

2 W High Gain Power Amplifier for Cellular Infrastructure

InGaP GaAs HBT

The MMZ25333B is a versatile 3-stage power amplifier targeted at driver and pre-driver applications for macro and micro base stations and final-stage applications for small cells. Its versatile design allows operation in any frequency band from 1500 to 2700 MHz providing gain of more than 40 dB. The device operates off a 5 V supply, and its bias currents and portions of the matching networks are adjustable for optimum performance in any specific application. It is housed in a QFN 4 × 4 surface mount package.

- Typical PA Driver Performance: $V_{CC1} = V_{CC2} = V_{CC3} = V_{BIAS} = 5$ Vdc, $I_{CQ} = 265$ mA

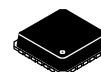
| Frequency | P _{out} (dBm) | G _{ps} (dB) | ACPR (dBc) | I _{CC} Total | Test Signal |
|-----------|------------------------|----------------------|------------|-----------------------|-------------|
| 2600 MHz | 18.0 | 42.6 | -50.8 | 296 | W-CDMA |
| 2140 MHz | 17.0 | 43.7 | -50.7 | 293 | W-CDMA |

- Typical Output PA Performance: $V_{CC1} = V_{CC2} = V_{CC3} = V_{BIAS} = 5$ Vdc, $I_{CQ} = 450$ mA

| Frequency | P _{out} (dBm) | G _{ps} (dB) | ACPR (dBc) | I _{CC} Total | Test Signal |
|-----------|------------------------|----------------------|------------|-----------------------|-------------|
| 2600 MHz | 22.2 | 42.7 | -48.0 | 501 | W-CDMA |

MMZ25333BT1

**1500–2700 MHz, 44.2 dB, 31.7 dBm
InGaP HBT LINEAR AMPLIFIER**



QFN 4 × 4

Features

- P1dB: up to 33 dBm
- Gain: More than 40 dB
- 5 V Supply
- Excellent Linearity
- High Efficiency
- Single-ended Power Detector
- Band Tunable
- In Tape and Reel. T1 Suffix = 1,000 Units, 12 mm Tape Width, 7-inch Reel.

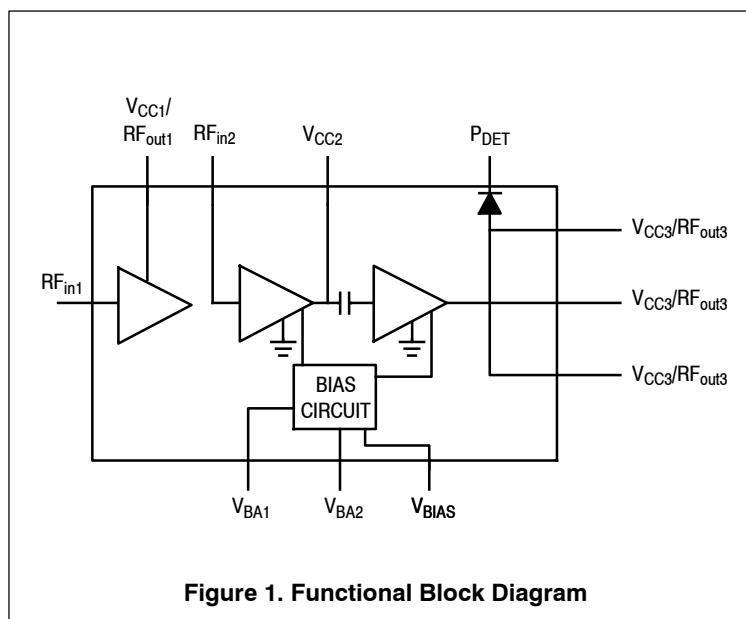


Figure 1. Functional Block Diagram

Table 1. Maximum Ratings

| Rating | Symbol | Value | Unit |
|---------------------------|-------------------------------------|------------------|------|
| Supply Voltage | V_{CC} | 6 | V |
| Supply Current | I_{CC1} I_{CC2} I_{CC3} | 66 240 960 | mA |
| RF Input Power | P_{in} | 10 | dBm |
| Storage Temperature Range | T_{stg} | -65 to +150 | °C |
| Junction Temperature | T_J | 175 | °C |

Table 2. Thermal Characteristics

| Characteristic | Symbol | Value ⁽¹⁾ | Unit |
|--|-----------------|----------------------|------|
| Thermal Resistance, Junction to Case Case Temperature 104°C, $V_{CC1} = V_{CC2} = V_{CC3} = V_{BIAS} = 5$ Vdc | $R_{\theta JC}$ | | °C/W |
| Stage 1 | | 28 | |
| Stage 2 | | 68 | |
| Stage 3 | | 21 | |

Table 3. Electrical Characteristics ($V_{CC1} = V_{CC2} = V_{CC3} = V_{BIAS} = 5$ Vdc, 2600 MHz, $T_A = 25^\circ\text{C}$, 50 ohm system, in Freescale PA Driver Application Circuit)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|----------|------|-------|-----|------|
| Small-Signal Gain (S21) | G_p | 40.4 | 43.0 | — | dB |
| Input Return Loss (S11) | IRL | — | -12.2 | — | dB |
| Output Return Loss (S22) | ORL | — | -7.1 | — | dB |
| Power Output @ 1dB Compression | P1dB | — | 32.0 | — | dBm |
| Third Order Output Intercept Point, Two-Tone CW | OIP3 | — | 42.8 | — | dBm |
| Total Supply Current ($I_{CC1} + I_{CC2} + I_{CC3} + I_{BIAS}$) | I_{CQ} | 244 | 265 | 284 | mA |
| Supply Voltage | V_{CC} | — | 5 | — | V |

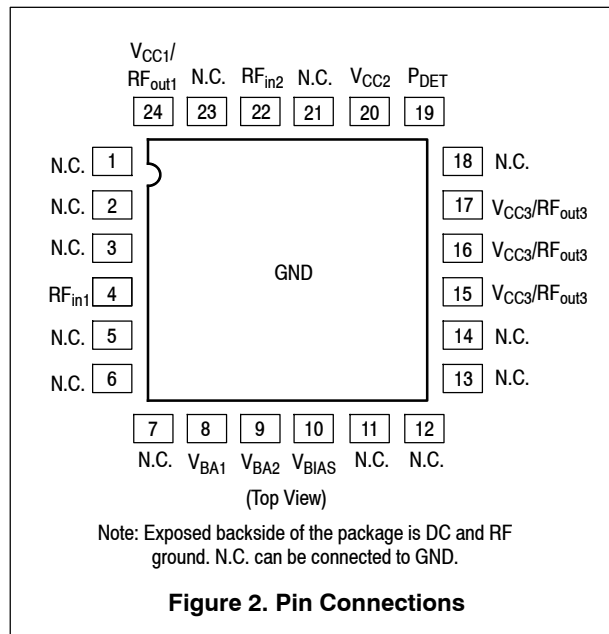
1. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers*. Go to <http://www.freescale.com/rf>. Select Documentation/Application Notes - AN1955.

Table 4. ESD Protection Characteristics

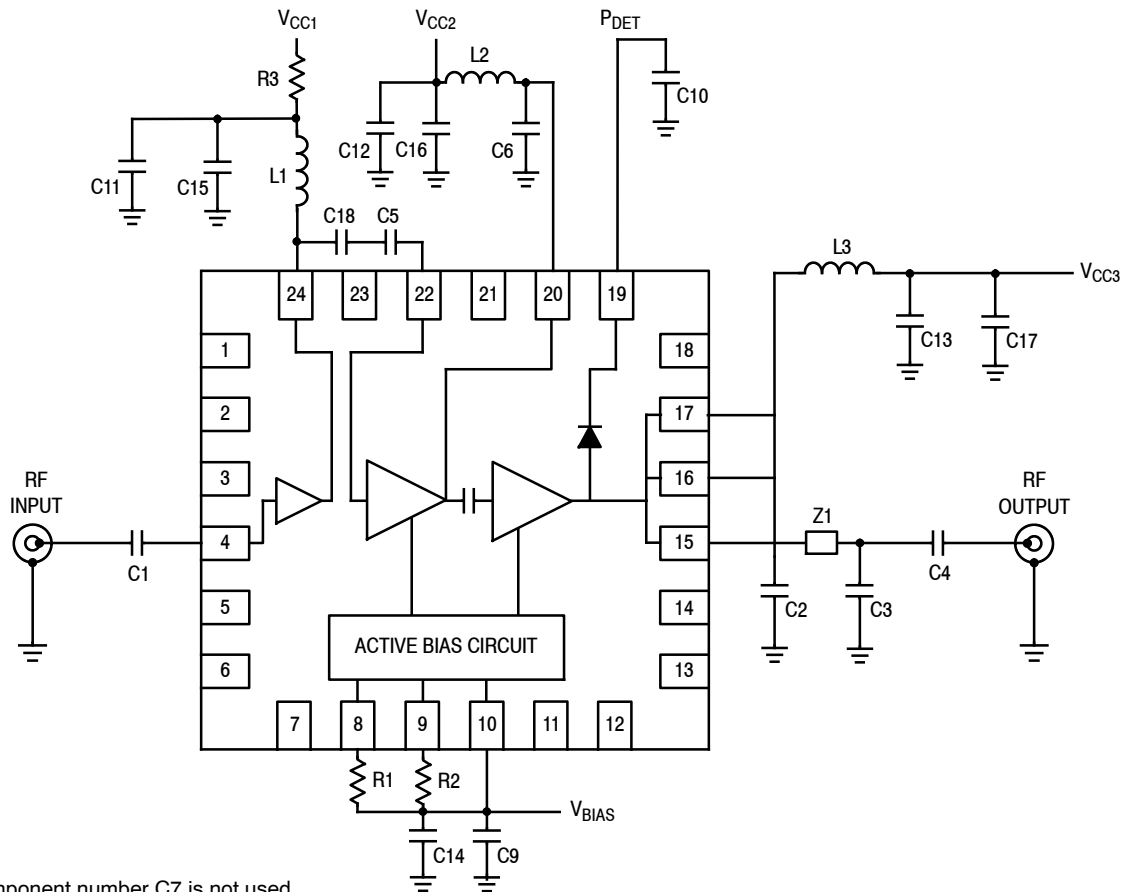
| Test Methodology | Class |
|---------------------------------------|-------|
| Human Body Model (per JESD22-A114) | 1C |
| Machine Model (per EIA/JESD22-A115) | A |
| Charge Device Model (per JESD22-C101) | IV |

Table 5. Moisture Sensitivity Level

| Test Methodology | Rating | Package Peak Temperature | Unit |
|--------------------------------------|--------|--------------------------|------|
| Per JESD22-A113, IPC/JEDEC J-STD-020 | 1 | 260 | °C |



50 OHM APPLICATION CIRCUIT: 2500–2700 MHz



Note: Component number C7 is not used.

Z1 0.143" x 0.022" Microstrip

Figure 3. MMZ2533BT1 Test Circuit Schematic

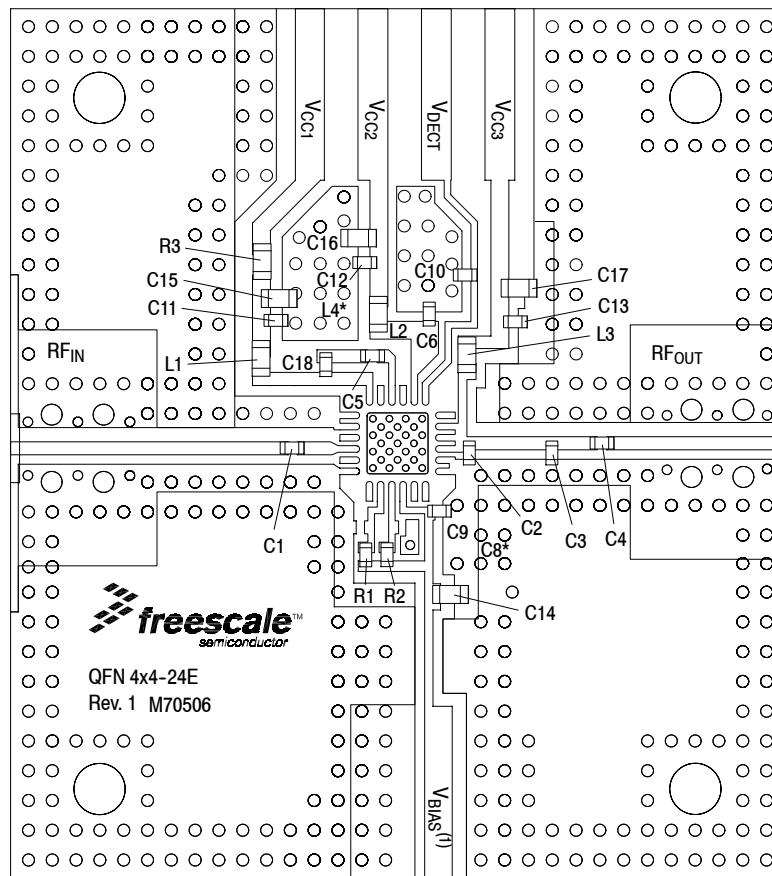
Table 6. MMZ2533BT1 Test Circuit Component Designations and Values

| Part | Description | Part Number | Manufacturer |
|-------------------------|---|-------------------|--------------|
| C1, C4, C5 | 22 pF Chip Capacitors | 04023J220BBS | AVX |
| C2 | 2 pF Chip Capacitor | 04023J2R0BBS | AVX |
| C3 | 1.5 pF Chip Capacitor | 04023J1R5BBS | AVX |
| C6 | 7.5 pF Chip Capacitor | 04023J7R5BBS | AVX |
| C8 | Component Not Placed | | |
| C9, C11, C12, C13 | 1000 pF Chip Capacitors | GCM155R71E103KA37 | Murata |
| C10 | 470 pF Chip Capacitor | GRM1555C1H471JA01 | Murata |
| C14, C16 | 1 μ F Chip Capacitors | GRM188R61A105KE15 | Murata |
| C15 | 0.01 μ F Chip Capacitor | C0603C103J5RAC | Kemet |
| C17 | 4.7 μ F Chip Capacitor | GRM188R60J475KE19 | Murata |
| C18 | 2.2 pF Chip Capacitor | 04023J12R2BBS | AVX |
| L1 | 56 nH Chip Inductor | 0603HC-56NX | Coilcraft |
| L2 | 10 nH Chip Inductor | 0603HC-10NX | Coilcraft |
| L3 | 6.8 nH Chip Inductor | 0603HC-6N8X | Coilcraft |
| L4 | Component Not Placed | | |
| R1 ($I_{CQ} = 265$ mA) | 1.8 k Ω , 1/16 W Chip Resistor | CR05-182J-B | Kyocera |
| R2 ($I_{CQ} = 265$ mA) | 680 Ω , 1/16 W Chip Resistor | CR05-681J-B | Kyocera |
| R1 ($I_{CQ} = 450$ mA) | 1.2 k Ω , 1/16 W Chip Resistor | CR05-122J-B | Kyocera |
| R2 ($I_{CQ} = 450$ mA) | 330 Ω , 1/16 W Chip Resistor | CR05-331J-B | Kyocera |
| R3 | 27 Ω , 1/10 W Chip Resistor | CR10-270J-T | Kyocera |
| PCB | Rogers RO4350B, 0.010", $\epsilon_r = 3.66$ | M70506 | MTL |

Note: Component numbers C8 and L4 are labeled on board but not placed.

MMZ2533BT1

50 OHM APPLICATION CIRCUIT: 2500–2700 MHz



PCB actual size: 1.3" × 1.46".

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

Note: Component number C7 is not used. Component numbers C8* and L4* are labeled on board but not placed.

Figure 4. MMZ25333BT1 Test Circuit Component Layout

Table 6. MMZ25333BT1 Test Circuit Component Designations and Values

| Part | Description | Part Number | Manufacturer |
|-------------------------------|---|-------------------|--------------|
| C1, C4, C5 | 22 pF Chip Capacitors | 04023J220BBS | AVX |
| C2 | 2 pF Chip Capacitor | 04023J2R0BBS | AVX |
| C3 | 1.5 pF Chip Capacitor | 04023J1R5BBS | AVX |
| C6 | 7.5 pF Chip Capacitor | 04023J7R5BBS | AVX |
| C8 | Component Not Placed | | |
| C9, C11, C12, C13 | 1000 pF Chip Capacitors | GCM155R71E103KA37 | Murata |
| C10 | 470 pF Chip Capacitor | GRM1555C1H471JA01 | Murata |
| C14, C16 | 1 μF Chip Capacitors | GRM188R61A105KE15 | Murata |
| C15 | 0.01 μF Chip Capacitor | C0603C103J5RAC | Kemet |
| C17 | 4.7 μF Chip Capacitor | GRM188R60J475KE19 | Murata |
| C18 | 2.2 pF Chip Capacitor | 04023J12R2BBS | AVX |
| L1 | 56 nH Chip Inductor | 0603HC-56NX | Coilcraft |
| L2 | 10 nH Chip Inductor | 0603HC-10NX | Coilcraft |
| L3 | 6.8 nH Chip Inductor | 0603HC-6N8X | Coilcraft |
| L4 | Component Not Placed | | |
| R1 (I _{CQ} = 265 mA) | 1.8 kΩ, 1/16 W Chip Resistor | CR05-182J-B | Kyocera |
| R2 (I _{CQ} = 265 mA) | 680 Ω, 1/16 W Chip Resistor | CR05-681J-B | Kyocera |
| R1 (I _{CQ} = 450 mA) | 1.2 kΩ, 1/16 W Chip Resistor | CR05-122J-B | Kyocera |
| R2 (I _{CQ} = 450 mA) | 330 Ω, 1/16 W Chip Resistor | CR05-331J-B | Kyocera |
| R3 | 27 Ω, 1/10 W Chip Resistor | CR10-270J-T | Kyocera |
| PCB | Rogers RO4350B, 0.010", ε _r = 3.66 | M70506 | MTL |

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

50 OHM TYPICAL CHARACTERISTICS: 2500–2700 MHz, $I_{CQ} = 265 \text{ mA}$

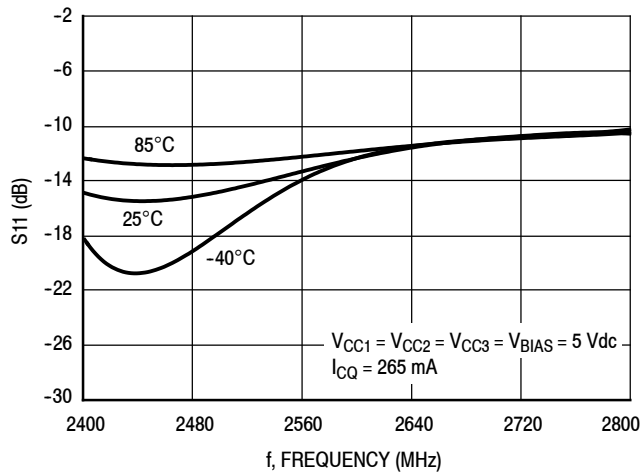


Figure 5. S11 versus Frequency versus Temperature

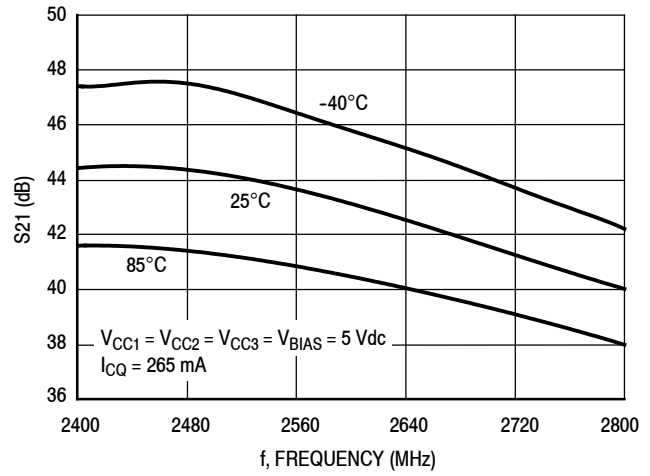


Figure 6. S21 versus Frequency versus Temperature

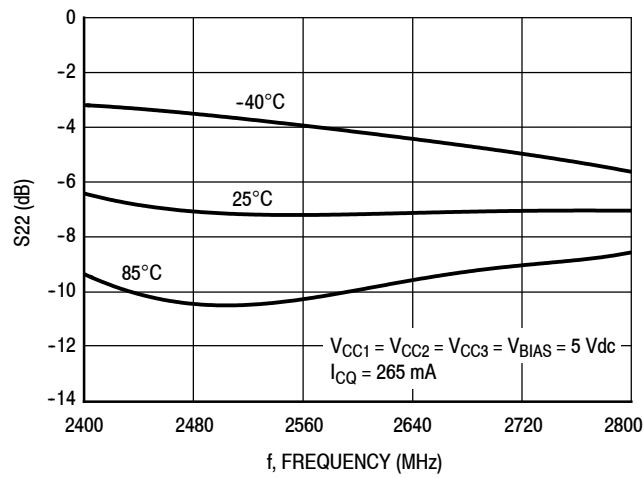


Figure 7. S22 versus Frequency versus Temperature

50 OHM TYPICAL CHARACTERISTICS: 2500–2700 MHz, $I_{CQ} = 265$ mA

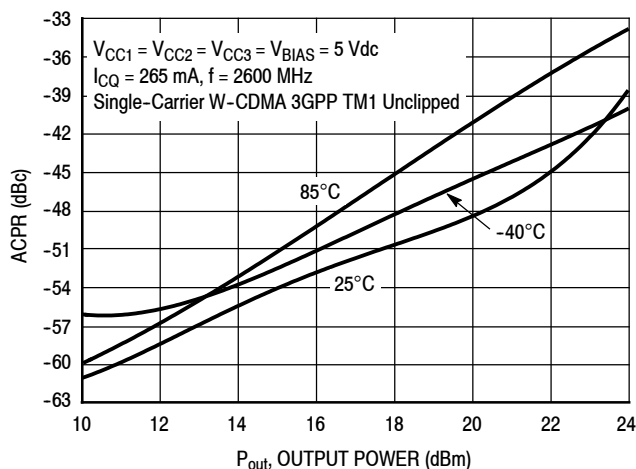


Figure 8. ACPR versus Output Power versus Temperature

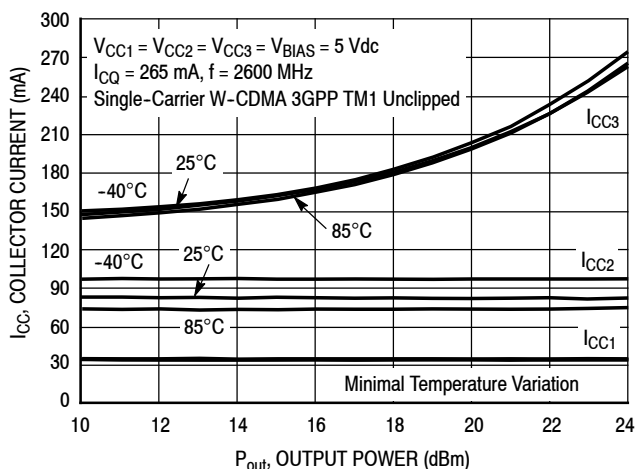


Figure 9. Stage Collector Current versus Output Power versus Temperature

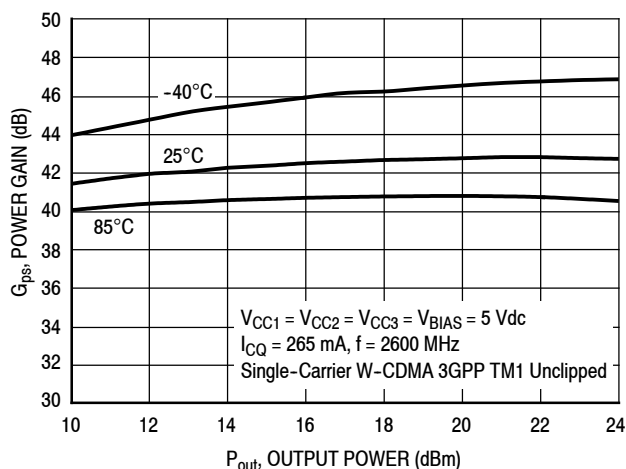


Figure 10. Power Gain versus Output Power versus Temperature

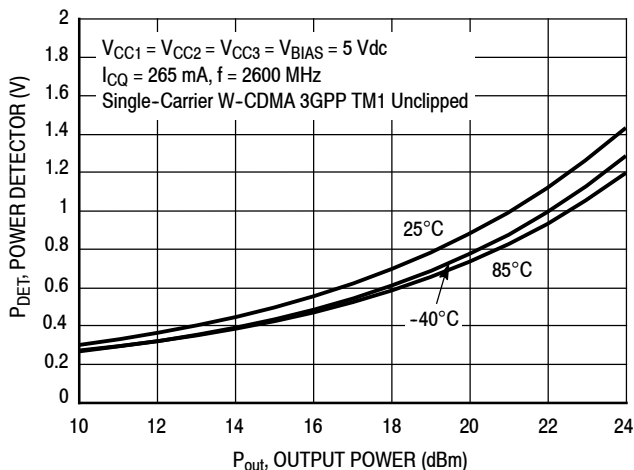


Figure 11. Power Detector versus Output Power versus Temperature

50 OHM TYPICAL CHARACTERISTICS: 2500–2700 MHz, $I_{CQ} = 450 \text{ mA}$

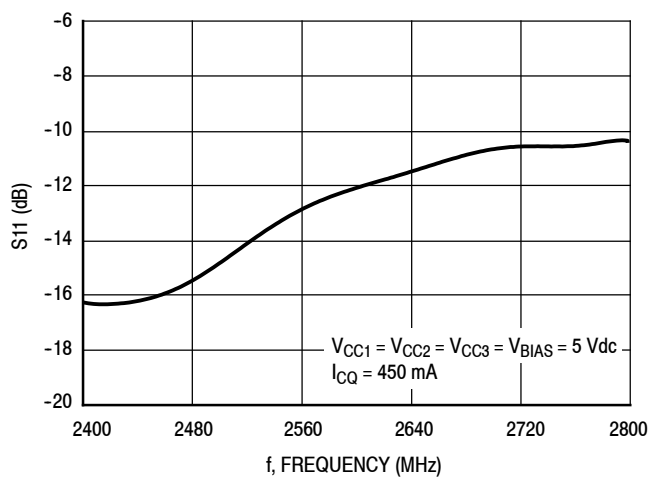


Figure 12. S11 versus Frequency

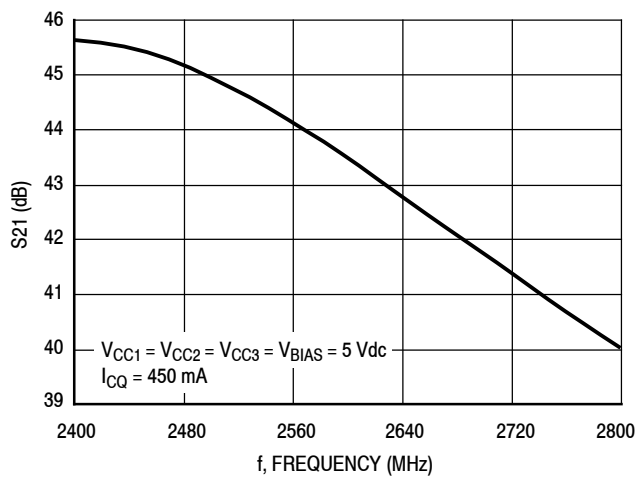


Figure 13. S21 versus Frequency

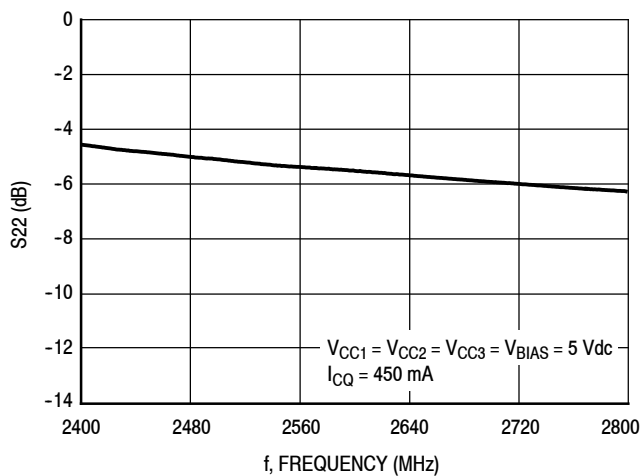


Figure 14. S22 versus Frequency

50 OHM TYPICAL CHARACTERISTICS: 2500–2700 MHz, $I_{CQ} = 450$ mA

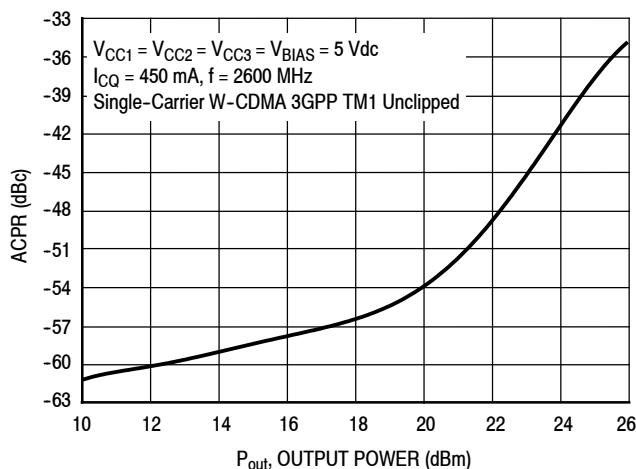


Figure 15. ACPR versus Output Power

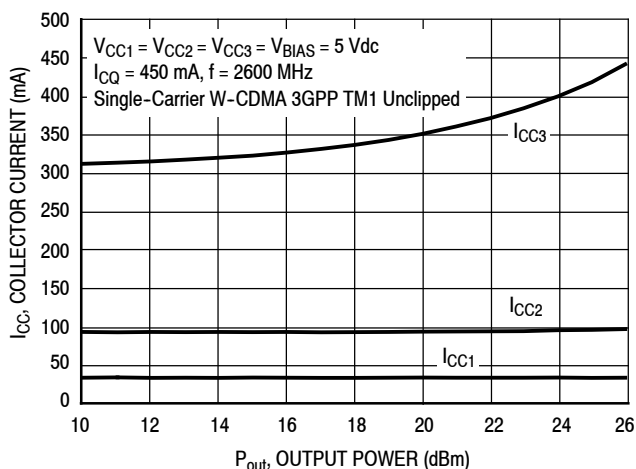


Figure 16. Stage Collector Current versus Output Power

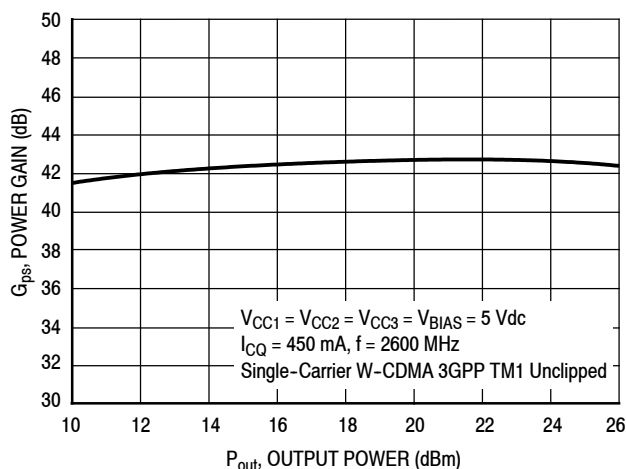


Figure 17. Power Gain versus Output Power

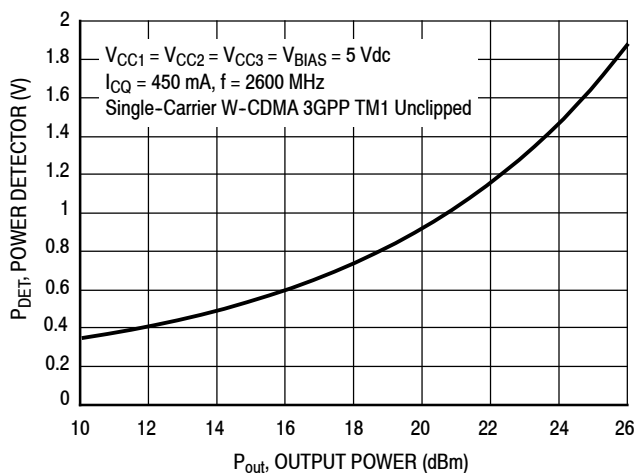
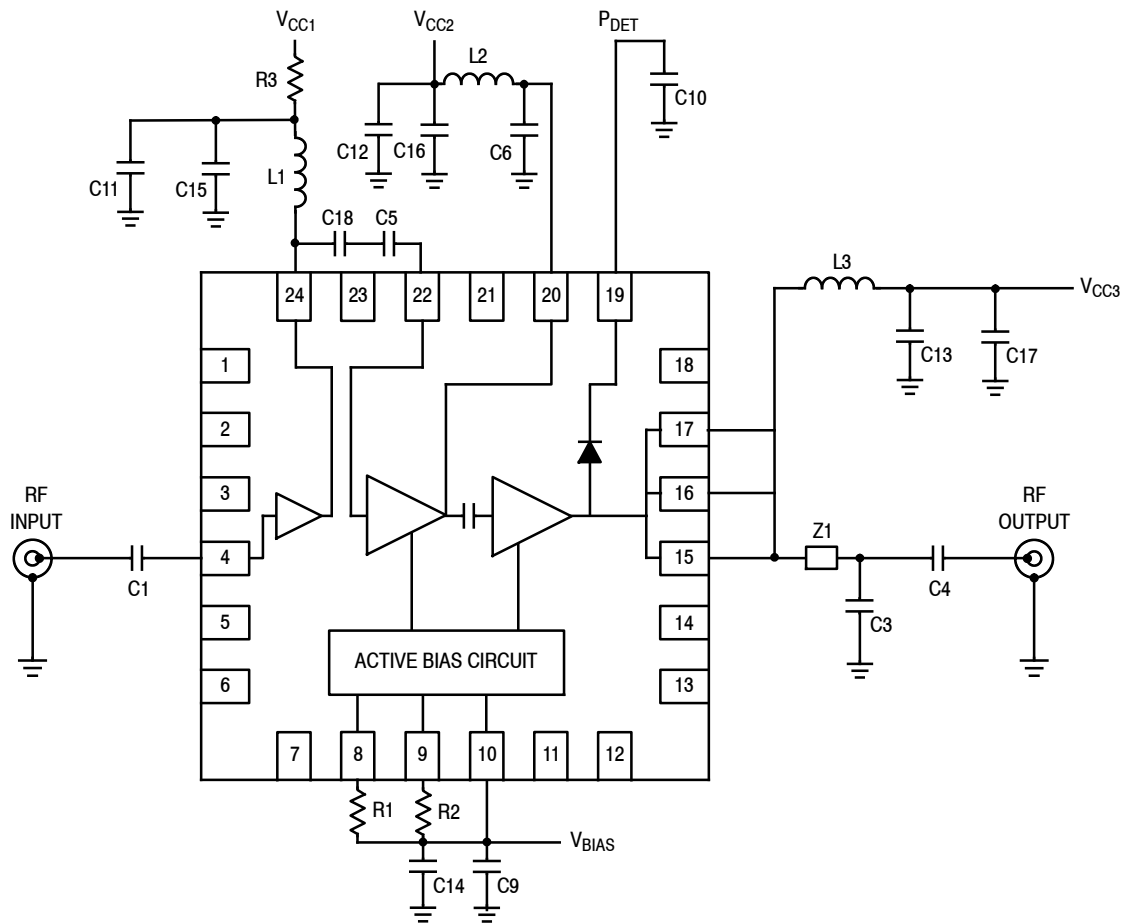


Figure 18. Power Detector versus Output Power

50 OHM APPLICATION CIRCUIT: 2110–2170 MHz, $I_{CQ} = 265$ mA



Note: Component number C7 is not used.

Z1 0.163" x 0.022" Microstrip

Figure 19. MMZ25333BT1 Test Circuit Schematic

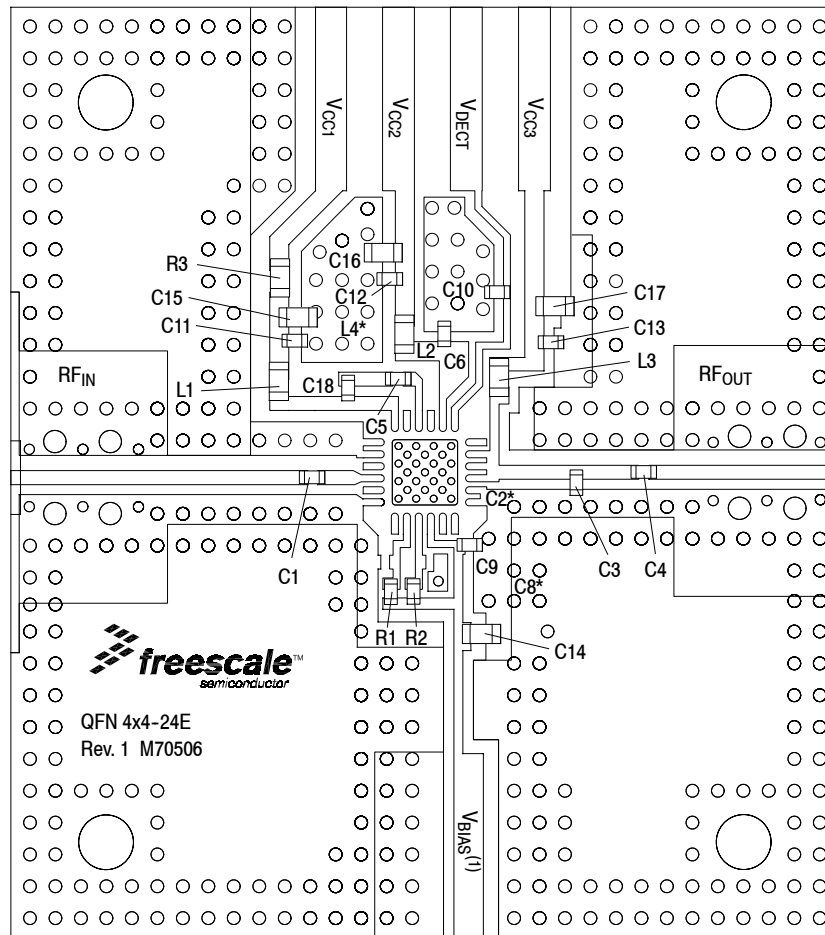
Table 7. MMZ25333BT1 Test Circuit Component Designations and Values

| Part | Description | Part Number | Manufacturer |
|-------------------------|---|-------------------|--------------|
| C1, C4, C5 | 22 pF Chip Capacitors | 04023J220BBS | AVX |
| C2 | Component Not Placed | | |
| C3 | 3.6 pF Chip Capacitor | 04023J3R6BBS | AVX |
| C6 | 8.2 pF Chip Capacitor | 04023J8R2BBS | AVX |
| C8 | Component Not Placed | | |
| C9, C11, C12, C13 | 1000 pF Chip Capacitors | GCM155R71E103KA37 | Murata |
| C10 | 470 pF Chip Capacitor | GRM1555C1H471JA01 | Murata |
| C14, C16 | 1 μ F Chip Capacitors | GRM188R61A105KE15 | Murata |
| C15 | 0.01 μ F Chip Capacitor | C0603C103J5RAC | Kemet |
| C17 | 4.7 μ F Chip Capacitor | GRM188R60J475KE19 | Murata |
| C18 | 2.2 pF Chip Capacitor | 04023J12R2BBS | AVX |
| L1 | 56 nH Chip Inductor | 0603HC-56NX | Coilcraft |
| L2 | 12 nH Chip Inductor | 0603HC-12NX | Coilcraft |
| L3 | 6.8 nH Chip Inductor | 0603HC-6N8X | Coilcraft |
| L4 | Component Not Placed | | |
| R1 ($I_{CQ} = 265$ mA) | 1.8 k Ω , 1/16 W Chip Resistor | CR05-182J-B | Kyocera |
| R2 ($I_{CQ} = 265$ mA) | 680 Ω , 1/16 W Chip Resistor | CR05-681J-B | Kyocera |
| R3 | 27 Ω , 1/10 W Chip Resistor | CR10-270J-T | Kyocera |
| PCB | Rogers RO4350B, 0.010", $\epsilon_r = 3.66$ | M70506 | MTL |

Note: Component numbers C2, C8 and L4 are labeled on board but not placed.

MMZ25333BT1

50 OHM APPLICATION CIRCUIT: 2110–2170 MHz, $I_{CQ} = 265$ mA



PCB actual size: 1.3" × 1.46".

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

Note: Component number C7 is not used. Component numbers C2*, C8* and L4* are labeled on board but not placed.

Figure 20. MMZ25333BT1 Test Circuit Component Layout

Table 7. MMZ25333BT1 Test Circuit Component Designations and Values

| Part | Description | Part Number | Manufacturer |
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| C1, C4, C5 | 22 pF Chip Capacitors | 04023J220BBS | AVX |
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| C6 | 8.2 pF Chip Capacitor | 04023J8R2BBS | AVX |
| C8 | Component Not Placed | | |
| C9, C11, C12, C13 | 1000 pF Chip Capacitors | GCM155R71E103KA37 | Murata |
| C10 | 470 pF Chip Capacitor | GRM1555C1H471JA01 | Murata |
| C14, C16 | 1 μ F Chip Capacitors | GRM188R61A105KE15 | Murata |
| C15 | 0.01 μ F Chip Capacitor | C0603C103J5RAC | Kemet |
| C17 | 4.7 μ F Chip Capacitor | GRM188R60J475KE19 | Murata |
| C18 | 2.2 pF Chip Capacitor | 04023J12R2BBS | AVX |
| L1 | 56 nH Chip Inductor | 0603HC-56NX | Coilcraft |
| L2 | 12 nH Chip Inductor | 0603HC-12NX | Coilcraft |
| L3 | 6.8 nH Chip Inductor | 0603HC-6N8X | Coilcraft |
| L4 | Component Not Placed | | |
| R1 ($I_{CQ} = 265$ mA) | 1.8 k Ω , 1/16 W Chip Resistor | CR05-182J-B | Kyocera |
| R2 ($I_{CQ} = 265$ mA) | 680 Ω , 1/16 W Chip Resistor | CR05-681J-B | Kyocera |
| R3 | 27 Ω , 1/10 W Chip Resistor | CR10-270J-T | Kyocera |
| PCB | Rogers RO4350B, 0.010", $\epsilon_r = 3.66$ | M70506 | MTL |

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

50 OHM TYPICAL CHARACTERISTICS: 2110–2170 MHz, $I_{CQ} = 265$ mA

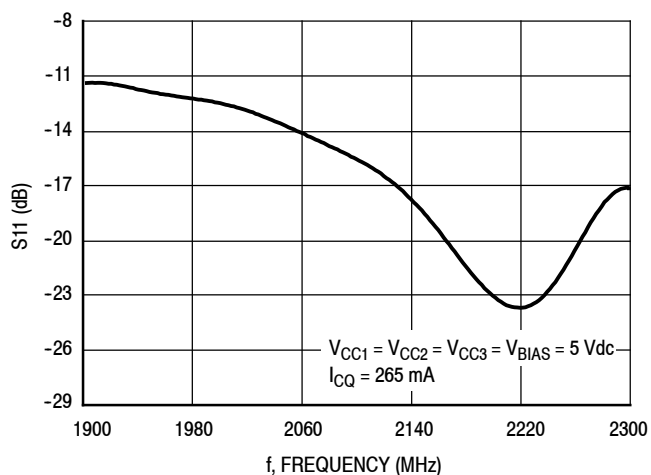


Figure 21. S11 versus Frequency

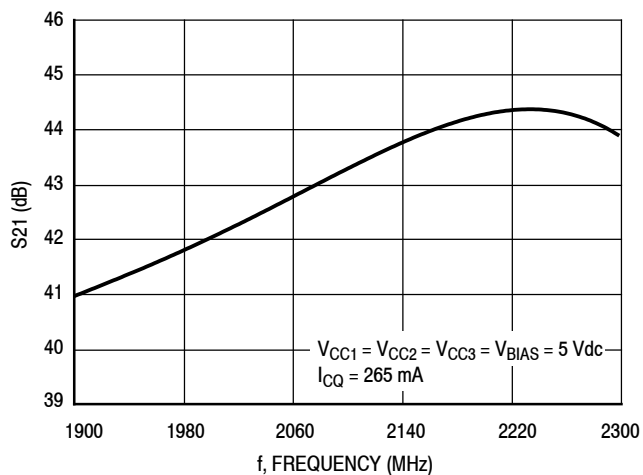


Figure 22. S21 versus Frequency

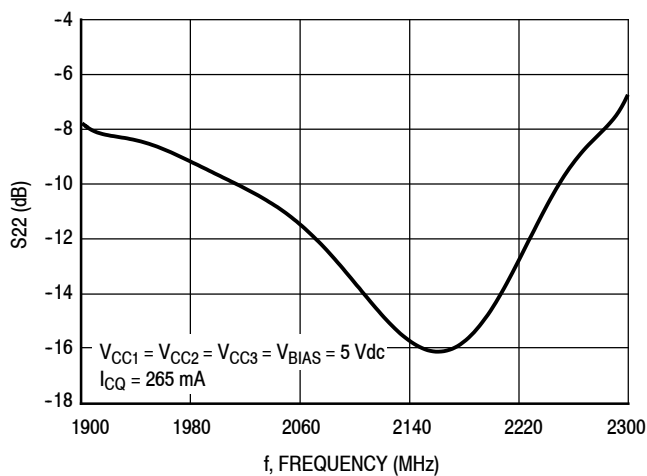


Figure 23. S22 versus Frequency

50 OHM TYPICAL CHARACTERISTICS: 2110–2170 MHz, $I_{CQ} = 265$ mA

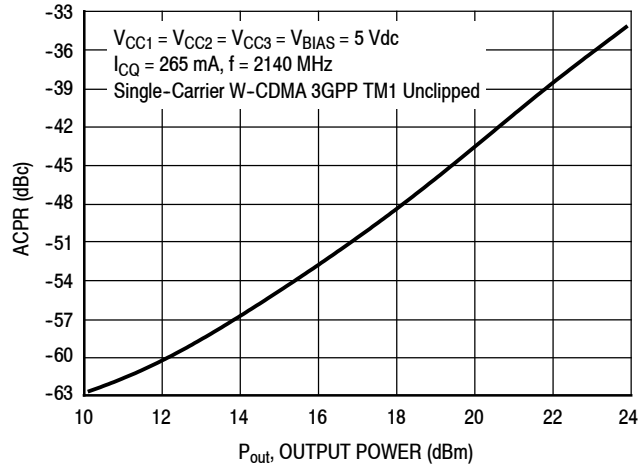


Figure 24. ACPR versus Output Power

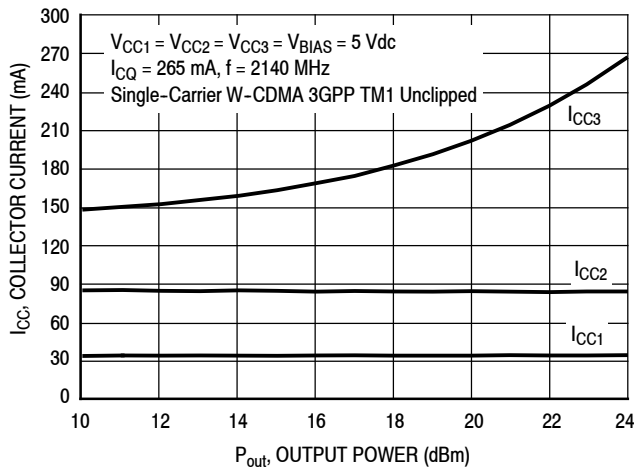


Figure 25. Stage Collector Current versus Output Power

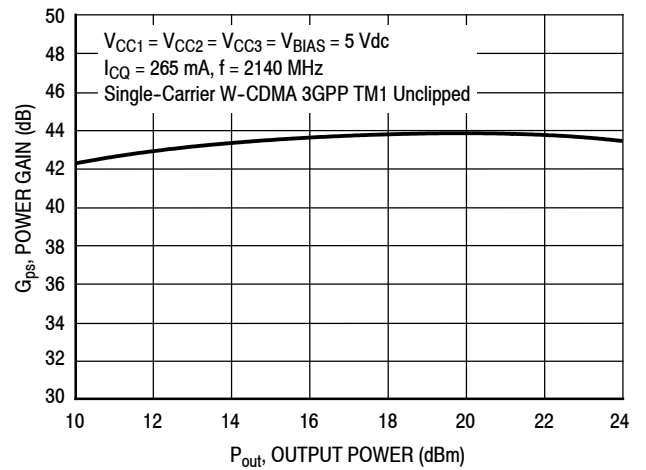


Figure 26. Power Gain versus Output Power

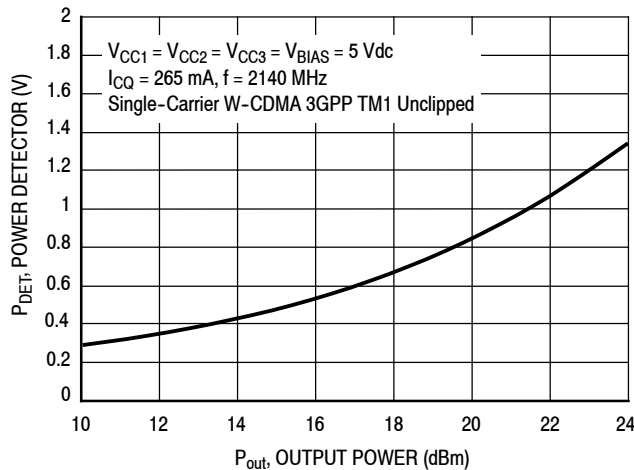


Figure 27. Power Detector versus Output Power

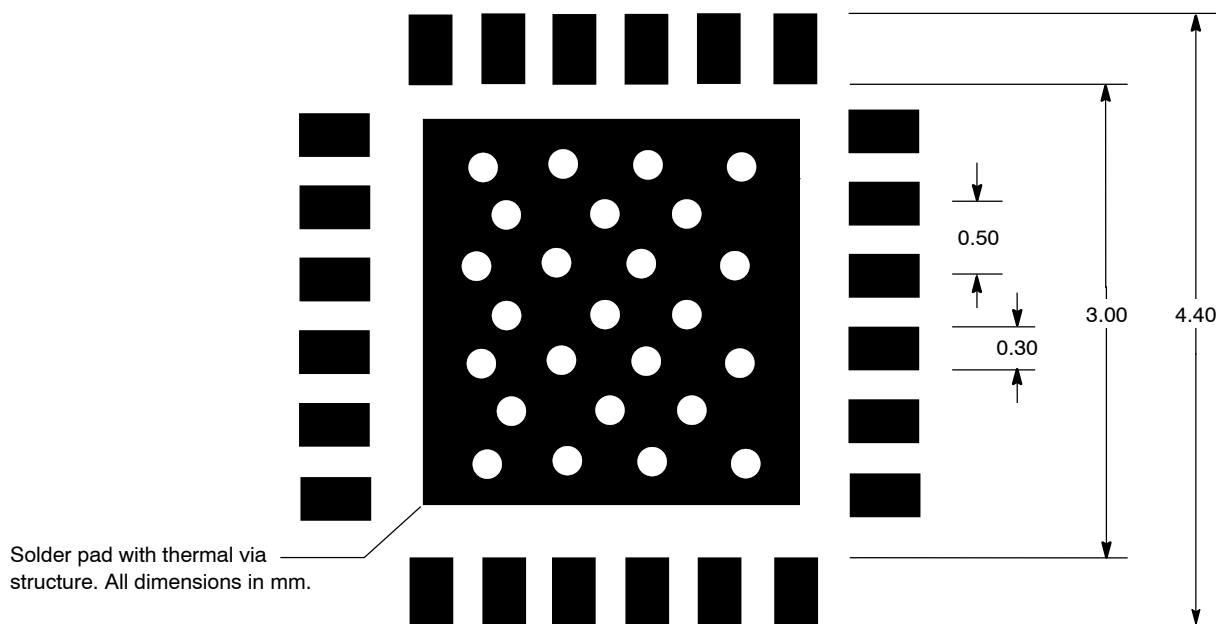
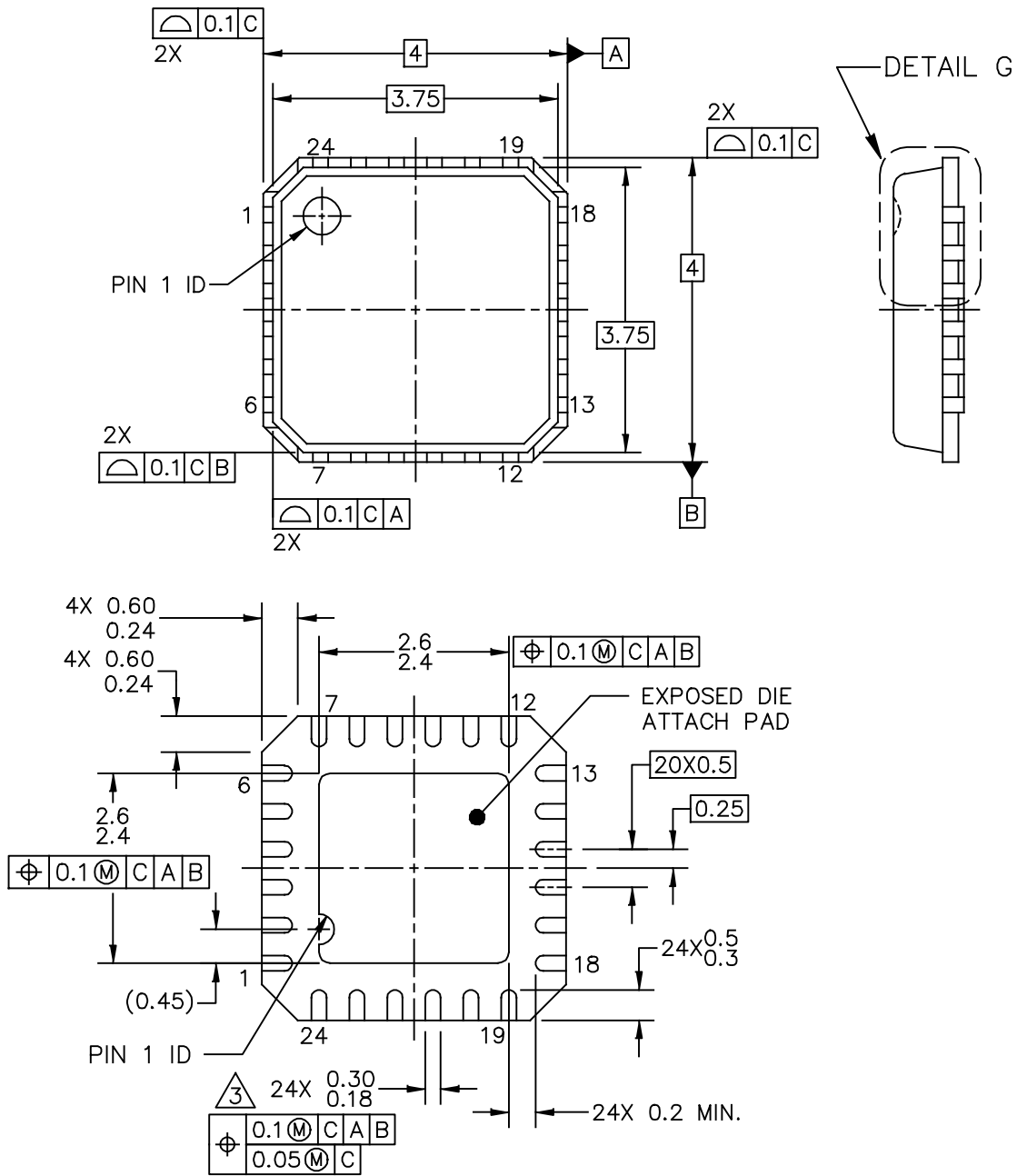


Figure 28. PCB Pad Layout for QFN 4 × 4

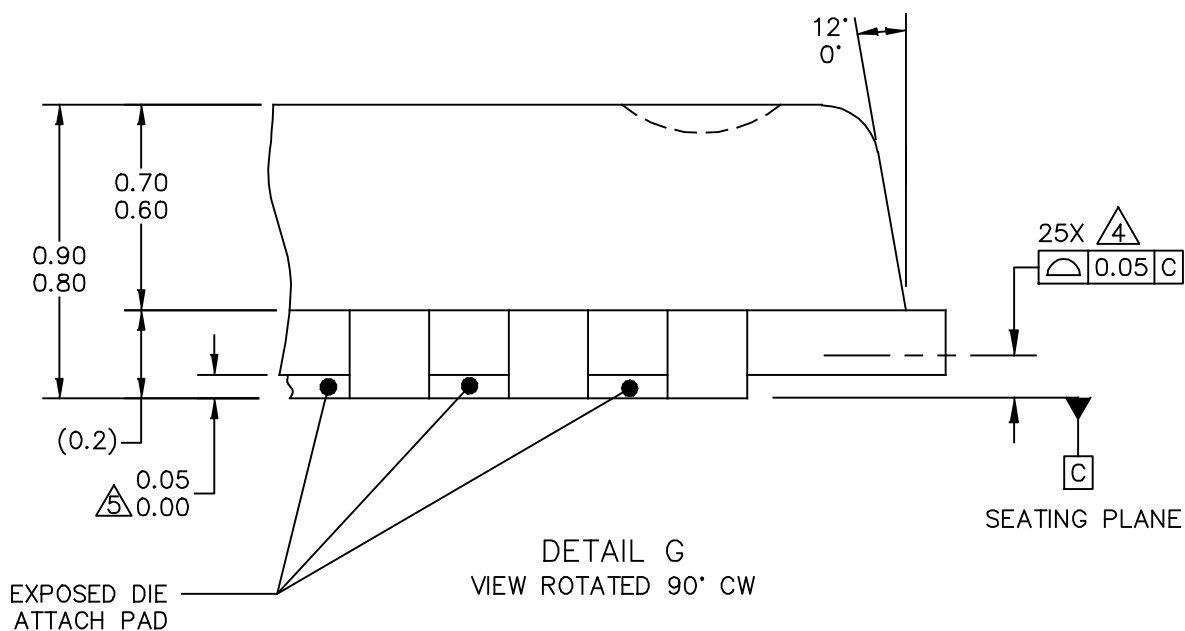


Figure 29. Product Marking

PACKAGE DIMENSIONS



| | | | | | |
|---|--|--------------------|--------------------------|----------------------------|-------------|
| © FREESCALE SEMICONDUCTOR, INC. ALL RIGHTS RESERVED. | | MECHANICAL OUTLINE | | PRINT VERSION NOT TO SCALE | |
| TITLE: QFN (PUNCH), THERMALLY ENHANCED 4 X 4 X 0.85, 0.5 PITCH, 24 TERMINAL | | | DOCUMENT NO: 98ASA00462D | | REV: 0 |
| | | | CASE NUMBER: 2285-01 | | 29 MAR 2012 |
| | | | STANDARD: NON-JEDEC | | |



| | | | |
|--|--------------------------|----------------------------|--|
| © FREESCALE SEMICONDUCTOR, INC. ALL RIGHTS RESERVED. | MECHANICAL OUTLINE | PRINT VERSION NOT TO SCALE | |
| TITLE: QFN (PUNCH), THERMALLY ENHANCED 4 X 4 X 0.85, 0.5 PITCH, 24 TERMINAL | DOCUMENT NO: 98ASA00462D | REV: 0 | |
| | CASE NUMBER: 2285-01 | 29 MAR 2012 | |
| | STANDARD: NON-JEDEC | | |

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS.

2. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994.

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

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

⑤ THIS DIMENSION APPLIES ONLY FOR TERMINALS.

| | | | |
|---|--------------------------|----------------------------|--|
| © FREESCALE SEMICONDUCTOR, INC. ALL RIGHTS RESERVED. | MECHANICAL OUTLINE | PRINT VERSION NOT TO SCALE | |
| TITLE: QFN (PUNCH), THERMALLY ENHANCED 4 X 4 X 0.85, 0.5 PITCH, 24 TERMINAL | DOCUMENT NO: 98ASA00462D | REV: 0 | |
| | CASE NUMBER: 2285-01 | 29 MAR 2012 | |
| | STANDARD: NON-JEDEC | | |

PRODUCT DOCUMENTATION, SOFTWARE AND TOOLS

Refer to the following resources 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.

FAILURE ANALYSIS

At this time, because of the physical characteristics of the part, failure analysis is limited to electrical signature analysis. In cases where Freescale is contractually obligated to perform failure analysis (FA) services, full FA may be performed by third party vendors with moderate success. For updates contact your local Freescale Sales Office.

REVISION HISTORY

The following table summarizes revisions to this document.

| Revision | Date | Description |
|----------|-----------|---|
| 0 | June 2014 | <ul style="list-style-type: none"> • Initial Release of Data Sheet |
| 1 | Aug. 2014 | <ul style="list-style-type: none"> • Table 1, Maximum Ratings: updated Junction Temperature from 150°C to 175°C to reflect recent test results of the device, p. 2 |

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