

Enhancement Mode pHEMT Technology (E-pHEMT)

Low Noise Amplifier

The MML09212H is a 2-stage low noise amplifier (LNA) with active bias and high isolation for use in cellular infrastructure applications. It is designed for a range of low noise, high linearity applications such as picocell, femtocell, tower mounted amplifiers (TMA) and receiver front end circuits. It operates from a single voltage supply and is suitable for applications with frequencies from 400 to 1400 MHz such as ISM, GSM, W-CDMA and LTE.

Features

- Low Noise Figure: 0.52 dB @ 900 MHz
- Frequency: 400–1400 MHz
- Unconditionally Stable Over Temperature
- High Reverse Isolation: –58 dB @ 900 MHz
- P1dB: 22.8 dBm @ 900 MHz
- Small-Signal Gain: 37.5 dB @ 900 MHz (adjustable externally)
- Third Order Output Intercept Point: 37.5 dBm @ 900 MHz
- Active Bias Control (On-chip)
- Single 5 Volt Supply
- Supply Current: 150 mA
- 50 Ohm Operation (some external matching required)
- Cost-effective QFN Surface Mount Package
- In Tape and Reel. T1 Suffix = 1,000 Units, 12 mm Tape Width, 7 inch Reel.

MML09212HT1

**400–1400 MHz, 37.5 dB
22.8 dBm, 0.52 NF
E-pHEMT**



**CASE 2131-01
QFN 3x3
PLASTIC**

Table 1. Typical Performance ⁽¹⁾

Characteristic	Symbol	400 MHz	900 MHz	1400 MHz	Unit
Noise Figure ⁽²⁾	NF	0.52	0.52	0.74	dB
Input Return Loss (S11)	IRL	–19	–24	–17	dB
Output Return Loss (S22)	ORL	–15	–14	–13.5	dB
Small-Signal Gain (S21)	G _p	40.0	37.5	35.0	dB
Power Output @ 1dB Compression	P1dB	22.6	22.8	22.5	dBm
Third Order Input Intercept Point	IIP3	–2	–0.5	3	dBm
Third Order Output Intercept Point	OIP3	38	37	38	dBm

1. V_{DD} = 5 Vdc, T_A = 25°C, 50 ohm system, application circuit tuned for specified frequency.

2. Noise Figure value calculated with connector losses removed.

Table 2. Maximum Ratings

Rating	Symbol	Value	Unit
Supply Voltage	V _{DD}	6	V
Supply Current	I _{DD}	300	mA
RF Input Power	P _{in}	20	dBm
Storage Temperature Range	T _{stg}	–65 to +150	°C
Junction Temperature ⁽³⁾	T _J	150	°C

3. For reliable operation, the junction temperature should not exceed 150°C.

Table 3. Thermal Characteristics

Characteristic	Symbol	Value ⁽⁴⁾	Unit
Thermal Resistance, Junction to Case Case Temperature 83°C, 5 Vdc, 150 mA, no RF applied	R _{θJC}	37	°C/W

4. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers*. Go to <http://www.freescale.com/rf>. Select Documentation/Application Notes – AN1955.

Table 4. Electrical Characteristics ($V_{DD} = 5$ Vdc, 900 MHz, $T_A = 25^\circ\text{C}$, 50 ohm system, in Freescale Application Circuit)

Characteristic	Symbol	Min	Typ	Max	Unit
Small-Signal Gain (S21)	G_p	35.0	37.5	—	dB
Input Return Loss (S11)	IRL	—	-24	—	dB
Output Return Loss (S22)	ORL	—	-14	—	dB
Power Output @ 1dB Compression	P1dB	—	22.8	—	dBm
Third Order Input Intercept Point	IIP3	—	-0.5	—	dBm
Third Order Output Intercept Point	OIP3	—	37	—	dBm
Reverse Isolation (S12)	S12	—	-58	—	dBm
Noise Figure ⁽¹⁾	NF	—	0.52	—	dB
Supply Current ^(2,3)	I_{DD}	128	150	178	mA
Supply Voltage ⁽²⁾	V_{DD}	—	5	—	V

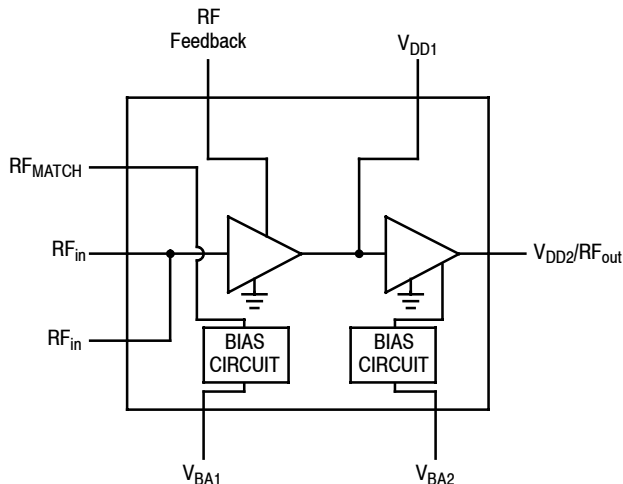
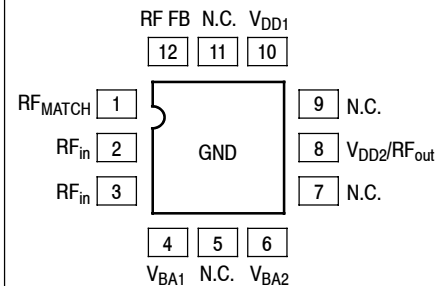
Table 5. ESD Protection Characteristics

Test Methodology	Class
Human Body Model (per JESD22-A114)	0
Machine Model (per EIA/JESD22-A115)	A
Charge Device Model (per JESD22-C101)	IV

Table 6. Moisture Sensitivity Level

Test Methodology	Rating	Package Peak Temperature	Unit
Per JESD22-A113, IPC/JEDEC J-STD-020	1	260	$^\circ\text{C}$

- Noise Figure value calculated with connector losses removed.
- For reliable operation, the junction temperature should not exceed 150°C .
- DC current measured with no RF signal applied.

**Figure 1. Functional Block Diagram**

Note: Exposed backside of the package is DC and RF ground.

Figure 2. Pin Connections

50 OHM APPLICATION CIRCUIT: 900 MHz

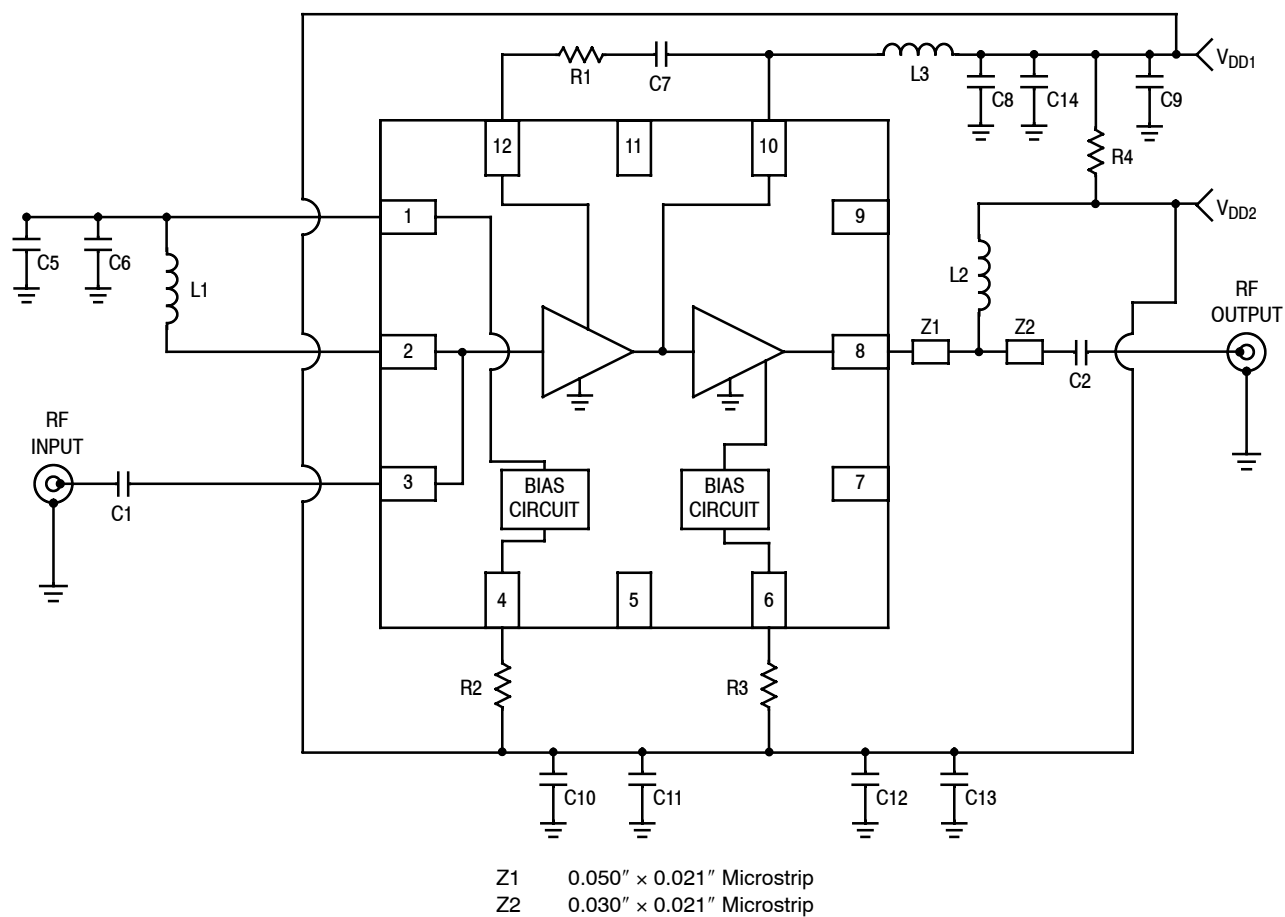
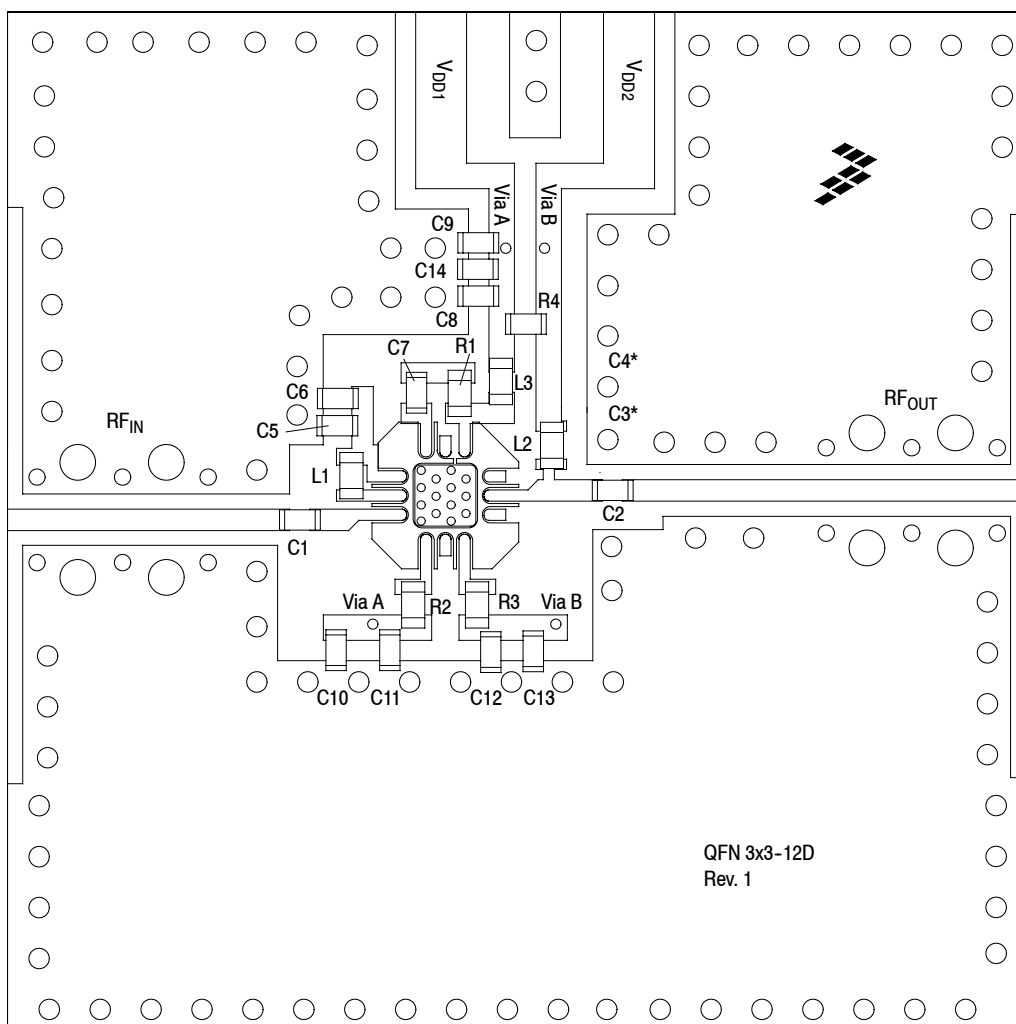


Figure 3. MML09212HT1 Test Circuit Schematic

Table 7. MML09212HT1 Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C2, C7, C14	56 pF Chip Capacitors	GRM1555C1H560JZ01	Murata
C3, C4	Components Not Used		
C5	180 pF Chip Capacitor	GRM1555C1H181JZ01	Murata
C6, C9, C10, C13	0.01 μ F Chip Capacitors	GRM155R71E103KA01	Murata
C8	1000 pF Chip Capacitor	GRM155R71E101KA01	Murata
C11, C12	100 pF Chip Capacitors	GRM1555C1H101JZ01	Murata
L1	12 nH Chip Inductor	0402CS-12NXGL	Coilcraft
L2	30 nH Chip Inductor	0402CS-30NXGL	Coilcraft
L3	8.2 nH Chip Inductor	0402CS-8N2XGL	Coilcraft
R1	82 Ω Chip Resistor	RC0402JR-07-82RL	Yageo
R2	1100 Ω Chip Resistor	RC0402FR-07-1K1L	Yageo
R3	910 Ω Chip Resistor	RC0402FR-07-910RL	Yageo
R4	0 Ω , 1 A Chip Resistor	ERJ2GE0R00X	Panasonic
PCB	0.010", $\epsilon_r = 3.48$, Multilayer	RO4350B	Rogers

50 OHM APPLICATION CIRCUIT: 900 MHz



*C3 and C4 components not used.

Figure 4. MML09212HT1 Test Circuit Component Layout

Table 7. MML09212HT1 Test Circuit Component Designations and Values

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C1, C2, C7, C14	56 pF Chip Capacitors	GRM1555C1H560JZ01	Murata
C3, C4	Components Not Used		
C5	180 pF Chip Capacitor	GRM1555C1H181JZ01	Murata
C6, C9, C10, C13	0.01 μ F Chip Capacitors	GRM155R71E103KA01	Murata
C8	1000 pF Chip Capacitor	GRM155R71E101KA01	Murata
C11, C12	100 pF Chip Capacitors	GRM1555C1H101JZ01	Murata
L1	12 nH Chip Inductor	0402CS-12NXGL	Coilcraft
L2	30 nH Chip Inductor	0402CS-30NXGL	Coilcraft
L3	8.2 nH Chip Inductor	0402CS-8N2XGL	Coilcraft
R1	82 Ω Chip Resistor	RC0402JR-07-82RL	Yageo
R2	1100 Ω Chip Resistor	RC0402FR-07-1K1L	Yageo
R3	910 Ω Chip Resistor	RC0402FR-07-910RL	Yageo
R4	0 Ω , 1 A Chip Resistor	ERJ2GE0R00X	Panasonic
PCB	0.010", $\epsilon_r = 3.48$, Multilayer	RO4350B	Rogers

(Test Circuit Component Designations and Values repeated for reference.)

50 OHM APPLICATION CIRCUIT: 400 MHz

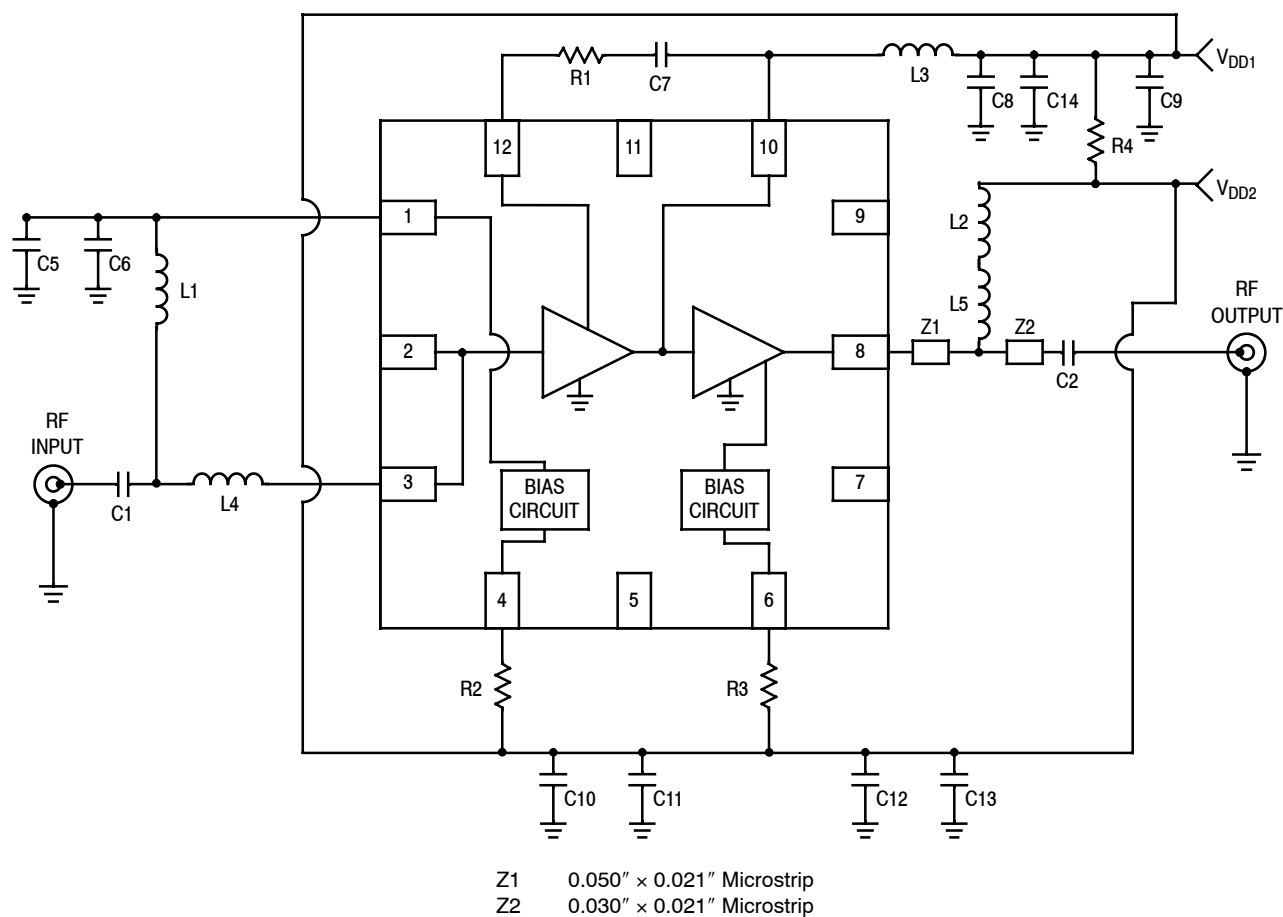
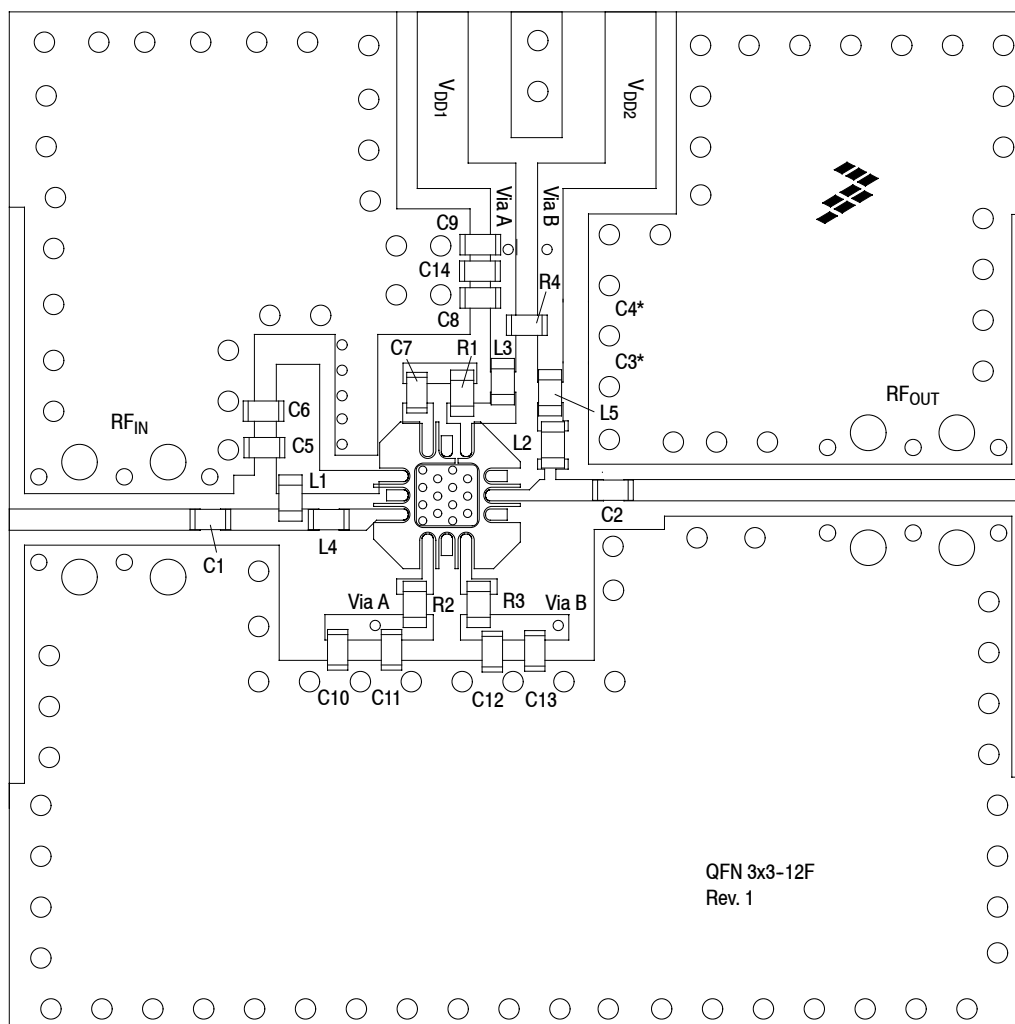


Figure 5. MML09212HT1 Test Circuit Schematic

Table 8. MML09212HT1 Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C2	100 pF Chip Capacitors	GRM1555C1H101JZ01	Murata
C3, C4	Components Not Used		
C5, C7, C8, C11, C12	390 pF Chip Capacitors	GRM1555C1H391JZ01	Murata
C6, C9, C10, C13	0.01 μ F Chip Capacitors	GRM155R71E103KA01	Murata
C14	1000 pF Chip Capacitor	GRM155R71E101KA01	Murata
L1	20 nH Chip Inductor	0402CS-20NXGL	Coilcraft
L2, L5	30 nH Chip Inductors	0402CS-30NXGL	Coilcraft
L3	16 nH Chip Inductor	0402CS-16NNXGL	Coilcraft
L4	1.2 nH Chip Inductor	0402CS-1N2XJL	Coilcraft
R1	100 Ω Chip Resistor	RC0402JR-07-100RL	Yageo
R2	1100 Ω Chip Resistor	RC0402FR-07-1K1L	Yageo
R3	910 Ω Chip Resistor	RC0402FR-07-910RL	Yageo
R4	0 Ω , 1 A Chip Resistor	ERJ2GE0R00X	Panasonic
PCB	0.010", $\epsilon_r = 3.48$, Multilayer	RO4350B	Rogers

50 OHM APPLICATION CIRCUIT: 400 MHz



*C3 and C4 components not used.

Figure 6. MML09212HT1 Test Circuit Component Layout

Table 8. MML09212HT1 Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C2	100 pF Chip Capacitors	GRM1555C1H101JZ01	Murata
C3, C4	Components Not Used		
C5, C7, C8, C11, C12	390 pF Chip Capacitors	GRM1555C1H391JZ01	Murata
C6, C9, C10, C13	0.01 μ F Chip Capacitors	GRM155R71E103KA01	Murata
C14	1000 pF Chip Capacitor	GRM155R71E101KA01	Murata
L1	20 nH Chip Inductor	0402CS-20NXGL	Coilcraft
L2, L5	30 nH Chip Inductors	0402CS-30NXGL	Coilcraft
L3	16 nH Chip Inductor	0402CS-16NNXGL	Coilcraft
L4	1.2 nH Chip Inductor	0402CS-1N2XJL	Coilcraft
R1	100 Ω Chip Resistor	RC0402JR-07-100RL	Yageo
R2	1100 Ω Chip Resistor	RC0402FR-07-1K1L	Yageo
R3	910 Ω Chip Resistor	RC0402FR-07-910RL	Yageo
R4	0 Ω , 1 A Chip Resistor	ERJ2GE0R00X	Panasonic
PCB	0.010", $\epsilon_r = 3.48$, Multilayer	RO4350B	Rogers

(Test Circuit Component Designations and Values repeated for reference.)

50 OHM APPLICATION CIRCUIT: 1400 MHz

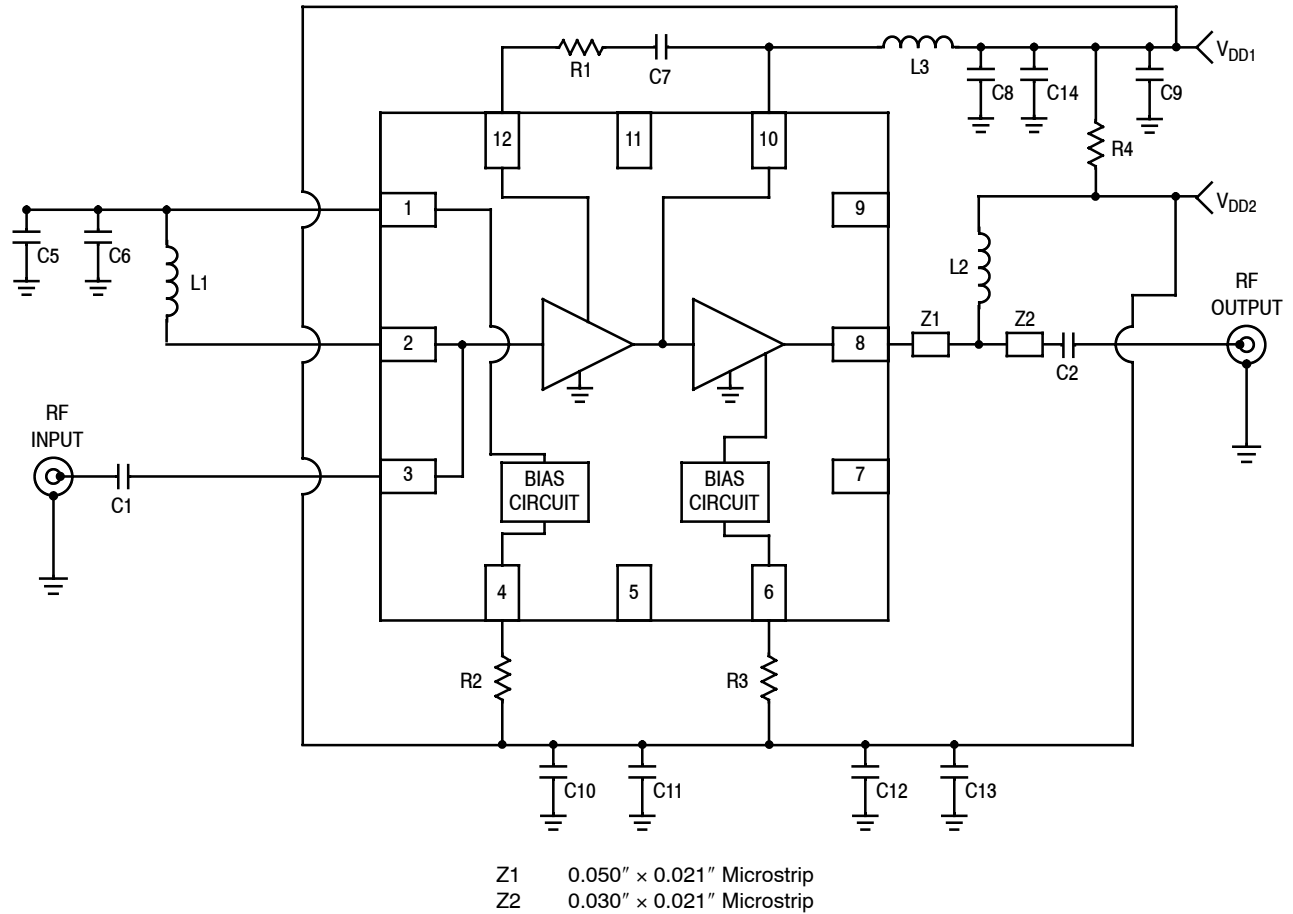
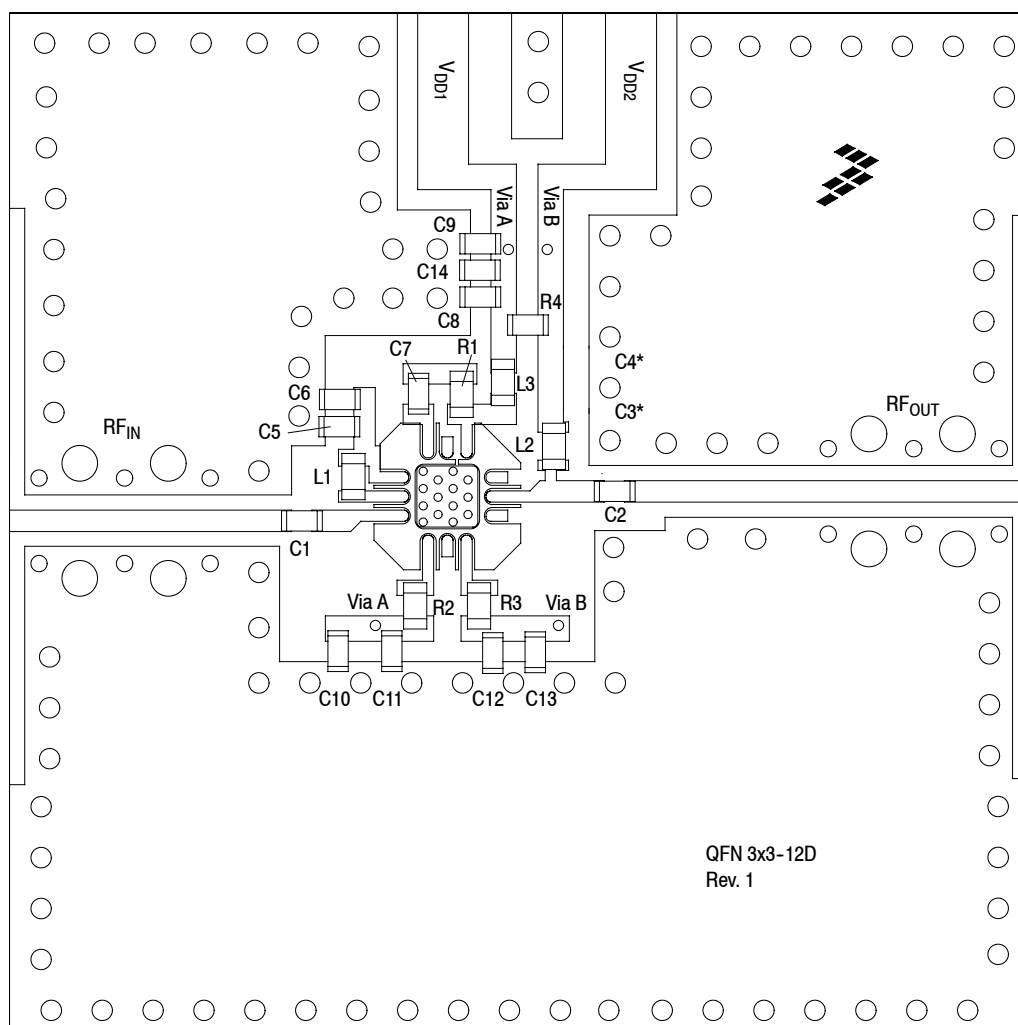


Figure 7. MML09212HT1 Test Circuit Schematic

Table 9. MML09212HT1 Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1	220 pF Chip Capacitor	GRM1555C1H221JZ01	Murata
C2, C7	56 pF Chip Capacitors	GRM1555C1H560JZ01	Murata
C3, C4	Components Not Used		
C5	180 pF Chip Capacitor	GRM1555C1H181JZ01	Murata
C6, C9, C10, C13	0.01 μ F Chip Capacitors	GRM155R71E103KA01	Murata
C8	1000 pF Chip Capacitor	GRM155R71E101KA01	Murata
C11, C12	100 pF Chip Capacitors	GRM1555C1H101JZ01	Murata
C14	68 pF Chip Capacitor	GRM1555C1H680JZ01	Murata
L1	6.8 nH Chip Inductor	0402CS-6N8XGL	Coilcraft
L2	23 nH Chip Inductor	0402CS-23NXGL	Coilcraft
L3	4.3 nH Chip Inductor	0402CS-4N3XGL	Coilcraft
R1	100 Ω Chip Resistor	RC0402JR-07-100RL	Yageo
R2	1100 Ω Chip Resistor	RC0402FR-07-1K1L	Yageo
R3	910 Ω Chip Resistor	RC0402FR-07-910RL	Yageo
R4	0 Ω , 1 A Chip Resistor	ERJ2GE0R00X	Panasonic
PCB	0.010", $\epsilon_r = 3.48$, Multilayer	RO4350B	Rogers

50 OHM APPLICATION CIRCUIT: 1400 MHz



*C3 and C4 components not used.

Figure 8. MML09212HT1 Test Circuit Component Layout

Table 9. MML09212HT1 Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1	220 pF Chip Capacitor	GRM1555C1H221JZ01	Murata
C2, C7	56 pF Chip Capacitors	GRM1555C1H560JZ01	Murata
C3, C4	Components Not Used		
C5	180 pF Chip Capacitor	GRM1555C1H181JZ01	Murata
C6, C9, C10, C13	0.01 μ F Chip Capacitors	GRM155R71E103KA01	Murata
C8	1000 pF Chip Capacitor	GRM155R71E101KA01	Murata
C11, C12	100 pF Chip Capacitors	GRM1555C1H101JZ01	Murata
C14	68 pF Chip Capacitor	GRM1555C1H680JZ01	Murata
L1	6.8 nH Chip Inductor	0402CS-6N8XGL	Coilcraft
L2	23 nH Chip Inductor	0402CS-23NXGL	Coilcraft
L3	4.3 nH Chip Inductor	0402CS-4N3XGL	Coilcraft
R1	100 Ω Chip Resistor	RC0402JR-07-100RL	Yageo
R2	1100 Ω Chip Resistor	RC0402FR-07-1K1L	Yageo
R3	910 Ω Chip Resistor	RC0402FR-07-910RL	Yageo
R4	0 Ω , 1 A Chip Resistor	ERJ2GE0R00X	Panasonic
PCB	0.010", $\epsilon_r = 3.48$, Multilayer	RO4350B	Rogers

(Test Circuit Component Designations and Values repeated for reference.)

MML09212HT1

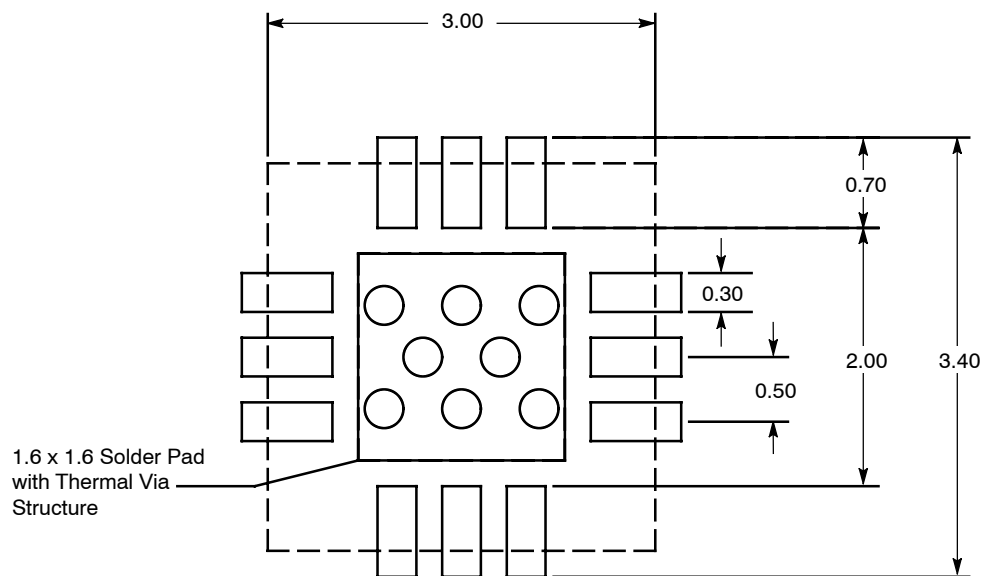
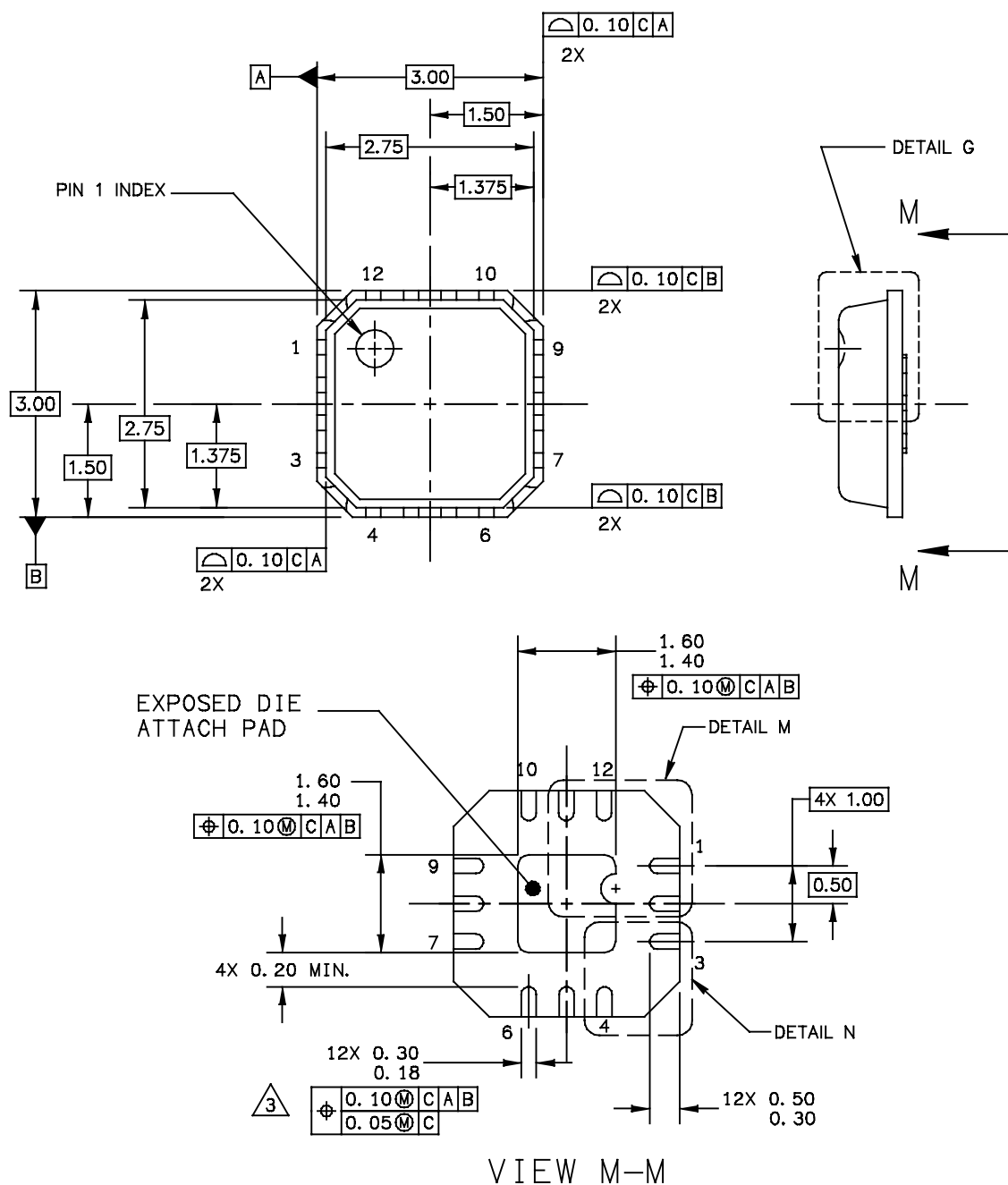


Figure 9. PCB Pad Layout for QFN 3x3



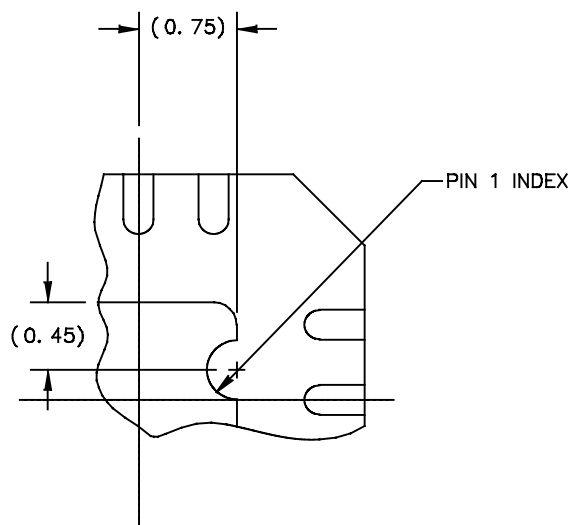
Figure 10. Product Marking

PACKAGE DIMENSIONS



VIEW M-M

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TITLE: THERMALLY ENHANCED QUAD FLAT NON-LEADED PACKAGE (QFN) 12 TERMINAL, 0.5 PITCH (3X3X0.85)	DOCUMENT NO: 98ASA00227D		REV: 0
	CASE NUMBER: 2131-01		14 MAY 2010
	STANDARD: NON-JEDEC		



DETAIL M
PIN 1 BACKSIDE INDEX



MML09212HT1

NOTE:

1. ALL DIMENSIONS ARE IN MILLIMETERS.

2. DIMENSIONING & TOLERANCING PER ASME Y14.5 – 2009.

△3. THIS DIMENSION APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.30 MM FROM TERMINAL TIP.

△4. BILATERAL COPLANARITY ZONE APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.

△5. THIS DIMENSION APPLIED ONLY FOR TERMINALS.

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	STANDARD: NON-JEDEC		

PRODUCT DOCUMENTATION, SOFTWARE AND TOOLS

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

Application Notes

- AN1955: Thermal Measurement Methodology of RF Power Amplifiers
- AN3100: General Purpose Amplifier and MMIC Biasing

Software

- .s2p File

Development Tools

- Printed Circuit Boards

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	Oct. 2012	• Initial Release of Data Sheet

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