Freescale Semiconductor
Technical Data

Document Number: MW7IC008N
Rev. 3, 12/2013

RF LDMOS Wideband Integrated Power Amplifier

The MW7IC008N wideband integrated circuit is designed with on-chip matching that makes it usable from 20 to 1000 MHz. This multi-stage structure is rated for 24 to 32 volt operation and covers most narrow bandwidth communication application 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

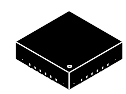
- Capable of Handling 10:1 VSWR, @ 32 Vdc, 900 MHz, P_{out} = 6.5 Watts CW (3 dB Input Overdrive from Rated P_{out})
- Stable into a 5:1 VSWR. All Spurs Below -60 dBc @ 1 mW to 8 Watts CW P_{out} @ 900 MHz
- Typical P_{out} @ 1 dB Compression Point ≃ 11 Watts CW @ 100 MHz, 9 Watts CW @ 400 MHz, 6.5 Watts 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
- In Tape and Reel. T1 Suffix = 1,000 Units, 16 mm Tape Width, 13-inch Reel.

MW7IC008NT1

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



PQFN 8 × 8 PLASTIC

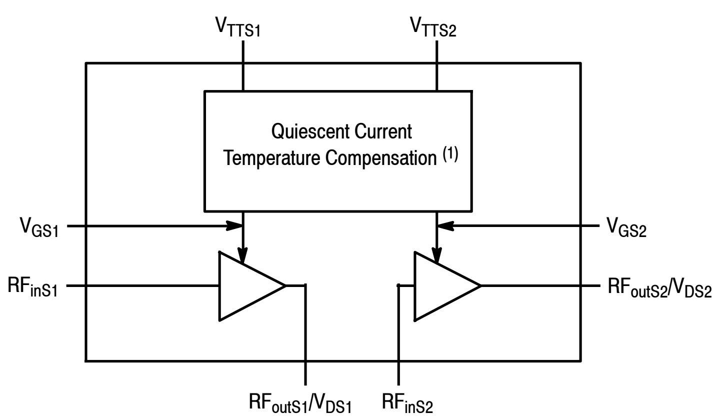


Figure 1. Functional Block Diagram

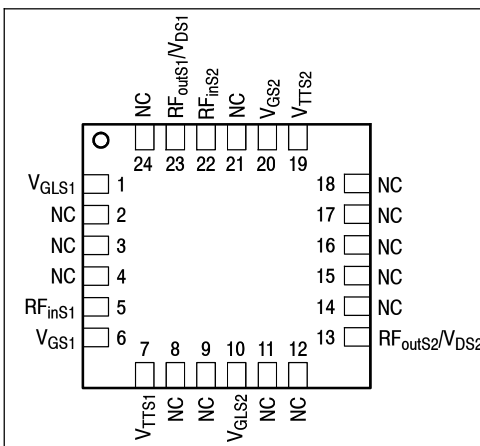


Figure 2. Pin Connections

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°C [3]		CW	11	W
400 MHz CW Operation @ T_A = 25°C [3]			6	W
900 MHz CW Operation @ T_A = 25°C [3]			5	W
Input Power	100 MHz 400 MHz 900 MHz	P_{in}	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
Machine Model (per EIA/JESD22-A115)	A
Charge Device Model (per JESD22-C101)	III

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).

Table 5. Electrical Characteristics (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Stage 1 — Off Characteristics					
Zero Gate Voltage Drain Leakage Current (V_{DS} = 65 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	10	μAdc
Zero Gate Voltage Drain Leakage Current (V_{DS} = 28 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	1	μAdc
Gate-Source Leakage Current (V_{GS} = 1.5 Vdc, V_{DS} = 0 Vdc)	I_{GSS}	—	—	10	μAdc
Stage 1 — On Characteristics					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 5.3 μAdc)	$V_{GS(th)}$	1.3	2	2.8	Vdc
Gate Quiescent Voltage (V_{DD} = 28 Vdc, I_D = 25 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 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	10	μAdc
Zero Gate Voltage Drain Leakage Current (V_{DS} = 28 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	1	μAdc
Gate-Source Leakage Current (V_{GS} = 1.5 Vdc, V_{DS} = 0 Vdc)	I_{GSS}	—	—	10	μAdc
Stage 2 — On Characteristics					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 23 μAdc)	$V_{GS(th)}$	1.3	2	2.8	Vdc
Gate Quiescent Voltage (V_{DD} = 28 Vdc, I_D = 75 mAdc, Measured in Functional Test)	$V_{GS(Q)}$	2	2.7	3.5	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 3.6 Adc)	$V_{DS(on)}$	0.1	0.3	1	Vdc
Functional Tests [1] (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ1} = 25 mA, I_{DQ2} = 75 mA, P_{out} = 6.5 W CW, f = 900 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 Vdc, I_{DQ1} = 25 mA, I_{DQ2} = 75 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°C unless otherwise noted) **(continued)**

Characteristic	Symbol	Min	Typ	Max	Unit
Typical Performances (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ1} = 25 mA, I_{DQ2} = 75 mA, 100–1000 MHz Bandwidth					
Characteristic	**Symbol**	**Min**	**Typ**	**Max**	**Unit**
IMD Symmetry @ 6.8 W PEP, P_{out} where IMD Third Order Intermodulation ≅ 30 dBc (1) (Delta IMD Third Order Intermodulation between Upper and Lower Sidebands > 2 dB)	IMD_{sym}	—	0.1	—	MHz
VBW Resonance Point (1) (IMD Third Order Intermodulation Inflection Point)	VBW_{res}	—	0.1	—	MHz
Gain Flatness in 500–1000 MHz Bandwidth @ P_{out} = 6 W Avg.	G_F	—	1.35	—	dB
Gain Variation over Temperature (–30°C to +85°C)	ΔG	—	0.024	—	dB/°C
Output Power Variation over Temperature (–30°C to +85°C)	ΔP1dB	—	0.005	—	dB/°C
Typical CW Performances — 100 MHz (In Freescale Test Fixture, 50 ohm system) V_{DD} = 28 Vdc, I_{DQ1} = 25 mA, I_{DQ2} = 75 mA, P_{out} = 11 W CW, f = 100 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 Vdc, I_{DQ1} = 25 mA, I_{DQ2} = 75 mA, P_{out} = 9 W CW, f = 400 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 Vdc, I_{DQ1} = 25 mA, I_{DQ2} = 75 mA, P_{out} = 6.5 W CW, f = 900 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. Not recommended for wide instantaneous bandwidth modulated signals.

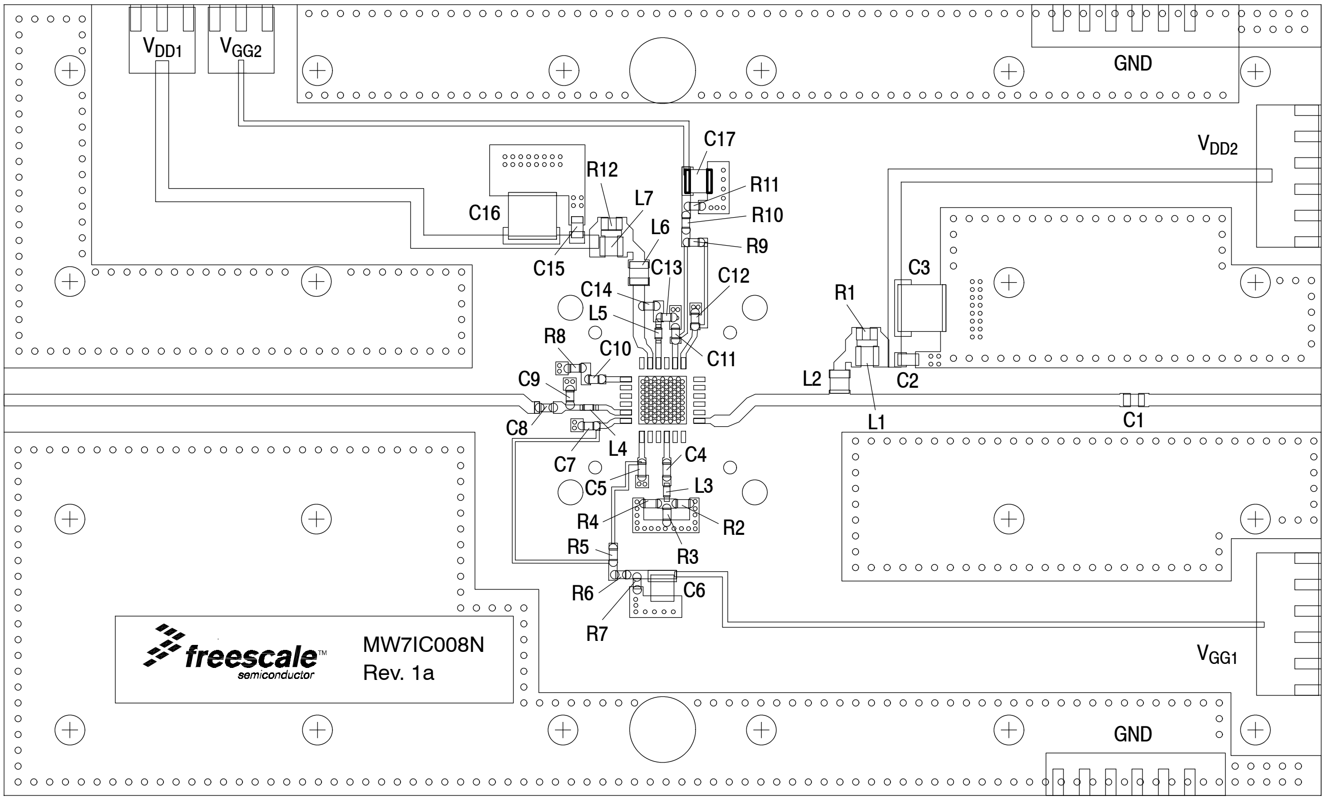


Figure 3. MW7IC008NT1 Test Circuit Component Layout

Table 6. MW7IC008NT1 Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1	0.01 μF Chip Capacitor	GRM3195C1E103JA01	Murata
C2, C15	0.1 μF Chip Capacitors	GRM219F51H104ZA01	Murata
C3, C16	10 μF Chip Capacitors	GRM55DR61H106KA88L	Murata
C4, C5, C7, C8, C10, C11, C12, C14	0.01 μF Chip Capacitors	C0805C103K5RAC	Kemet
C6, C17	1 μF, 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 Ω, 1/10 W Chip Resistors	RR1220P-511-B-T5	Susumu
R2, R3, R4	91 Ω, 1/8 W Chip Resistors	CRCW080591R0FKEA	Vishay
R5*, R9*	0 Ω, 2.5 A Chip Resistors	CRCW08050000Z0EA	Vishay
R6	10 KΩ, 1/8 W Chip Resistor	CRCW080510K0JNEA	Vishay
R7, R11	12 KΩ, 1/8 W Chip Resistors	CRCW080512K0JNEA	Vishay
R8	43 Ω, 1/8 W Chip Resistor	CRCW080543R0FKEA	Vishay
R10	15 KΩ, 1/8 W Chip Resistor	CRCW080515K0JNEA	Vishay
PCB	0.020″, ε_r = 3.66	RO4350B	Rogers

*Add for temperature compensation

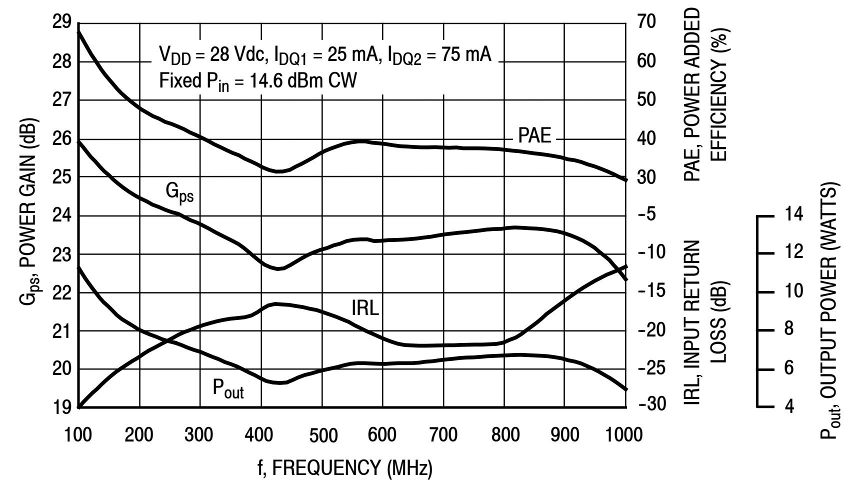


Figure 4. Broadband Performance @ P_{in} = 14.6 dBm CW

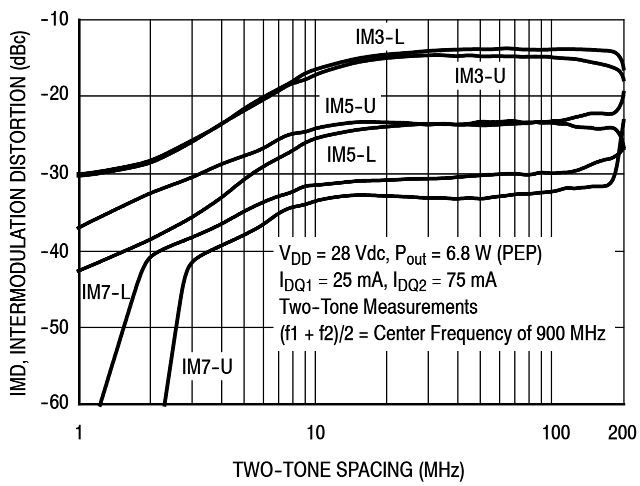


Figure 5. Intermodulation Distortion Products versus Two-Tone Spacing

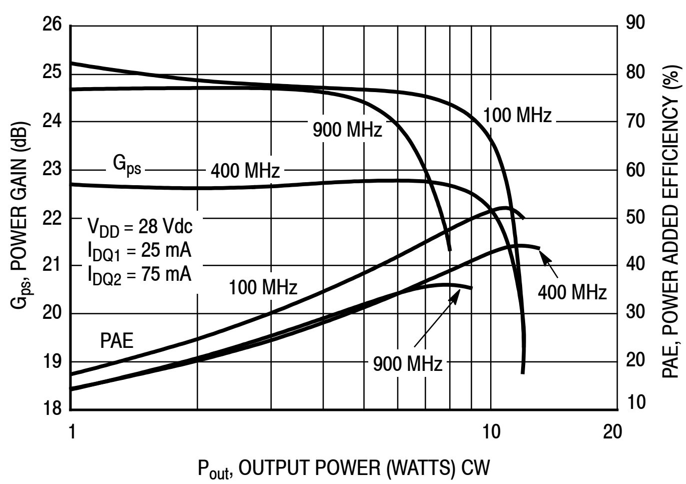


Figure 6. Power Gain and Power Added Efficiency versus Output Power

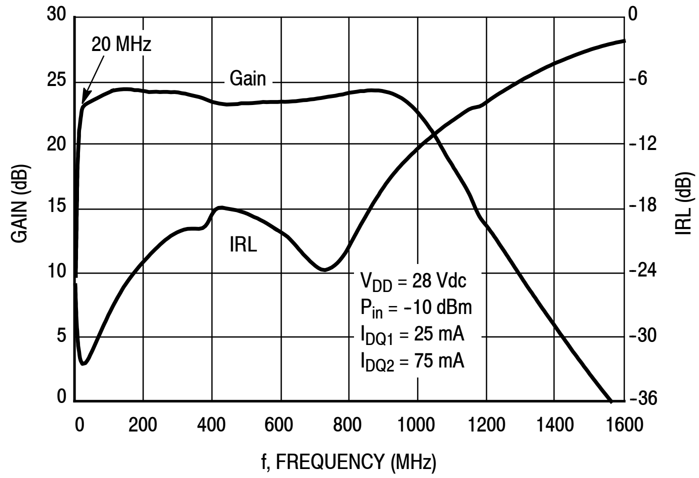


Figure 7. Broadband Frequency Response

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

f MHz	Z_{in} Ω	Z_{load} Ω
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.

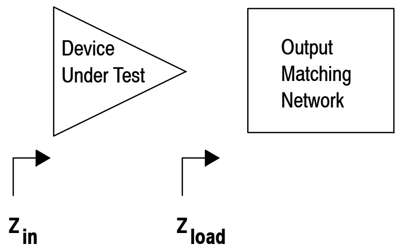
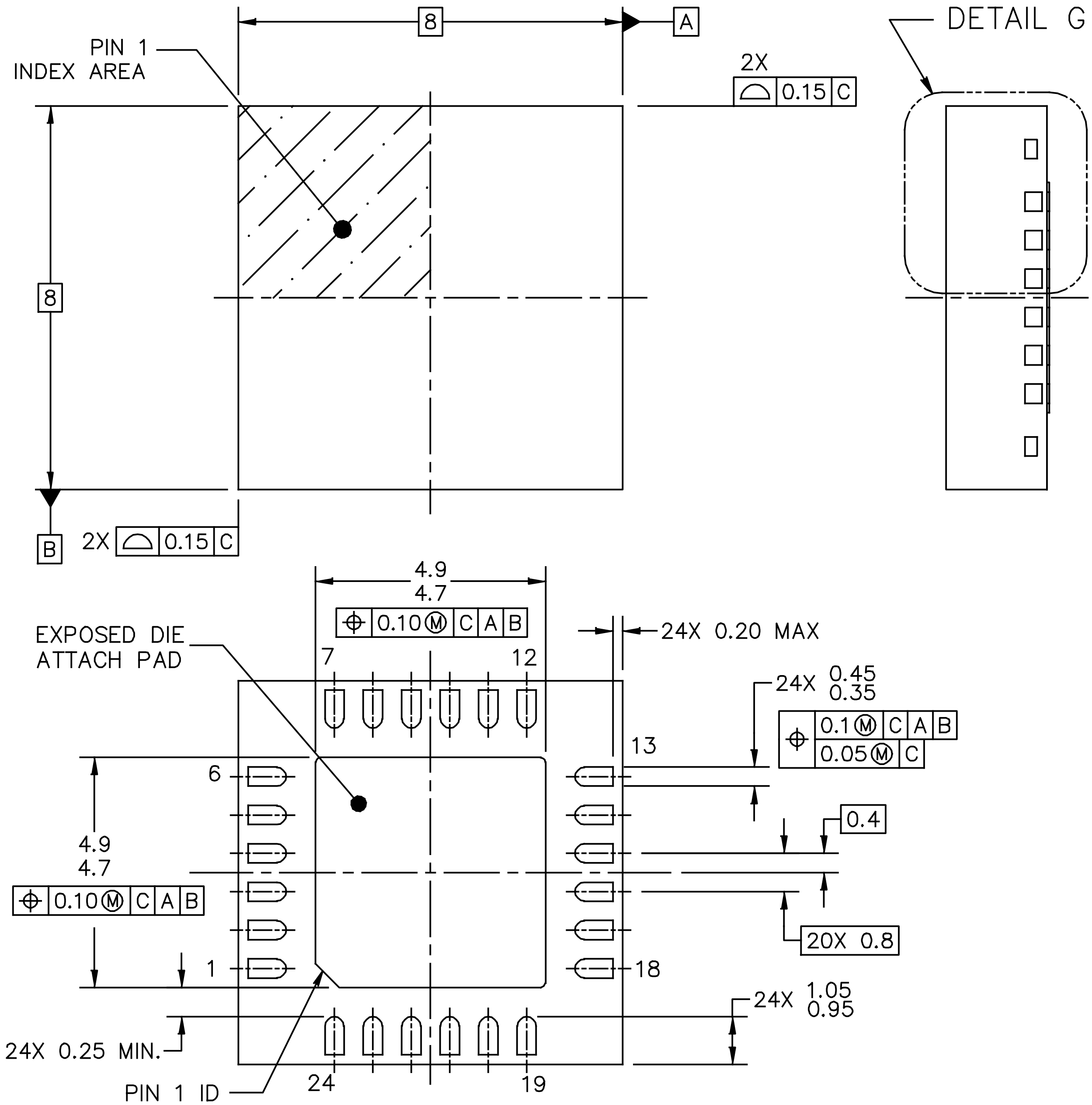


Figure 8. Series Equivalent Input and Load Impedance

PACKAGE DIMENSIONS



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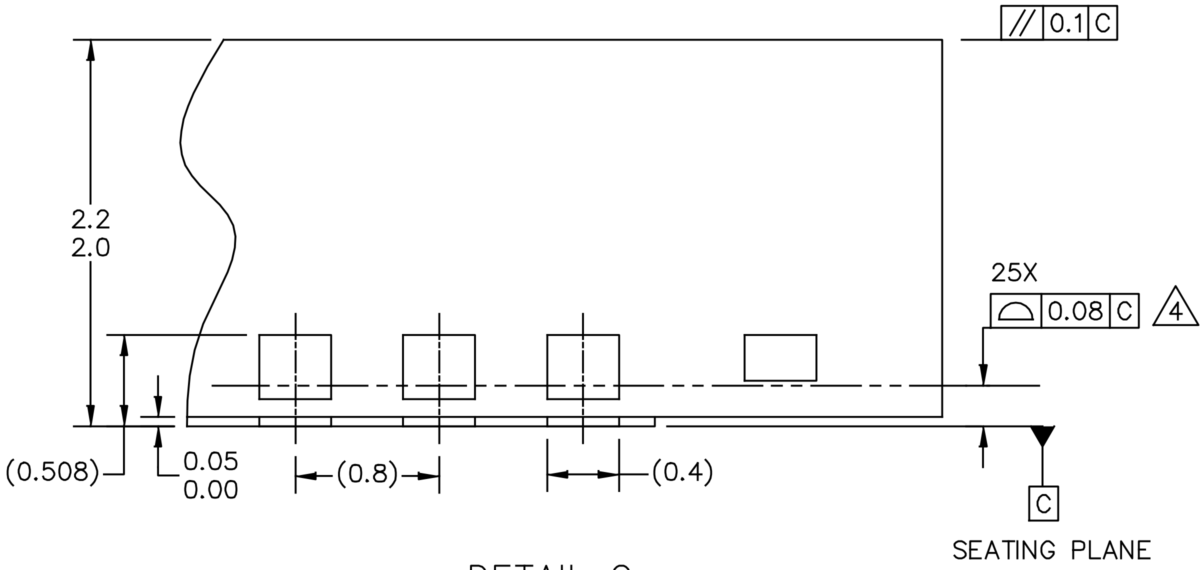
TITLE: PQFN (SAW), THERMALLY ENHANCED 8 X 8 X 2.1, 0.8 PITCH, 24 TERMINAL	DOCUMENT NO: 98ASA10760D	REV: A
	CASE NUMBER: 1894-02	29 MAY 2012
	STANDARD: NON-JEDEC	



DETAIL G
VIEW ROTATED 90° CW

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	CASE NUMBER: 1894-02	29 MAY 2012
	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.

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TITLE: PQFN (SAW), THERMALLY ENHANCED 8 X 8 X 2.1, 0.8 PITCH, 24 TERMINAL	DOCUMENT NO: 98ASA10760D	REV: A
	CASE NUMBER: 1894–02	29 MAY 2012
	STANDARD: NON–JEDEC	

PRODUCT DOCUMENTATION AND SOFTWARE

Refer to the following documents 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, 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	• Initial Release of Data Sheet
1	Sept. 2009	• Modified Fig. 3, Test Circuit Component Layout and Table 6, Test Circuit Component Designations and Values to include temperature compensation options, p. 5 • Fig. 3, Test Circuit Component Layout, corrected V_{DD1} to V_{GG1}, p. 5 • Table 6, Test Circuit Component Designations and Values, C6, C17: updated description from "1 μF Tantalum Capacitors" to "1 μF, 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 Ω Chip Resistors" to "510 Ω, 1/10 W Chip Resistors", p. 5
2	Mar. 2011	• Updated frequency in overview paragraph from "100 to 1000 MHz" to "20 to 1000 MHz" to reflect lower 20 MHz capability and narrow bandwidth modulation, p. 1 • Updated IMD_{sym} Typical value from 180 MHz to 0.1 MHz and VBW_{res} Typical value from 210 MHz to 0.1 MHz; modified Footnote 1 to reflect limited device capability regarding wide video bandwidth, Typical Performance table, p. 4
2.1	Mar. 2012	• Table 3, ESD Protection Characteristics, removed the word "Minimum" after the ESD class rating. ESD ratings are characterized during new product development but are not 100% tested during production. ESD ratings provided in the data sheet are intended to be used as a guideline when handling ESD sensitive devices, p. 2
3	Dec. 2013	• Table 6, Test Circuit Component Designations and Values: updated PCB description to reflect most current board specifications from Rogers, p. 5 • Replaced Case Outline 98ASA10760D, Rev. O with Rev. A, pp. 9-11. Mechanical outline drawing modified to reflect the correct lead end features. Format of the mechanical outline was also updated to the current Freescale format for Freescale mechanical outlines.

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