

Heterojunction Bipolar Transistor Technology (InGaP HBT)

High Efficiency/Linearity Amplifier

The MMZ09312B is a 2-stage high efficiency, Class AB InGaP HBT amplifier designed for use as a linear driver amplifier in wireless base station applications as well as an output stage in femtocell or repeater applications. It is suitable for applications with frequencies from 400 to 1000 MHz such as CDMA, GSM, LTE and ZigBee® at operating voltages from 3 to 5 Volts. The amplifier is housed in a cost-effective, surface mount QFN plastic package.

- Typical Performance: $V_{CC1} = V_{CC2} = V_{BIAS} = 5$ Volts, $I_{CQ} = 74$ mA

| Frequency | P _{out} (dBm) | G _{ps} (dB) | ACPR (dBc) | PAE (%) | Test Signal |
|-----------|------------------------|----------------------|------------|---------|------------------|
| 900 MHz | 24 | 31.5 | -50.0 | 26.0 | IS-95 CDMA |
| 750 MHz | 17.5 | 32.0 | -50.0 | 15.3 | LTE 10/20 MHz |
| 450 MHz | 29 | 33.0 | -40.0 | 57.0 | ZigBee |

Features

- Frequency: 400–1000 MHz
- P1dB: 29.6 dBm @ 900 MHz
- Power Gain: 31.7 dB @ 900 MHz
- OIP3: 42 dBm @ 900 MHz
- Active Bias Control (adjustable externally)
- Single 3 to 5 Volt Supply
- Performs Well with Digital Predistortion Systems
- Single-ended Power Detector
- Cost-effective QFN Surface Mount Package
- In Tape and Reel. T1 Suffix = 1,000 Units, 12 mm Tape Width, 7 inch Reel.

MMZ09312BT1

**400–1000 MHz, 31.7 dB
29.6 dBm
InGaP HBT**



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

Table 1. Typical Performance (1)

| Characteristic | Symbol | 450 MHz | 900 MHz | Unit |
|--------------------------------|----------------|---------|---------|------|
| Small-Signal Gain (S21) | G _p | 33.8 | 31.7 | dB |
| Input Return Loss (S11) | IRL | -22 | -15 | dB |
| Output Return Loss (S22) | ORL | -25 | -18 | dB |
| Power Output @ 1dB Compression | P1dB | 28.8 | 29.6 | dBm |

1. $V_{CC1} = V_{CC2} = V_{BIAS} = 5$ Vdc, $T_A = 25^\circ\text{C}$, 50 ohm system, CW Application Circuit

Table 2. Maximum Ratings

| Rating | Symbol | Value | Unit |
|---------------------------|-----------|-------------|------------------|
| Supply Voltage | V_{CC} | 6 | V |
| Supply Current | I_{CC} | 550 | mA |
| RF Input Power | P_{in} | 14 | dBm |
| Storage Temperature Range | T_{stg} | -65 to +150 | $^\circ\text{C}$ |
| Junction Temperature (2) | T_J | 150 | $^\circ\text{C}$ |

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

Table 3. Thermal Characteristics

| Characteristic | Symbol | Value (3) | Unit |
|--|-----------------|-----------|--------------------|
| Thermal Resistance, Junction to Case Case Temperature 84°C , $V_{CC1} = V_{CC2} = V_{BIAS} = 5$ Vdc | $R_{\theta JC}$ | 56 | $^\circ\text{C/W}$ |

3. 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 ($V_{CC1} = V_{CC2} = V_{BIAS} = 5$ Vdc, 900 MHz, $T_A = 25^\circ\text{C}$, 50 ohm system, in Freescale CW Application Circuit)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|----------|-----|------|-----|------|
| Small-Signal Gain (S21) | G_p | 29 | 31.7 | — | dB |
| Input Return Loss (S11) | IRL | — | -15 | — | dB |
| Output Return Loss (S22) | ORL | — | -18 | — | dB |
| Power Output @ 1dB Compression | P1dB | — | 29.6 | — | dBm |
| Third Order Output Intercept Point, Two-Tone CW | OIP3 | — | 42 | — | dBm |
| Noise Figure | NF | — | 4 | — | dB |
| Supply Current (1) | I_{CQ} | 69 | 74 | 83 | mA |
| Supply Voltage (1) | V_{CC} | — | 5 | — | V |

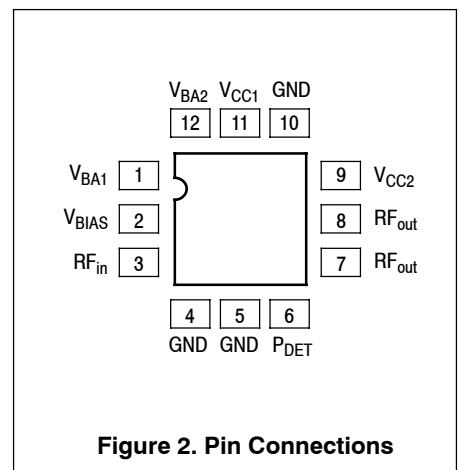
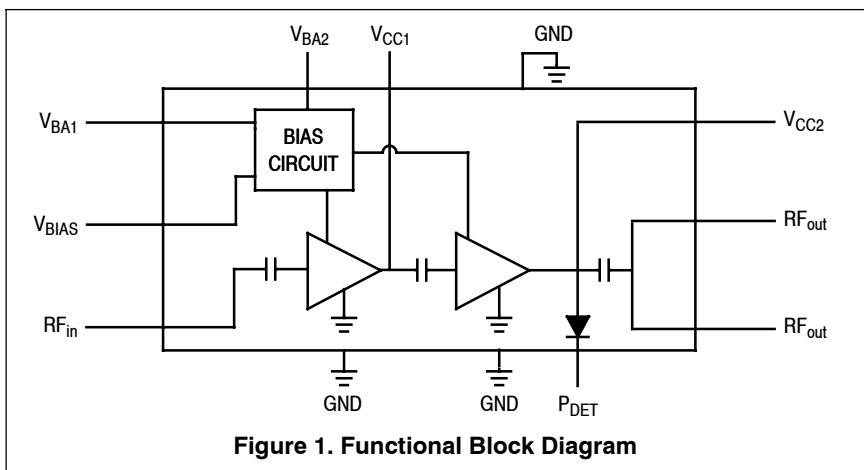
Table 5. ESD Protection Characteristics

| Test Methodology | Class |
|---------------------------------------|--|
| Human Body Model (per JESD22-A114) | Meets 2000 V for all pins except: Pin 11 meets 400 V Pin 8 meets 200 V Class 0 Rating |
| 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 | $^\circ\text{C}$ |

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



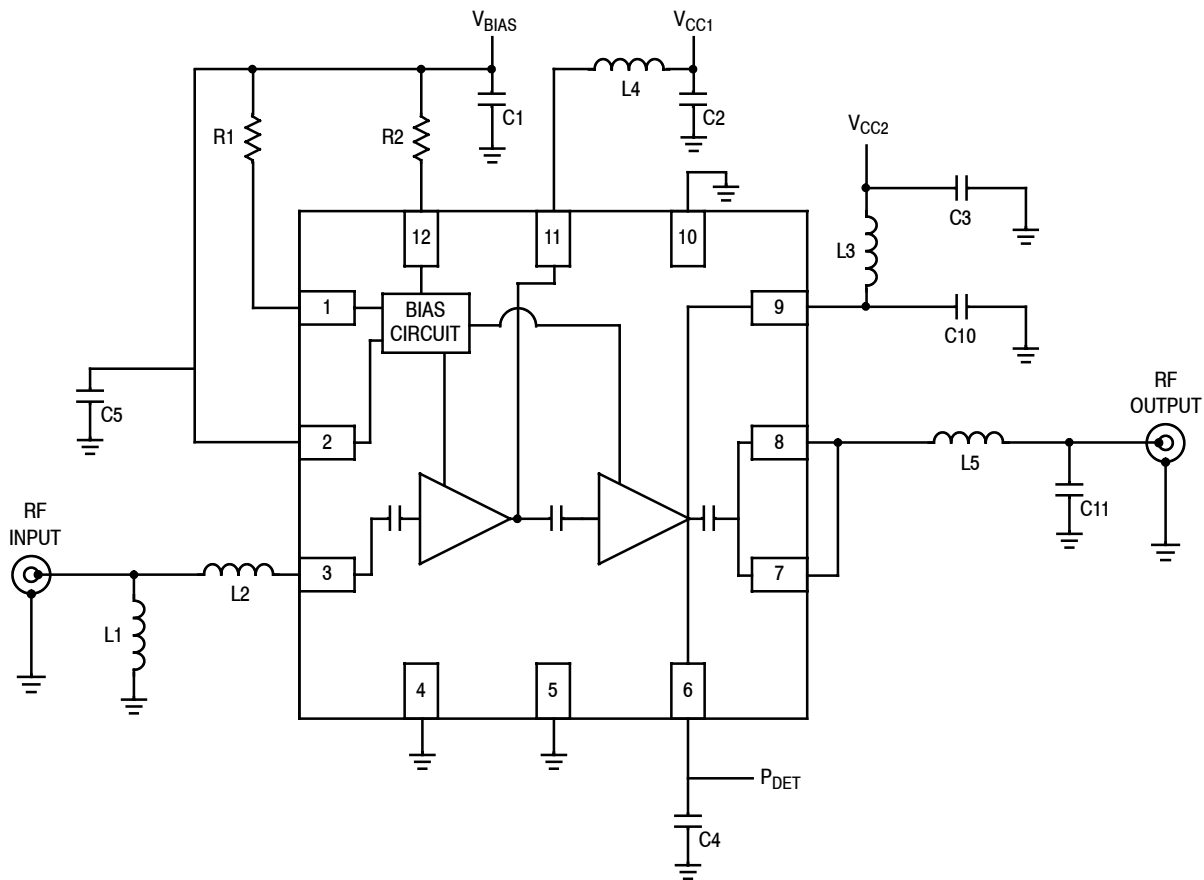
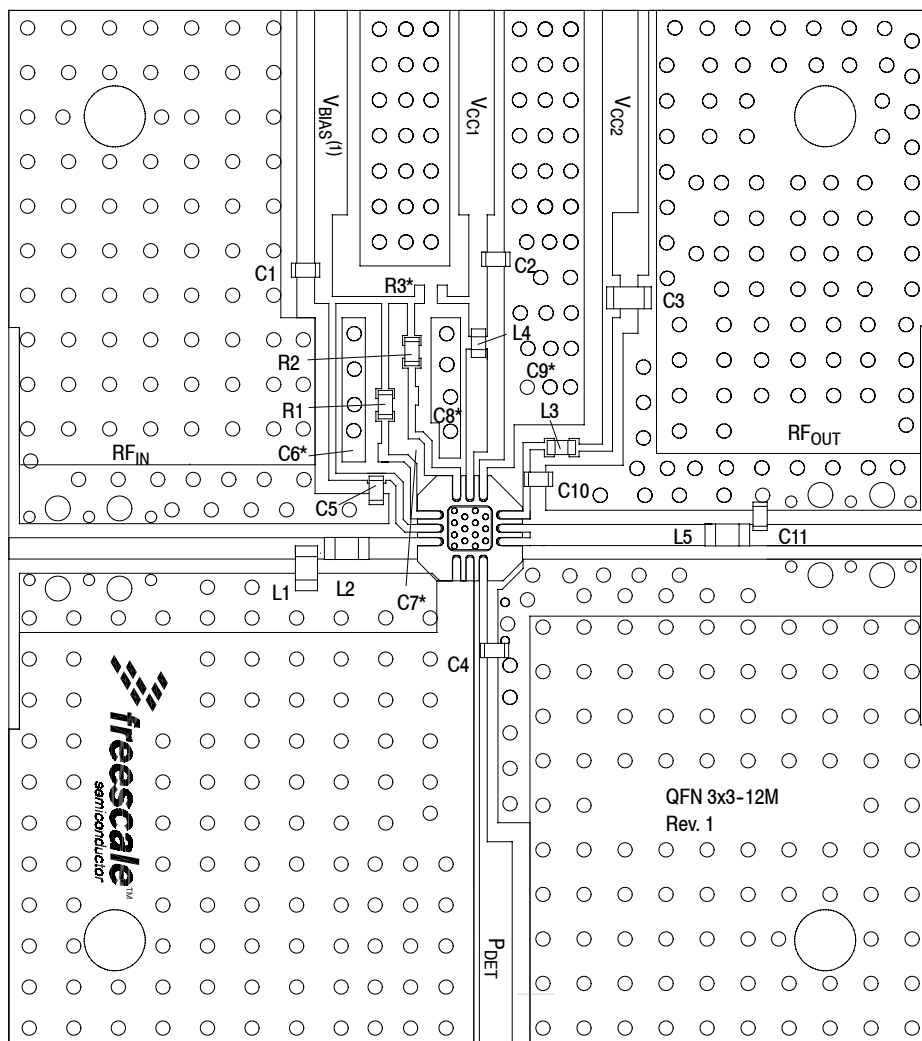


Figure 3. MMZ09312B Test Circuit Schematic — 900 MHz, 5 Volt Operation

Table 7. MMZ09312B Test Circuit Component Designations and Values — 900 MHz, 5 Volt Operation

| Part | Description | Part Number | Manufacturer |
|----------------|---------------------------------------|-------------------|--------------|
| C1, C2 | 1 μ F Chip Capacitors | GRM155R61A105KE15 | Murata |
| C3 | 4.7 μ F Chip Capacitor | GRM188R60J475KE19 | Murata |
| C4 | 470 pF Chip Capacitor | GRM1555C1H471JA01 | Murata |
| C5 | 100 pF Chip Capacitor | GRM1555C1H101JA01 | Murata |
| C6, C7, C8, C9 | Components Not Placed | | |
| C10 | 4.7 pF Chip Capacitor | 04023J4R7BBSTR | AVX |
| C11 | 6.8 pF Chip Capacitor | 04023J6R8BBSTR | AVX |
| L1 | 8.2 nH Chip Inductor | LL1608-FSL8N2JL | TOKO |
| L2 | 1.2 nH Chip Inductor | LL1608-FSL1N2S | TOKO |
| L3 | 33 nH Chip Inductor | 0402CS-33NXGLW | Coilcraft |
| L4 | 22 nH Chip Inductor | 0402CS-22NXGLW | Coilcraft |
| L5 | 3.3 nH Chip Inductor | 0603CS-3N3XJLW | Coilcraft |
| R1 | 330 Ω , 1/16 W Chip Resistor | RC0402JR-07331RL | Yageo |
| R2 | 1.5 k Ω , 1/16 W Chip Resistor | RC0402JR-07152RL | Yageo |
| R3 | Component Not Placed | | |
| PCB | 0.014", $\epsilon_r = 3.7$ | FR408 | Isola |

Note: Component numbers C6, C7, C8, C9 and R3 are labeled on board but not placed.



(1) VBIAS [Board] supplies V_{BA1}, V_{BA2} and V_{BIAS} [Device].

Note: Component numbers C6*, C7*, C8*, C9* and R3* are labeled on board but not placed.

Figure 4. MMZ09312B Test Circuit Component Layout — 900 MHz, 5 Volt Operation

Table 7. MMZ09312B Test Circuit Component Designations and Values — 900 MHz, 5 Volt Operation

| Part | Description | Part Number | Manufacturer |
|----------------|---------------------------------------|-------------------|--------------|
| C1, C2 | 1 μ F Chip Capacitors | GRM155R61A105KE15 | Murata |
| C3 | 4.7 μ F Chip Capacitor | GRM188R60J475KE19 | Murata |
| C4 | 470 pF Chip Capacitor | GRM1555C1H471JA01 | Murata |
| C5 | 100 pF Chip Capacitor | GRM1555C1H101JA01 | Murata |
| C6, C7, C8, C9 | Components Not Placed | | |
| C10 | 4.7 pF Chip Capacitor | 04023J4R7BBSTR | AVX |
| C11 | 6.8 pF Chip Capacitor | 04023J6R8BBSTR | AVX |
| L1 | 8.2 nH Chip Inductor | LL1608-FSL8N2JL | TOKO |
| L2 | 1.2 nH Chip Inductor | LL1608-FSL1N2S | TOKO |
| L3 | 33 nH Chip Inductor | 0402CS-33NXGLW | Coilcraft |
| L4 | 22 nH Chip Inductor | 0402CS-22NXGLW | Coilcraft |
| L5 | 3.3 nH Chip Inductor | 0603CS-3N3XJLW | Coilcraft |
| R1 | 330 Ω , 1/16 W Chip Resistor | RC0402JR-07331RL | Yageo |
| R2 | 1.5 k Ω , 1/16 W Chip Resistor | RC0402JR-07152RL | Yageo |
| R3 | Component Not Placed | | |
| PCB | 0.014", $\epsilon_r = 3.7$ | FR408 | Isola |

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

MMZ09312BT1

TYPICAL CHARACTERISTICS — 900 MHz, 5 VOLT OPERATION

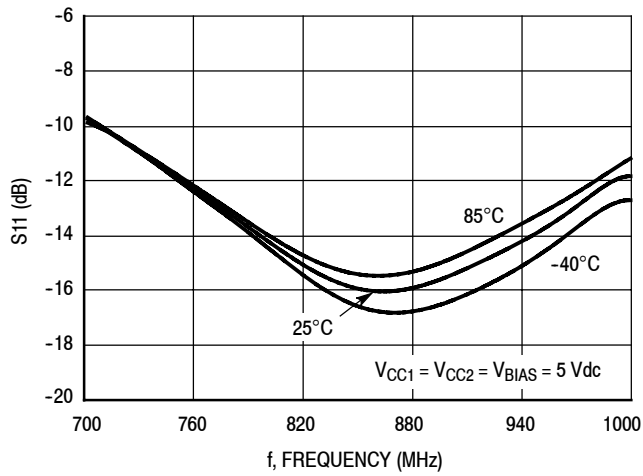


Figure 5. S11 versus Frequency versus Temperature

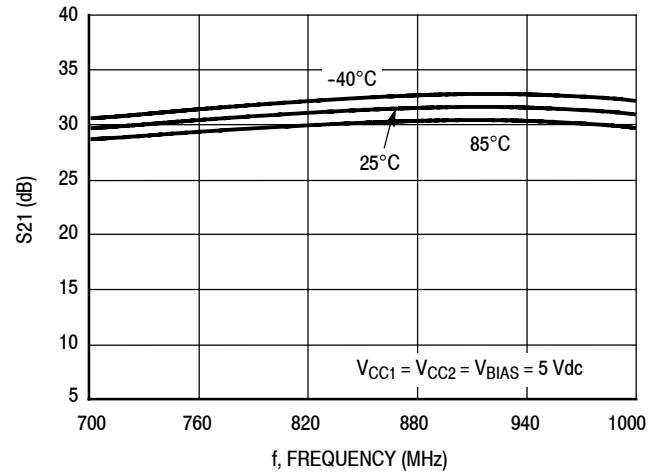


Figure 6. S21 versus Frequency versus Temperature

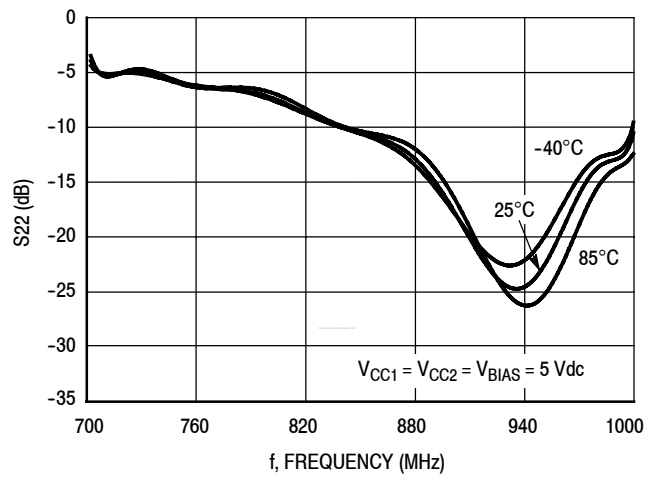


Figure 7. S22 versus Frequency versus Temperature

TYPICAL CHARACTERISTICS — 900 MHz, 5 VOLT OPERATION

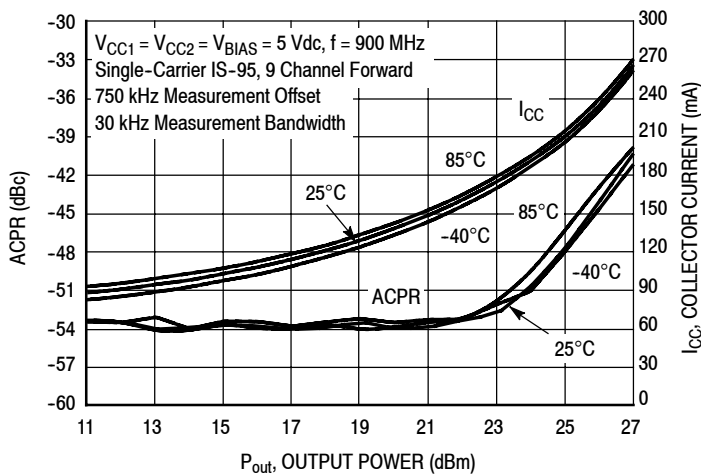


Figure 8. ACPR versus Collector Current versus Output Power versus Temperature

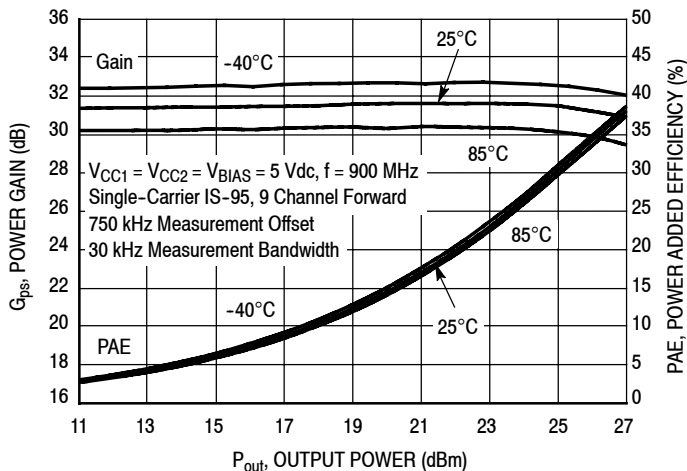


Figure 9. Power Gain versus Power Added Efficiency versus Output Power versus Temperature

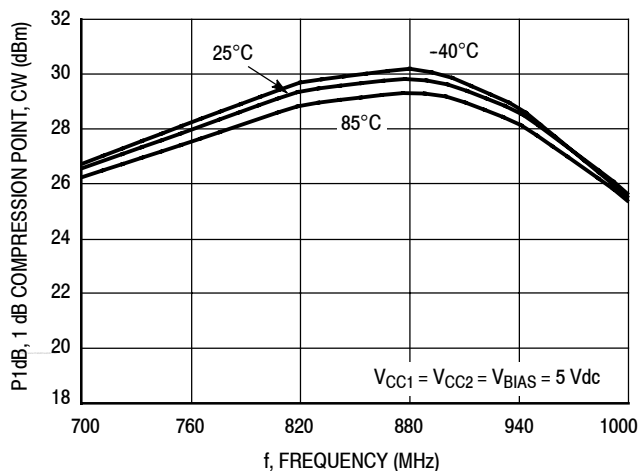


Figure 10. P1dB versus Frequency versus Temperature, CW

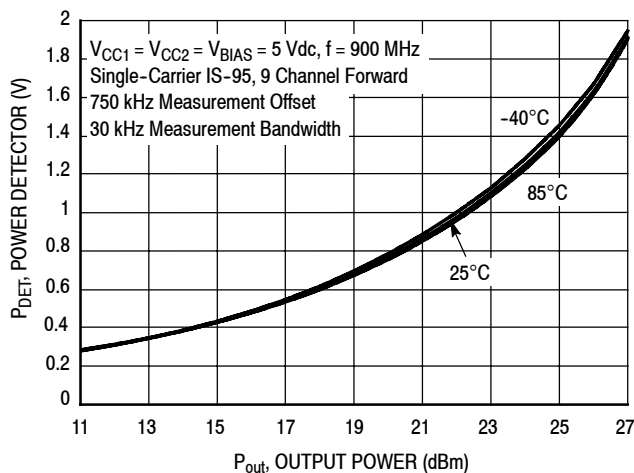


Figure 11. Power Detector versus Output Power versus Temperature

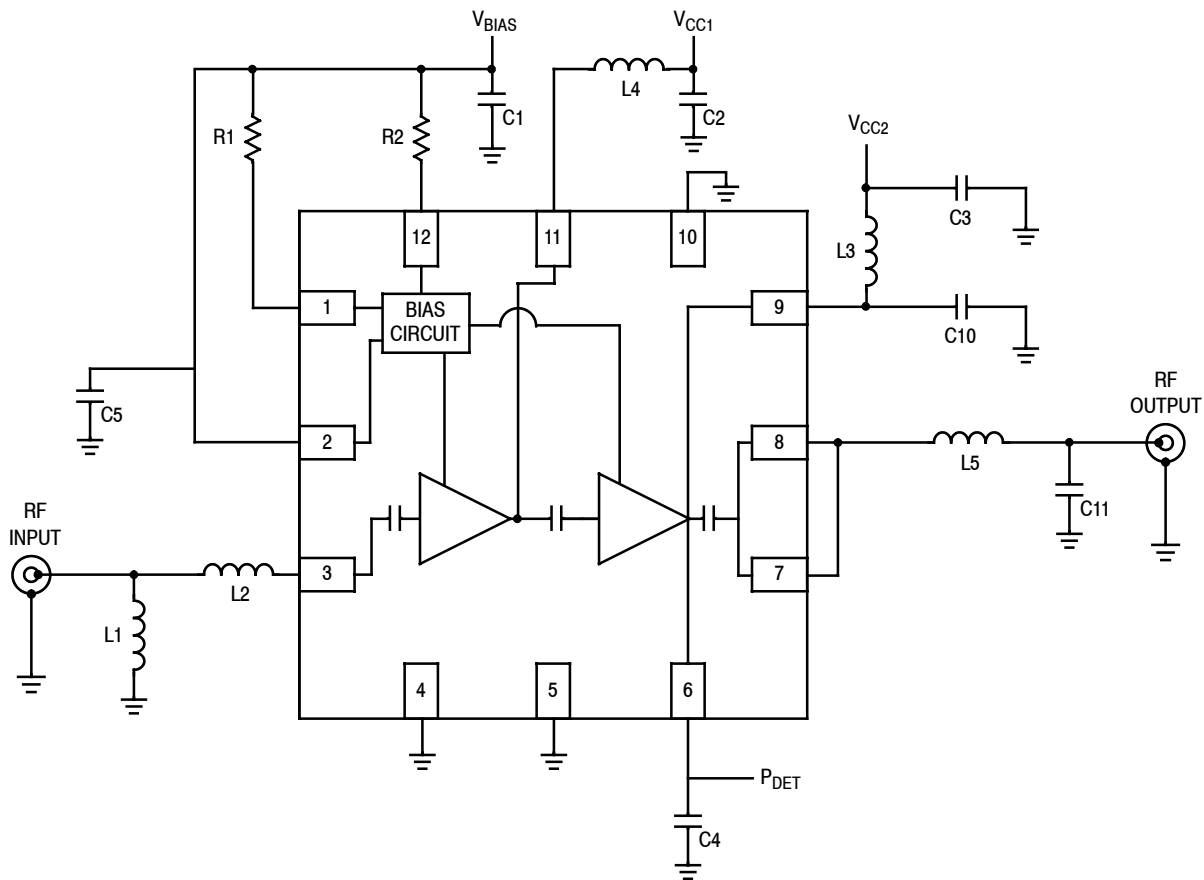
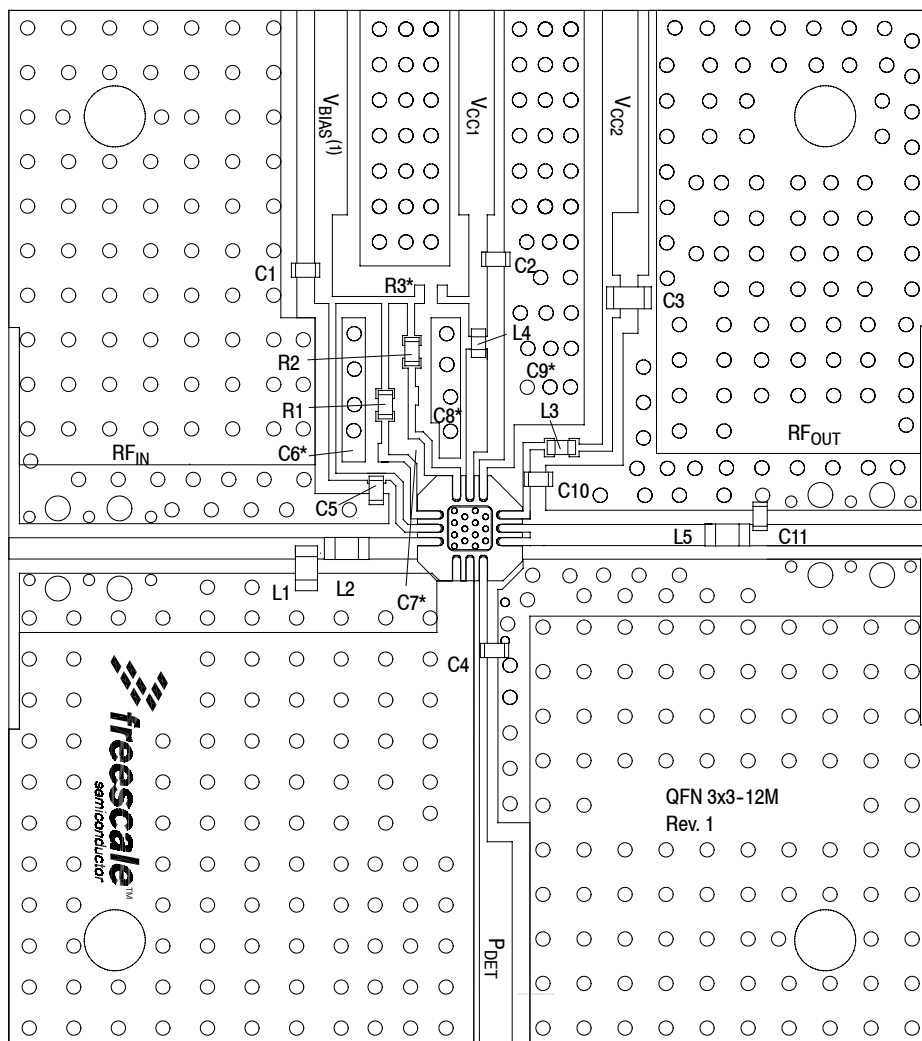


Figure 12. MMZ09312B Test Circuit Schematic — 900 MHz, 3.3 Volt Operation

Table 8. MMZ09312B Test Circuit Component Designations and Values — 900 MHz, 3.3 Volt Operation

| Part | Description | Part Number | Manufacturer |
|----------------|-------------------------------------|-------------------|--------------|
| C1, C2 | 1 μ F Chip Capacitors | GRM155R61A105KE15 | Murata |
| C3 | 4.7 μ F Chip Capacitor | GRM188R60J475KE19 | Murata |
| C4 | 470 pF Chip Capacitor | GRM1555C1H471JA01 | Murata |
| C5 | 100 pF Chip Capacitor | GRM1555C1H101JA01 | Murata |
| C6, C7, C8, C9 | Components Not Placed | | |
| C10 | 4.7 pF Chip Capacitor | 04023J4R7BBSTR | AVX |
| C11 | 6.8 pF Chip Capacitor | 04023J6R8BBSTR | AVX |
| L1 | 8.2 nH Chip Inductor | LL1608-FSL8N2JL | TOKO |
| L2 | 1.2 nH Chip Inductor | LL1608-FSL1N2S | TOKO |
| L3 | 33 nH Chip Inductor | 0402CS-33NXGLW | Coilcraft |
| L4 | 22 nH Chip Inductor | 0402CS-22NXGLW | Coilcraft |
| L5 | 3.3 nH Chip Inductor | 0603CS-3N3XJLW | Coilcraft |
| R1 | 82 Ω , 1/16 W Chip Resistor | RC0402JR-07820RL | Yageo |
| R2 | 470 Ω , 1/16 W Chip Resistor | RC0402JR-07471RL | Yageo |
| R3 | Component Not Placed | | |
| PCB | 0.014", $\epsilon_r = 3.7$ | FR408 | Isola |

Note: Component numbers C6, C7, C8, C9 and R3 are labeled on board but not placed.



(1) V_{BIAS} [Board] supplies V_{BA1} , V_{BA2} and V_{BIAS} [Device].

Note: Component numbers C6*, C7*, C8*, C9* and R3* are labeled on board but not placed.

Figure 13. MMZ09312B Test Circuit Component Layout — 900 MHz, 3.3 Volt Operation

Table 8. MMZ09312B Test Circuit Component Designations and Values — 900 MHz, 3.3 Volt Operation

| Part | Description | Part Number | Manufacturer |
|----------------|-------------------------------------|-------------------|--------------|
| C1, C2 | 1 μ F Chip Capacitors | GRM155R61A105KE15 | Murata |
| C3 | 4.7 μ F Chip Capacitor | GRM188R60J475KE19 | Murata |
| C4 | 470 pF Chip Capacitor | GRM1555C1H471JA01 | Murata |
| C5 | 100 pF Chip Capacitor | GRM1555C1H101JA01 | Murata |
| C6, C7, C8, C9 | Components Not Placed | | |
| C10 | 4.7 pF Chip Capacitor | 04023J4R7BBSTR | AVX |
| C11 | 6.8 pF Chip Capacitor | 04023J6R8BBSTR | AVX |
| L1 | 8.2 nH Chip Inductor | LL1608-FSL8N2JL | TOKO |
| L2 | 1.2 nH Chip Inductor | LL1608-FSL1N2S | TOKO |
| L3 | 33 nH Chip Inductor | 0402CS-33NXGLW | Coilcraft |
| L4 | 22 nH Chip Inductor | 0402CS-22NXGLW | Coilcraft |
| L5 | 3.3 nH Chip Inductor | 0603CS-3N3XJLW | Coilcraft |
| R1 | 82 Ω , 1/16 W Chip Resistor | RC0402JR-07820RL | Yageo |
| R2 | 470 Ω , 1/16 W Chip Resistor | RC0402JR-07471RL | Yageo |
| R3 | Component Not Placed | | |
| PCB | 0.014", $\epsilon_r = 3.7$ | FR408 | Isola |

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

MMZ09312BT1

TYPICAL CHARACTERISTICS — 900 MHz, 3.3 VOLT OPERATION

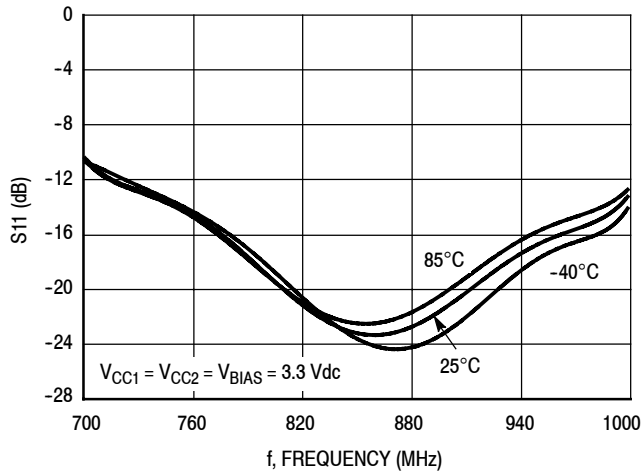


Figure 14. S11 versus Frequency versus Temperature

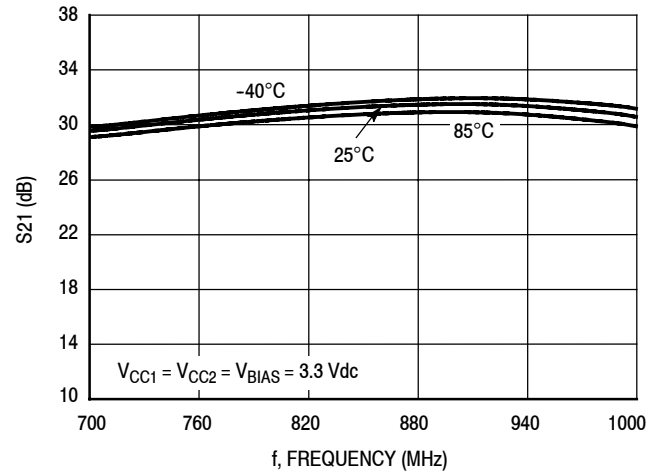


Figure 15. S21 versus Frequency versus Temperature

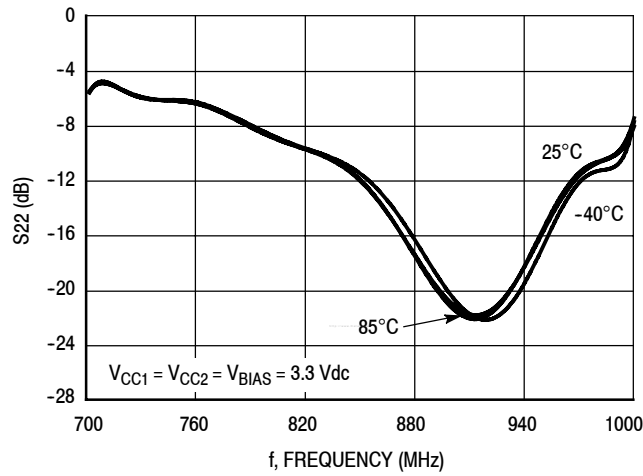


Figure 16. S22 versus Frequency versus Temperature

TYPICAL CHARACTERISTICS — 900 MHz, 3.3 VOLT OPERATION

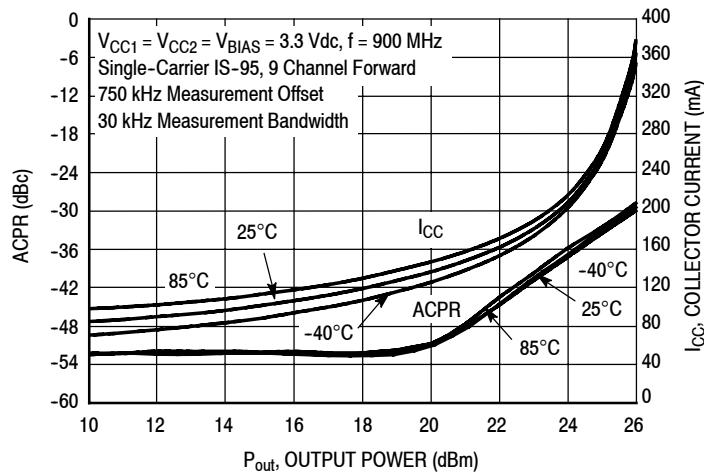


Figure 17. ACPR versus Collector Current versus Output Power versus Temperature

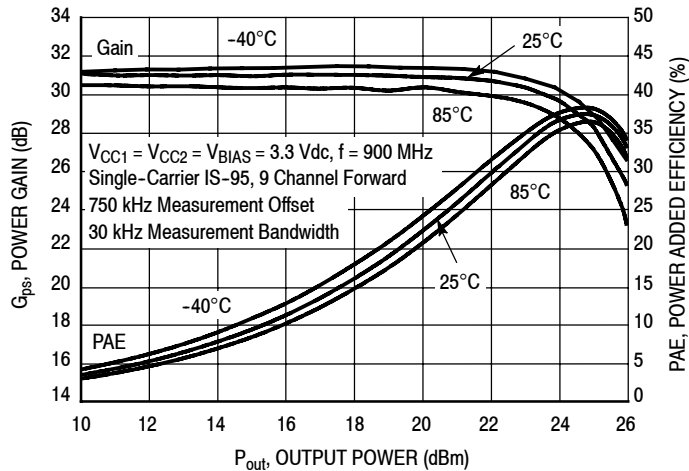


Figure 18. Power Gain versus Power Added Efficiency versus Output Power versus Temperature

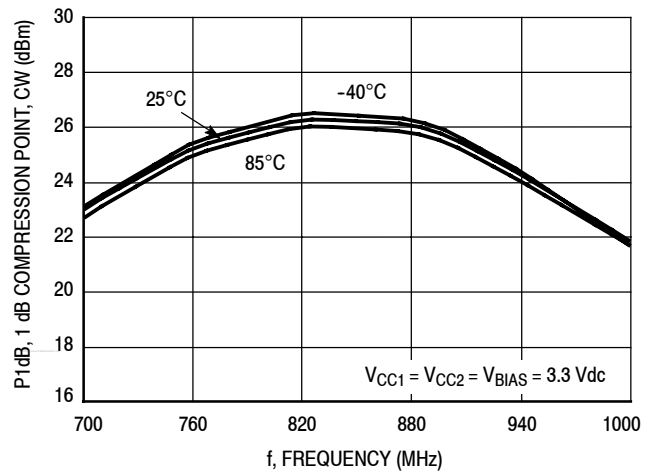


Figure 19. P1dB versus Frequency versus Temperature, CW

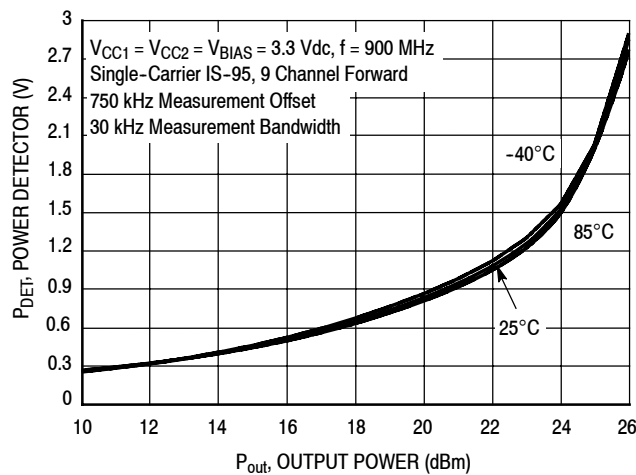


Figure 20. Power Detector versus Output Power versus Temperature

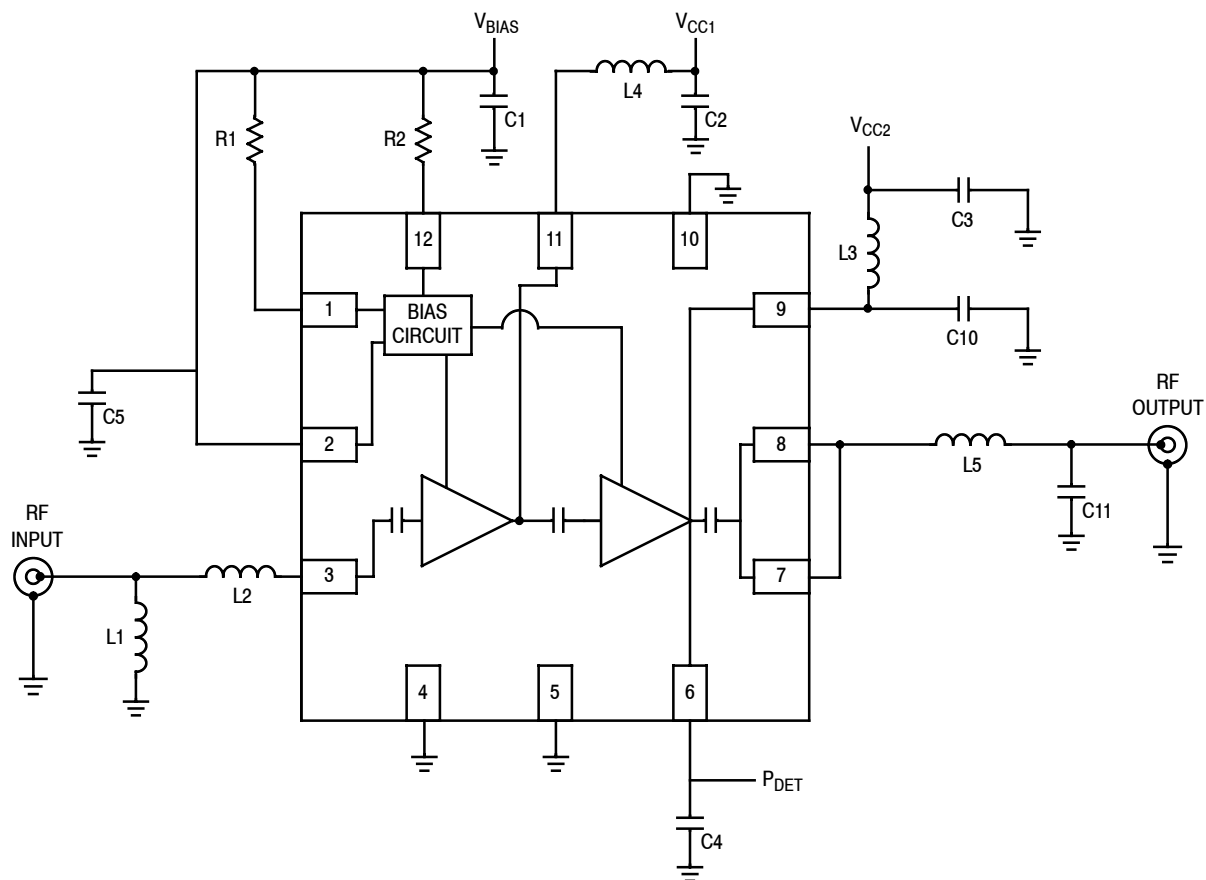
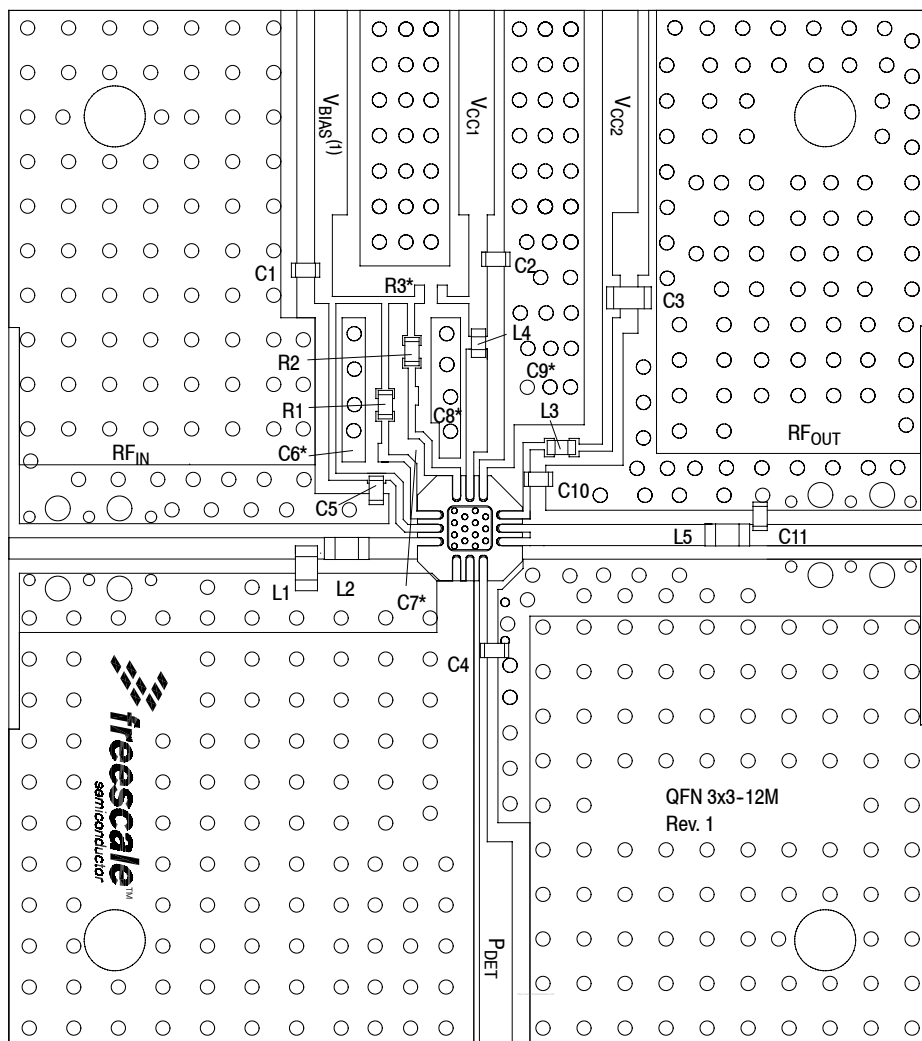


Figure 21. MMZ09312B Test Circuit Schematic — 450 MHz, 5 Volt Operation

Table 9. MMZ09312B Test Circuit Component Designations and Values — 450 MHz, 5 Volt Operation

| Part | Description | Part Number | Manufacturer |
|----------------|---------------------------------------|-------------------|--------------|
| C1, C2 | 1 μ F Chip Capacitors | GRM155R61A105KE15 | Murata |
| C3 | 4.7 μ F Chip Capacitor | GRM188R60J475KE19 | Murata |
| C4 | 470 pF Chip Capacitor | GRM1555C1H471JA01 | Murata |
| C5 | 100 pF Chip Capacitor | GRM1555C1H101JA01 | Murata |
| C6, C7, C8, C9 | Components Not Placed | | |
| C10 | 3.9 pF Chip Capacitor | 04023J3R9BBSTR | AVX |
| C11 | 10 pF Chip Capacitor | 04023J10R0BBSTR | AVX |
| L1 | 18 nH Chip Inductor | LL1608-FSL18N0S | TOKO |
| L2 | 1.2 nH Chip Inductor | LL1608-FSL1N2S | TOKO |
| L3 | 3.9 nH Chip Inductor | LL1608-FSL3N9S | TOKO |
| L4 | 12 nH Chip Inductor | LL1608-FSL12N0S | TOKO |
| L5 | 12 nH Chip Inductor | 0603CS-12NXJL | Coilcraft |
| R1 | 330 Ω , 1/16 W Chip Resistor | RC0402JR-07331RL | Yageo |
| R2 | 1.5 k Ω , 1/16 W Chip Resistor | RC0402JR-07152RL | Yageo |
| R3 | Component Not Placed | | |
| PCB | 0.014", $\epsilon_r = 3.7$ | FR408 | Isola |

Note: Component numbers C6, C7, C8, C9 and R3 are labeled on board but not placed.



(1) V_{BIAS} [Board] supplies V_{BA1} , V_{BA2} and V_{BIAS} [Device].

Note: Component numbers C6*, C7*, C8*, C9* and R3* are labeled on board but not placed.

Figure 22. MMZ09312B Test Circuit Component Layout — 450 MHz, 5 Volt Operation

Table 9. MMZ09312B Test Circuit Component Designations and Values — 450 MHz, 5 Volt Operation

| Part | Description | Part Number | Manufacturer |
|----------------|---------------------------------------|-------------------|--------------|
| C1, C2 | 1 μ F Chip Capacitors | GRM155R61A105KE15 | Murata |
| C3 | 4.7 μ F Chip Capacitor | GRM188R60J475KE19 | Murata |
| C4 | 470 pF Chip Capacitor | GRM1555C1H471JA01 | Murata |
| C5 | 100 pF Chip Capacitor | GRM1555C1H101JA01 | Murata |
| C6, C7, C8, C9 | Components Not Placed | | |
| C10 | 3.9 pF Chip Capacitor | 04023J3R9BBSTR | AVX |
| C11 | 10 pF Chip Capacitor | 04023J10R0BBSTR | AVX |
| L1 | 18 nH Chip Inductor | LL1608-FSL18N0S | TOKO |
| L2 | 1.2 nH Chip Inductor | LL1608-FSL1N2S | TOKO |
| L3 | 3.9 nH Chip Inductor | LL1608-FSL3N9S | TOKO |
| L4 | 12 nH Chip Inductor | LL1608-FSL12N0S | TOKO |
| L5 | 12 nH Chip Inductor | 0603CS-12NXJL | Coilcraft |
| R1 | 330 Ω , 1/16 W Chip Resistor | RC0402JR-07331RL | Yageo |
| R2 | 1.5 k Ω , 1/16 W Chip Resistor | RC0402JR-07152RL | Yageo |
| R3 | Component Not Placed | | |
| PCB | 0.014", $\epsilon_r = 3.7$ | FR408 | Isola |

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

MMZ09312BT1

TYPICAL CHARACTERISTICS — 450 MHz, 5 VOLT OPERATION

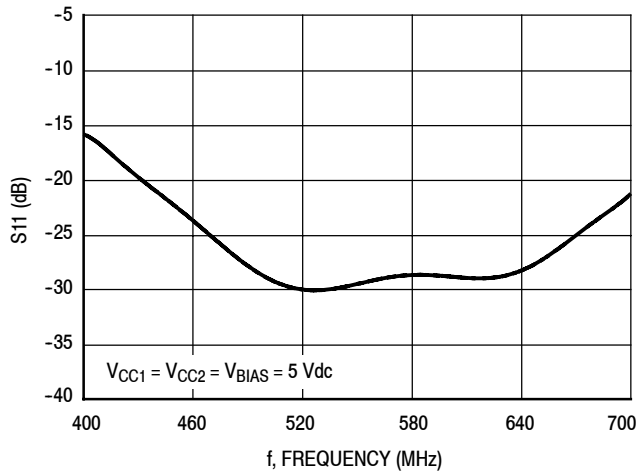


Figure 23. S_{11} versus Frequency

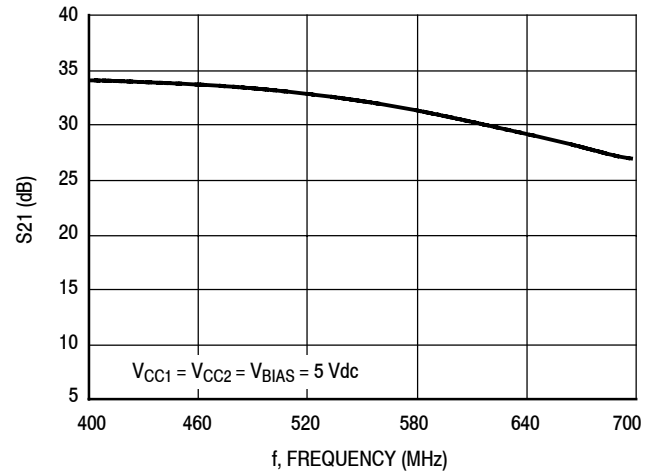


Figure 24. S_{21} versus Frequency

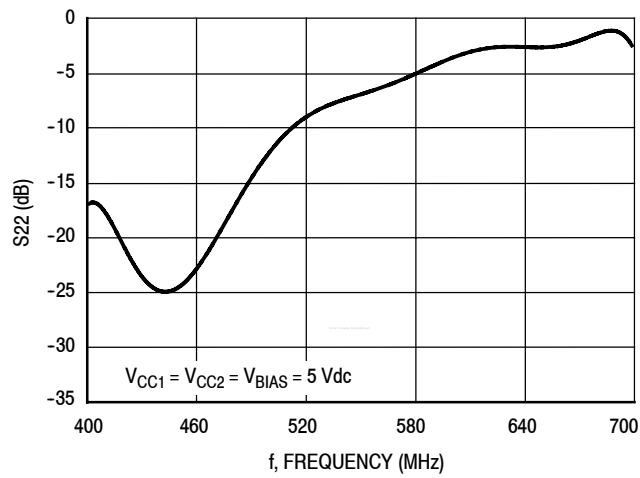


Figure 25. S_{22} versus Frequency

TYPICAL CHARACTERISTICS — 450 MHz, 5 VOLT OPERATION

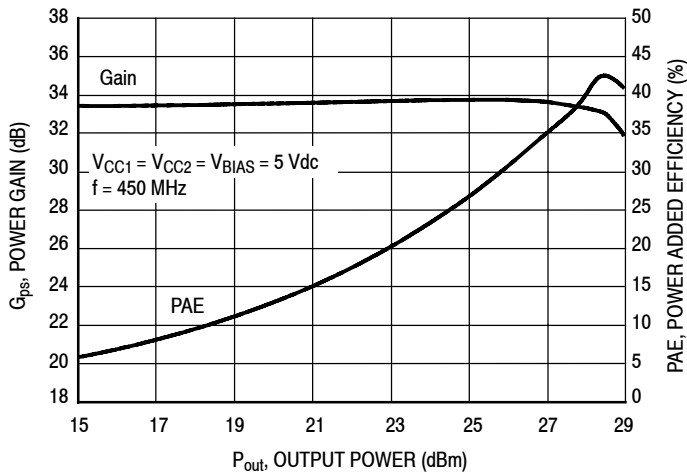


Figure 26. Power Gain versus Power Added Efficiency versus Output Power, CW

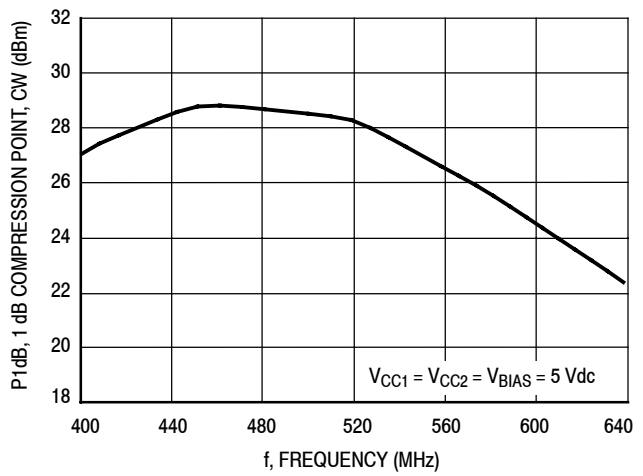


Figure 27. P1dB versus Frequency, CW

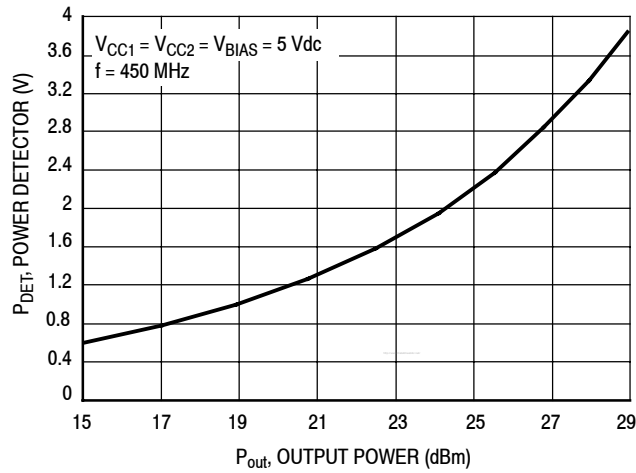


Figure 28. Power Detector versus Output Power, CW

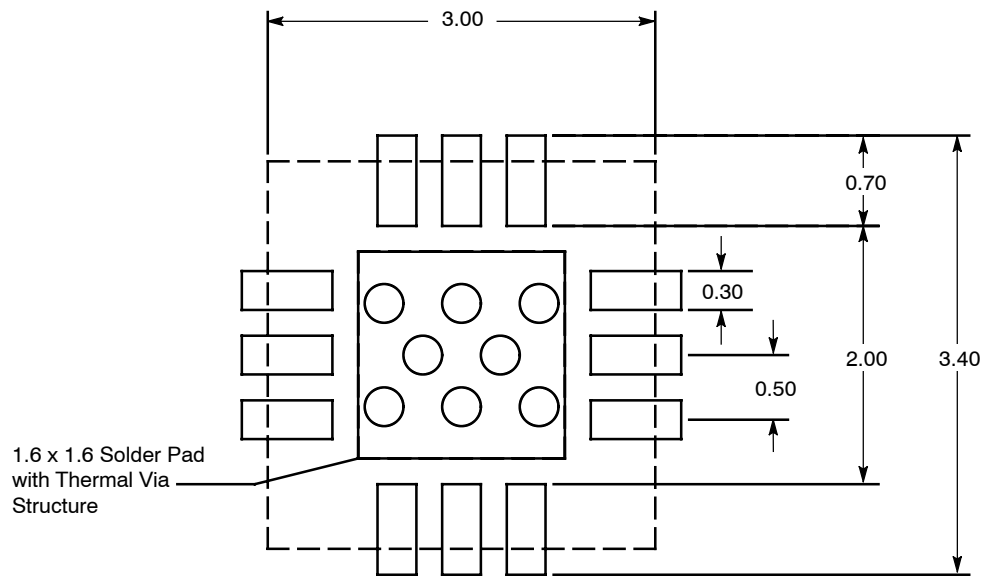
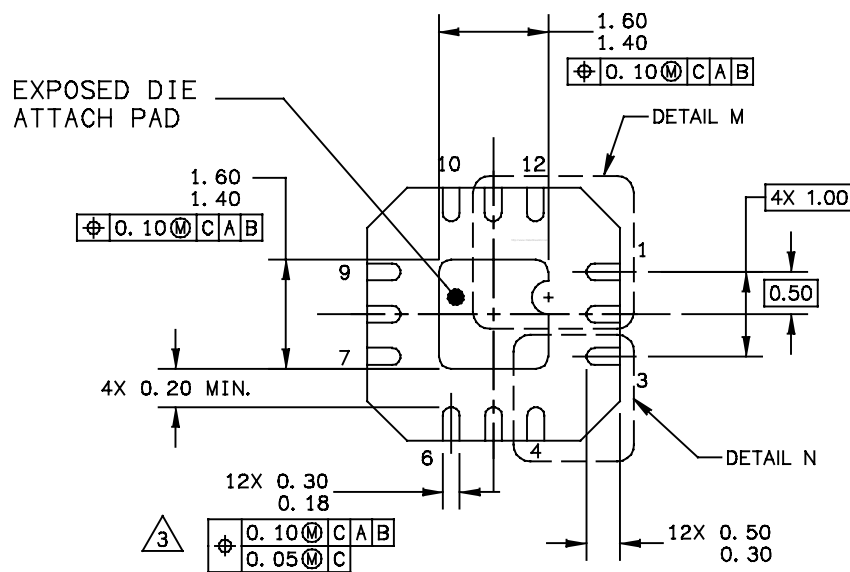
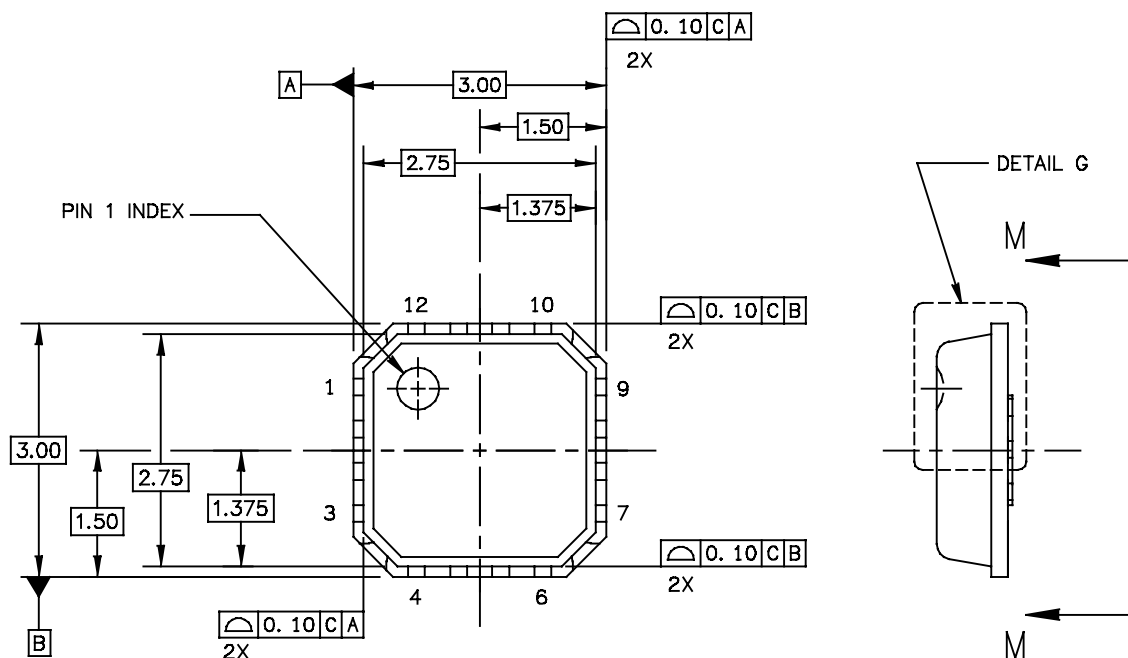


Figure 29. PCB Pad Layout for QFN 3x3



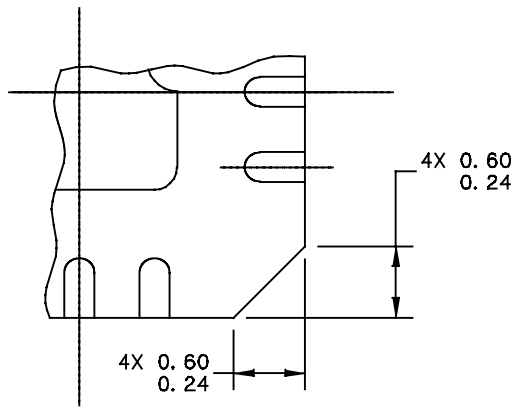
Figure 30. Product Marking

PACKAGE DIMENSIONS

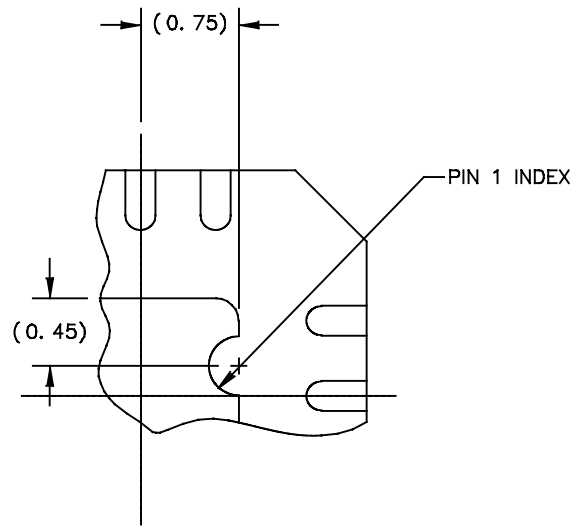


VIEW M-M

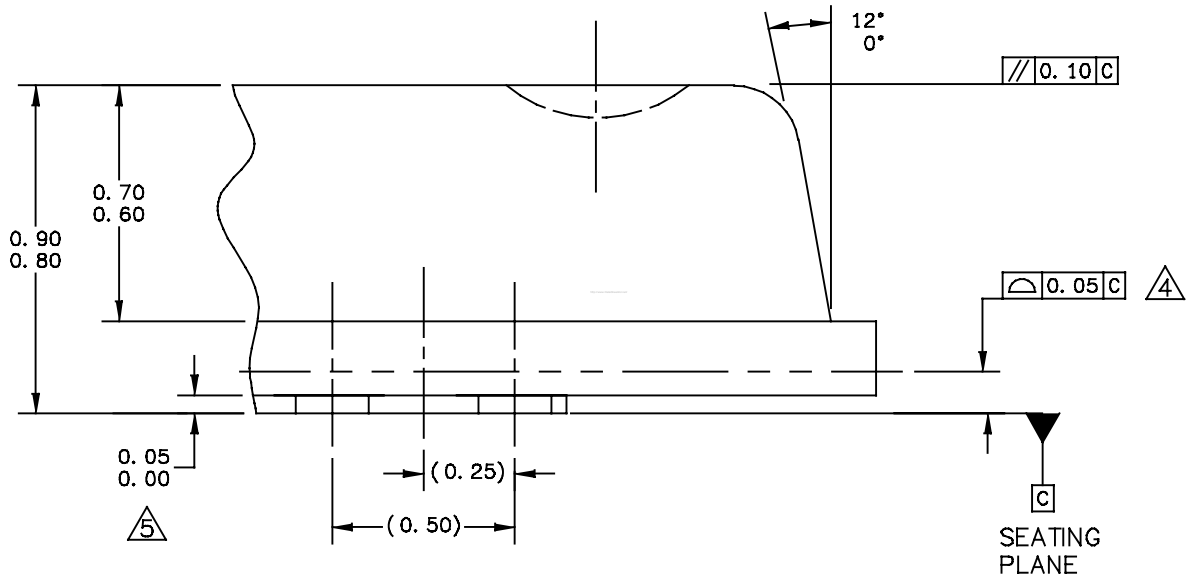
| | | | |
|---|--------------------------|----------------------------|--|
| © FREESCALE SEMICONDUCTOR, INC. ALL RIGHTS RESERVED. | MECHANICAL OUTLINE | PRINT VERSION NOT TO SCALE | |
| TITLE: THERMALLY ENHANCED QUAD FLAT NON-LEADED PACKAGE (QFN) 12 TERMINAL, 0.5 PITCH (3X3X0.85) | DOCUMENT NO: 98ASA00227D | REV: 0 | |
| | CASE NUMBER: 2131-01 | 14 MAY 2010 | |
| | STANDARD: NON-JEDEC | | |



DETAIL N
CORNER CONFIGURATION



DETAIL M
PIN 1 BACKSIDE INDEX



DETAIL G
VIEW ROTATED 90° CW

| | | | |
|---|--------------------------|----------------------------|--|
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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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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

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 | Nov. 2011 | <ul style="list-style-type: none">• Initial Release of Data Sheet |
| 1 | Feb. 2012 | <ul style="list-style-type: none">• Typical Performance table: changed P_{out} at 750 MHz from 19.5 to 17.5 dBm to reflect recent performance measurements, p. 1• Figs. 3, 12 and 21, MMZ09312B Test Circuit Schematic: corrected L1 inductor label in test circuit schematics, p. 3, 7 and 11 |

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