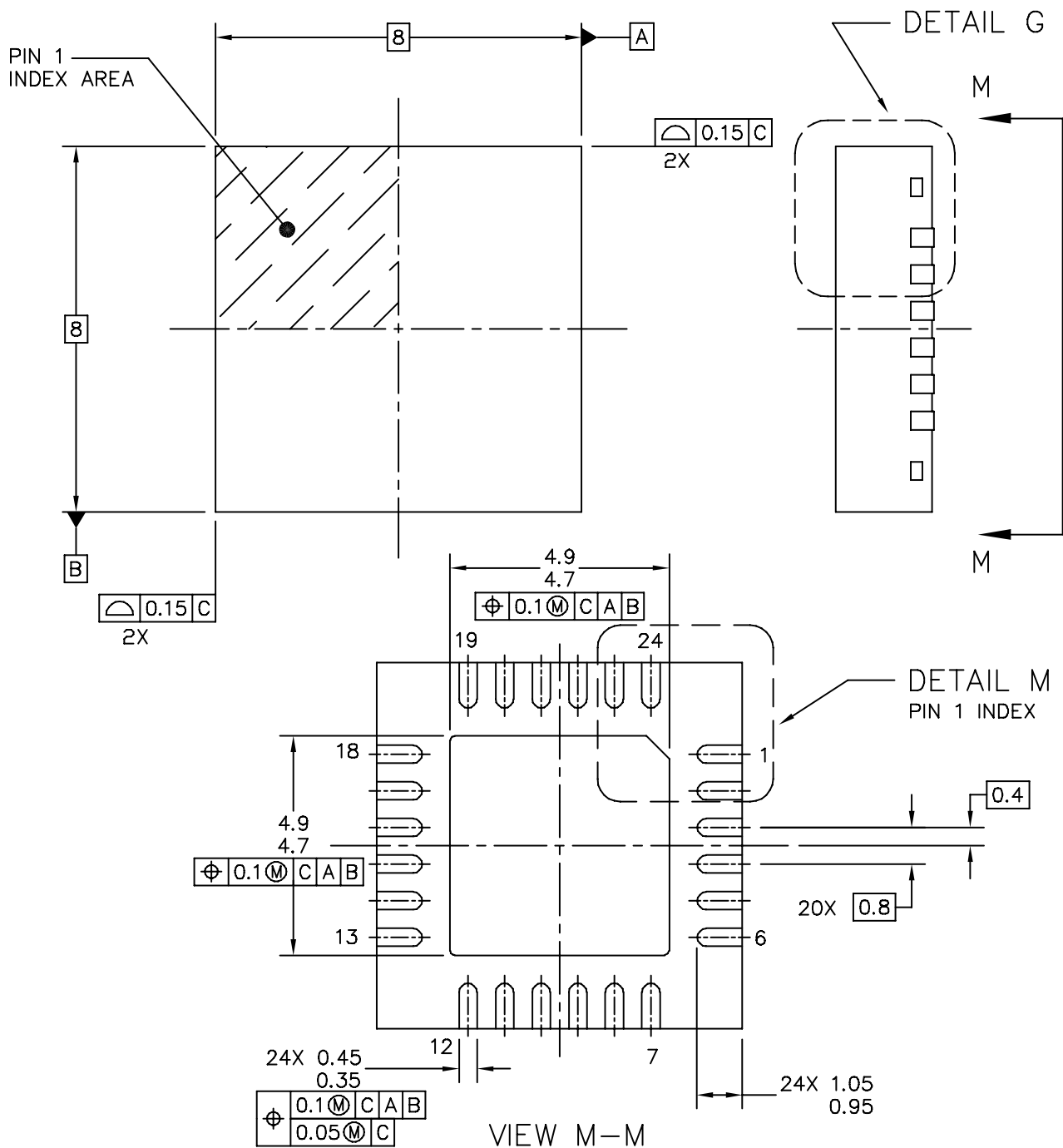


Figure 8. Series Equivalent Input and Load Impedance

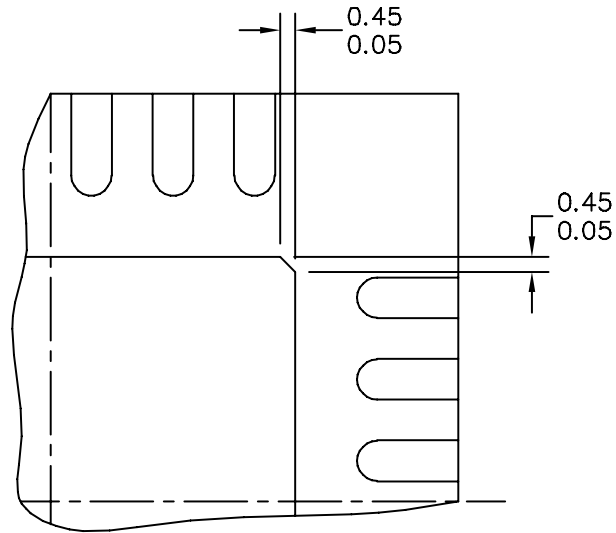


PACKAGE DIMENSIONS

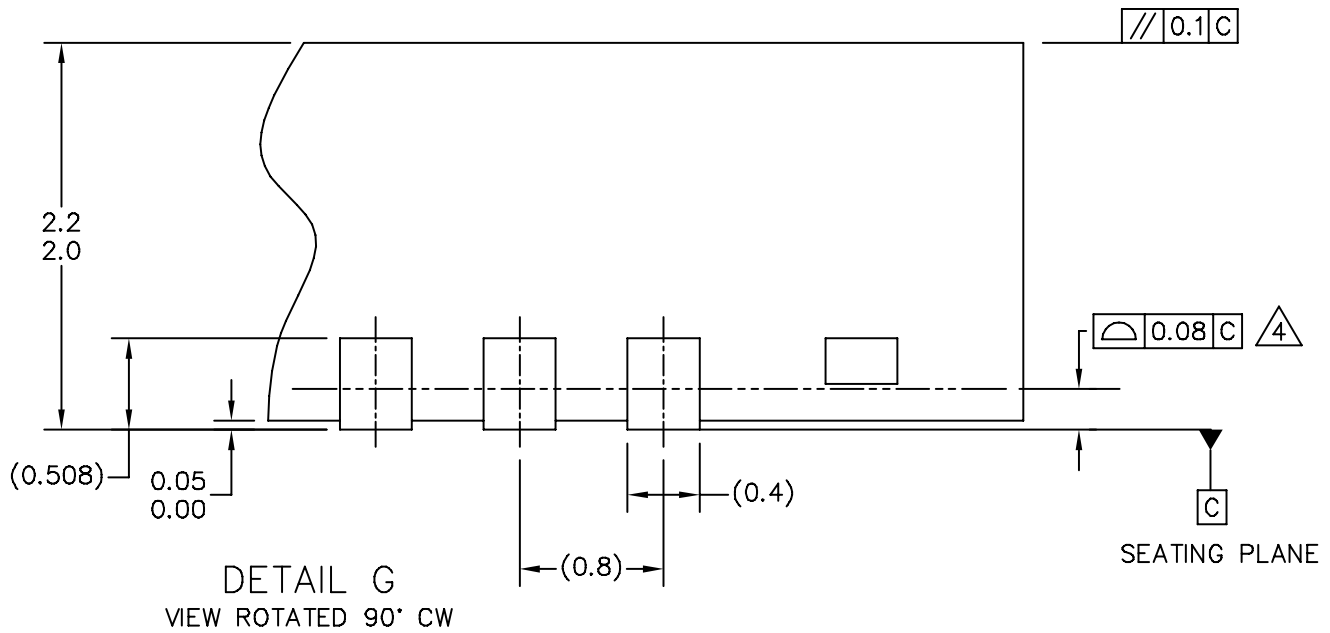


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MW71C008NT1




DETAIL M  
BACKSIDE PIN 1 INDEX



DETAIL G  
VIEW ROTATED 90° CW

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	CASE NUMBER: 1894-01	05 SEP 2006	
	STANDARD: NON-JEDEC		

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994.
3. THE COMPLETE JEDEC DESIGNATOR FOR THIS PACKAGE IS: HF-PQFN.
4.  COPLANARITY APPLIES TO LEADS AND DIE ATTACH PAD.
5. MINIMUM METAL GAP SHOULD BE 0.25MM.

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	CASE NUMBER: 1894-01	05 SEP 2006	
	STANDARD: NON-JEDEC		

## PRODUCT DOCUMENTATION, TOOLS AND SOFTWARE

Refer to the following documents, tools and software to aid your design process.

### Application Notes

- AN1955: Thermal Measurement Methodology of RF Power Amplifiers
- AN1977 Quiescent Current Thermal Tracking Circuit in the RF Integrated Circuit Family
- AN1987 Quiescent Current Control for the RF Integrated Circuit Device Family

### Engineering Bulletins

- EB212: Using Data Sheet Impedances for RF LDMOS Devices

### Software

- Electromigration MTTF Calculator
- RF High Power Model
- .s2p File

For Software and Tools, do a Part Number search at <http://www.freescale.com>, and select the “Part Number” link. Go to the Software & Tools tab on the part’s Product Summary page to download the respective tool.

## REVISION HISTORY

The following table summarizes revisions to this document.

Revision	Date	Description
0	Aug. 2009	<ul style="list-style-type: none"><li>• Initial Release of Data Sheet</li></ul>
1	Sept. 2009	<ul style="list-style-type: none"><li>• Modified Fig. 3, Test Circuit Component Layout and Table 6, Test Circuit Component Designations and Values to include temperature compensation options, p. 5</li><li>• Fig. 3, Test Circuit Component Layout, corrected <math>V_{DD1}</math> to <math>V_{GG1}</math>, p. 5</li><li>• Table 6, Test Circuit Component Designations and Values, C6, C17: updated description from “1 <math>\mu</math>F Tantalum Capacitors” to “1 <math>\mu</math>F, 35 V Tantalum Capacitors”; L1, L7, L2, L6: corrected manufacturer from Coilcraft to Toko; L3: corrected part number from “0603HC-1N6XJLC” to “0603HC-1N6XJLW”; L4, L5: corrected part number from “100B100JT500XT” to “0603HP-5N1XJLW”; R1, R12: updated description from “510 <math>\Omega</math> Chip Resistors” to “510 <math>\Omega</math>, 1/10 W Chip Resistors”, p. 5</li></ul>

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