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Freescale Semiconductor
Technical Data

Document Number: MMA20312BV
Rev. 2, 9/2014

Heterojunction Bipolar Transistor Technology (InGaP HBT)

High Efficiency/Linearity Amplifier

MMA20312BVT1

1800–2200 MHz, 27.2 dB
30.5 dBm
InGaP HBT LINEAR AMPLIFIER

QFN 3 × 3

The MMA20312BV 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 1800 to 2200 MHz such as CDMA, TD–SCDMA, PCS, UMTS and LTE at operating voltages from 3 to 5 V. The amplifier is housed in a cost–effective, surface mount QFN plastic package.

- Typical Performance: V_{CC} = 5 Vdc, I_{CQ} = 70 mA, P_{out} = 17 dBm

Frequency	G_{ps} (dB)	ACPR (dBc)	PAE (%)	Test Signal
1880 MHz	29.0	–47.4	9.1	TD–SCDMA
1920 MHz	29.0	–46.7	9.0	TD–SCDMA
2010 MHz	27.4	–52.0	9.3	TD–SCDMA
2025 MHz	26.8	–50.0	9.5	TD–SCDMA
2140 MHz	27.0	–51.7	9.4	W–CDMA

Features

- Frequency: 1800–2200 MHz
- P1dB: 30.5 dBm @ 2140 MHz (CW Application Circuit)
- Power Gain: 26.4 dB @ 2140 MHz (CW Application Circuit)
- OIP3: 44.5 dBm @ 2140 MHz (W–CDMA Application Circuit)
- Active Bias Control (adjustable externally)
- Single 3 to 5 V Supply
- Cost–effective 12–pin, 3 mm QFN Surface Mount Plastic Package
- In Tape and Reel. T1 Suffix = 1,000 Units, 12 mm Tape Width, 7–inch Reel.

Table 1. Typical Performance (1)

Characteristic	Symbol	1800 MHz	2140 MHz	2200 MHz	Unit
Small–Signal Gain (S21)	G_p	28.8	26.4	25.5	dB
Input Return Loss (S11)	IRL	–17.6	–10.9	–9.7	dB
Output Return Loss (S22)	ORL	–20.3	–14.7	–13.7	dB
Power Output @ 1dB Compression	P1dB	30.5	30.5	30.5	dBm

1. V_{CC1} = V_{CC2} = V_{BIAS} = 5 Vdc, T_A = 25°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	°C
Junction Temperature	T_J	175	°C

Table 3. Thermal Characteristics

Characteristic	Symbol	Value (2)	Unit
Thermal Resistance, Junction to Case Case Temperature 86°C, V_{CC1} = V_{CC2} = V_{BIAS} = 5 Vdc	$R_{\theta JC}$	52	°C/W

2. 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, 2140 MHz, T_A = 25°C, 50 ohm system, in Freescale W-CDMA Application Circuit)

Characteristic	Symbol	Min	Typ	Max	Unit
Small-Signal Gain (S21) (1)	G_p	23.6	27.2	—	dB
Input Return Loss (S11)	IRL	—	-10.7	—	dB
Output Return Loss (S22)	ORL	—	-15.5	—	dB
Power Output @ 1dB Compression, CW	P1dB	—	28.2	—	dBm
Third Order Output Intercept Point, Two-Tone CW	OIP3	—	44.5	—	dBm
Noise Figure	NF	—	3.3	—	dB
Supply Current (1)	I_{CQ}	62.5	70	77	mA
Supply Voltage	V_{CC}	—	5	—	V

Table 5. ESD Protection Characteristics

Test Methodology	Class
Human Body Model (per JESD22-A114)	0, rated to 150 V
Machine Model (per EIA/JESD22-A115)	A
Charge Device Model (per JESD22-C101)	III

Table 6. Moisture Sensitivity Level

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

1. Specified data is based on performance of soldered down part in W-CDMA application circuit.

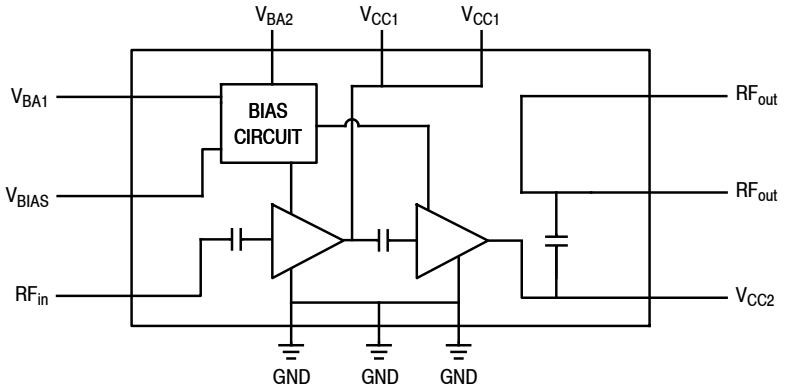


Figure 1. Functional Block Diagram

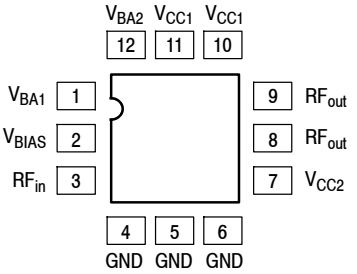
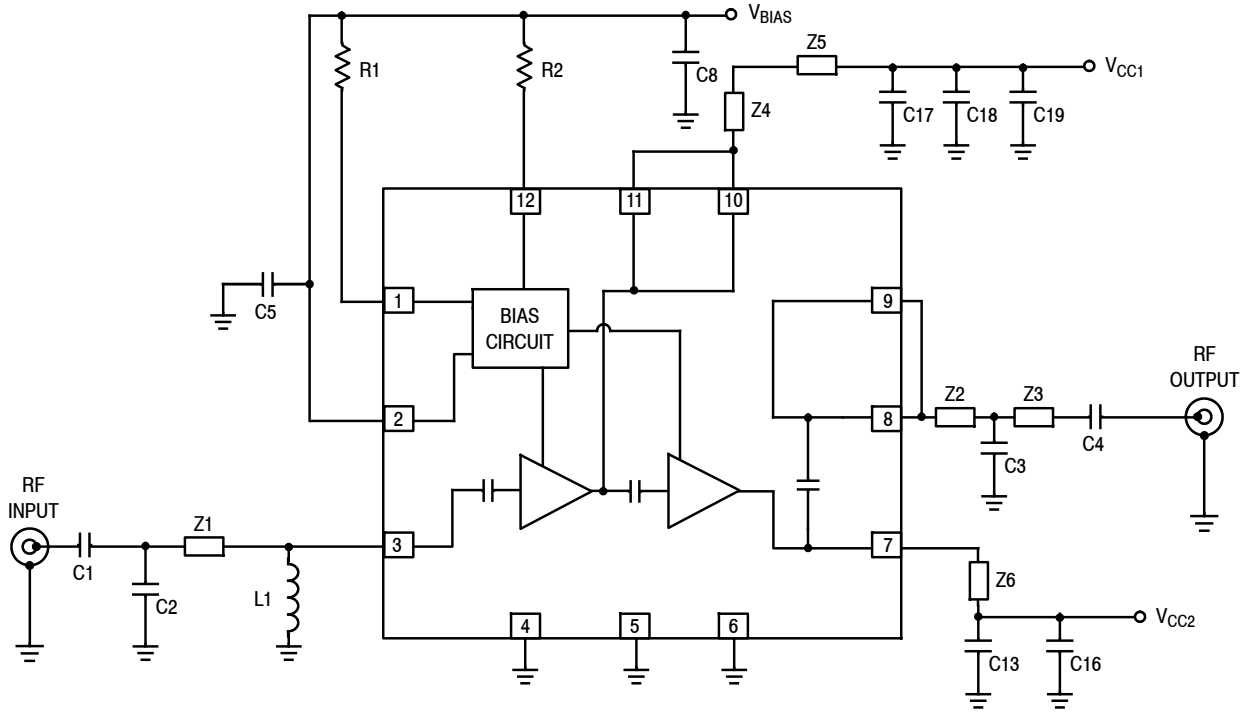


Figure 2. Pin Connections



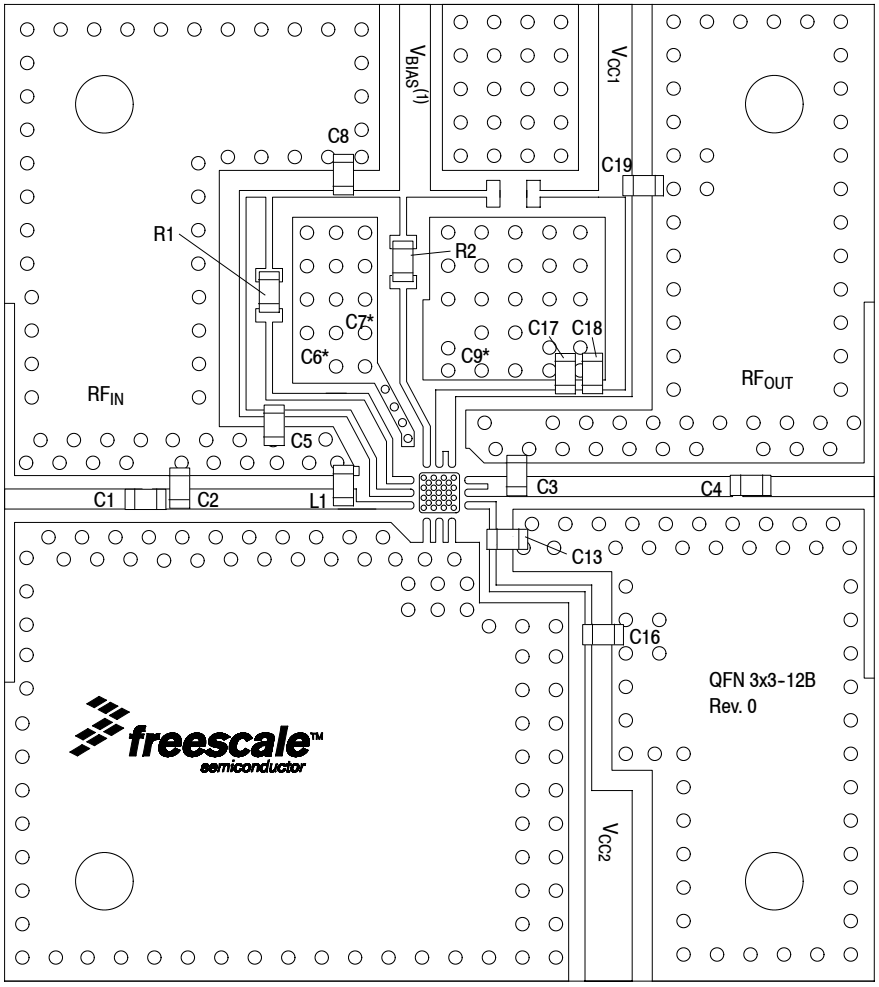
Z1	0.250″ x 0.030″ Microstrip	Z4	0.080″ x 0.030″ Microstrip
Z2	0.035″ x 0.030″ Microstrip	Z5	0.155″ x 0.010″ Microstrip
Z3	0.283″ x 0.030″ Microstrip	Z6	0.045″ x 0.010″ Microstrip

Figure 3. MMA20312BV Test Circuit Schematic — TD-SCDMA, 5 Volt Operation

Table 7. MMA20312BV Test Circuit Component Designations and Values — TD-SCDMA, 5 Volt Operation

Part	Description	Part Number	Manufacturer
C1, C5	22 pF Chip Capacitors	06033J220GBS	AVX
C2	1.8 pF Chip Capacitor	06035J1R8BBS	AVX
C3	2.2 pF Chip Capacitor	06035J2R2BBS	AVX
C4	5.6 pF Chip Capacitor	06035J5R6BBS	AVX
C6, C7, C9	Components Not Placed		
C8, C18	1 μF Chip Capacitors	GRM188R61A105KA61	Murata
C13	10 pF Chip Capacitor	06035J100GBS	AVX
C16, C19	10 μF Chip Capacitors	GRM188R60J106ME47	Murata
C17	0.1 μF Chip Capacitor	GRM188R71H104KA93	Murata
L1	1.8 nH Chip Inductor	LL1608-FS1N8S	TOKO
R1	330 Ω Chip Resistor	RR0816Q-331-D	Susumu
R2	1.5 kΩ Chip Resistor	RR0816Q-152-D	Susumu
PCB	0.01″, ε_r = 3.38	680-338	Isola

Note: Component numbers C6, C7 and C9 are labeled on board but not placed. C10, C11, C12, C14 and C15 are intentionally omitted.



(1) V_{BIAS} [Board] supplies V_{BA1}, V_{BA2} and V_{BIAS} [Device].
Note: Component numbers C6*, C7* and C9* are labeled on board but not placed.

Figure 4. MMA20312BV Test Circuit Component Layout — TD-SCDMA, 5 Volt Operation

Table 7. MMA20312BV Test Circuit Component Designations and Values — TD-SCDMA, 5 Volt Operation

Part	Description	Part Number	Manufacturer
C1, C5	22 pF Chip Capacitors	06033J220GBS	AVX
C2	1.8 pF Chip Capacitor	06035J1R8BBS	AVX
C3	2.2 pF Chip Capacitor	06035J2R2BBS	AVX
C4	5.6 pF Chip Capacitor	06035J5R6BBS	AVX
C6, C7, C9	Components Not Placed		
C8, C18	1 μF Chip Capacitors	GRM188R61A105KA61	Murata
C13	10 pF Chip Capacitor	06035J100GBS	AVX
C16, C19	10 μF Chip Capacitors	GRM188R60J106ME47	Murata
C17	0.1 μF Chip Capacitor	GRM188R71H104KA93	Murata
L1	1.8 nH Chip Inductor	LL1608-FS1N8S	TOKO
R1	330 Ω Chip Resistor	RR0816Q-331-D	Susumu
R2	1.5 kΩ Chip Resistor	RR0816Q-152-D	Susumu
PCB	0.01″, ε_r = 3.38	680-338	Isola

Note: Component numbers C10, C11, C12, C14 and C15 are intentionally omitted.

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

TYPICAL CHARACTERISTICS — TD-SCDMA

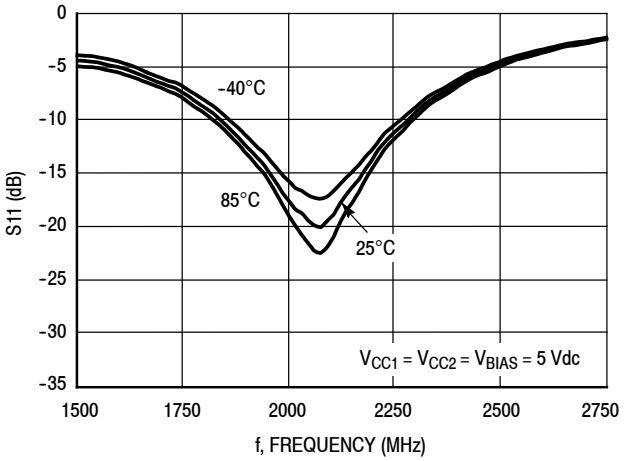


Figure 5. S11 versus Frequency versus Temperature

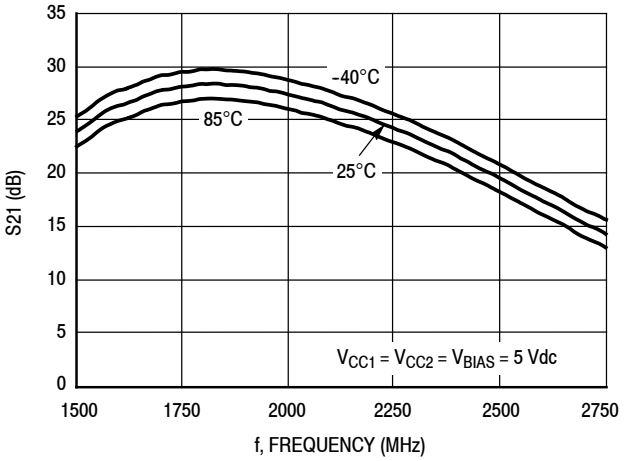


Figure 6. S21 versus Frequency versus Temperature

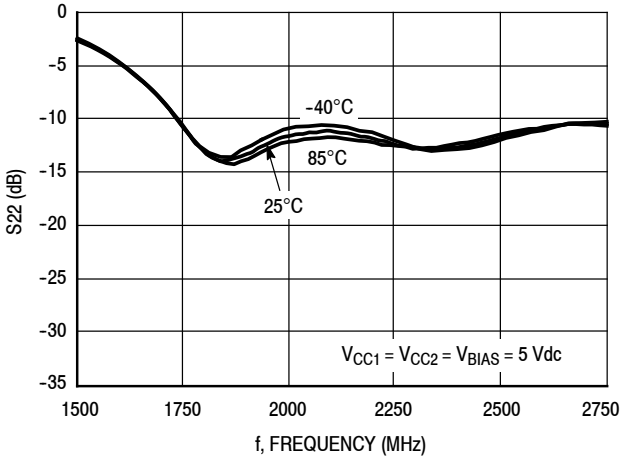


Figure 7. S22 versus Frequency versus Temperature

TYPICAL CHARACTERISTICS — TD-SCDMA

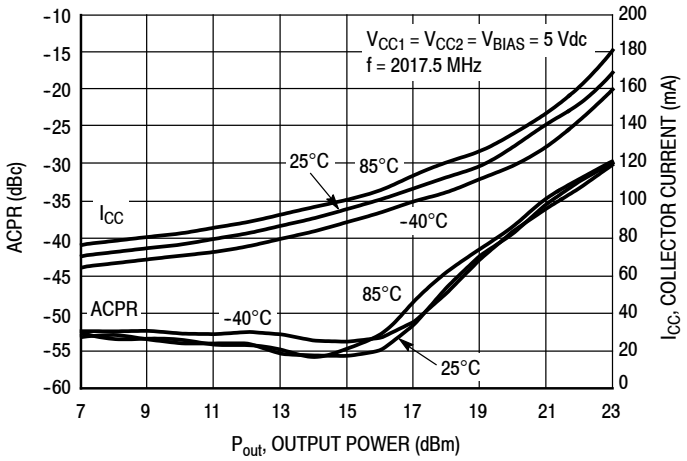


Figure 8. ACPR versus Collector Current versus Output Power versus Temperature

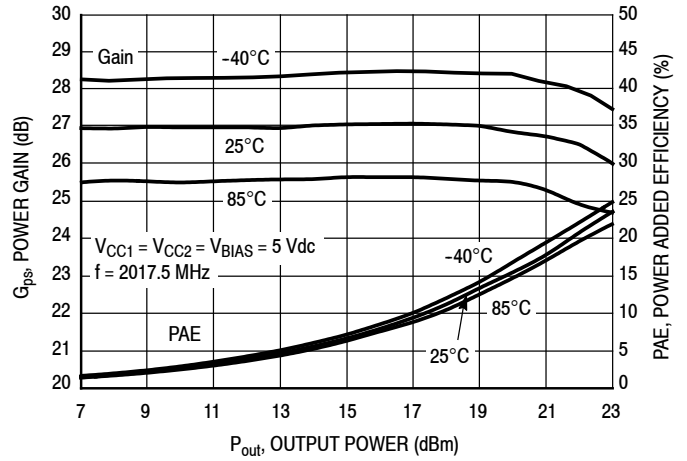


Figure 9. Power Gain versus Power Added Efficiency versus Output Power versus Temperature

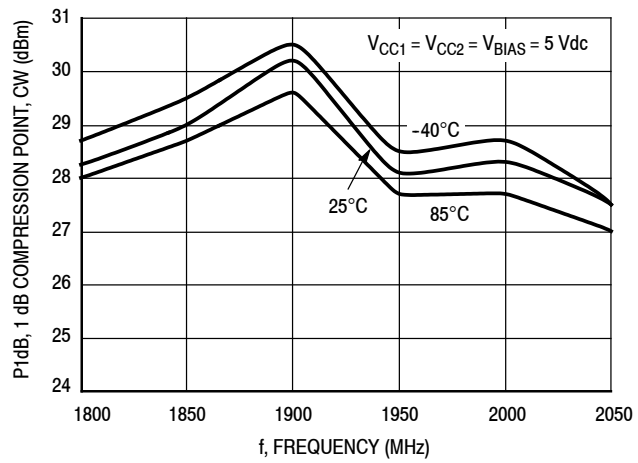
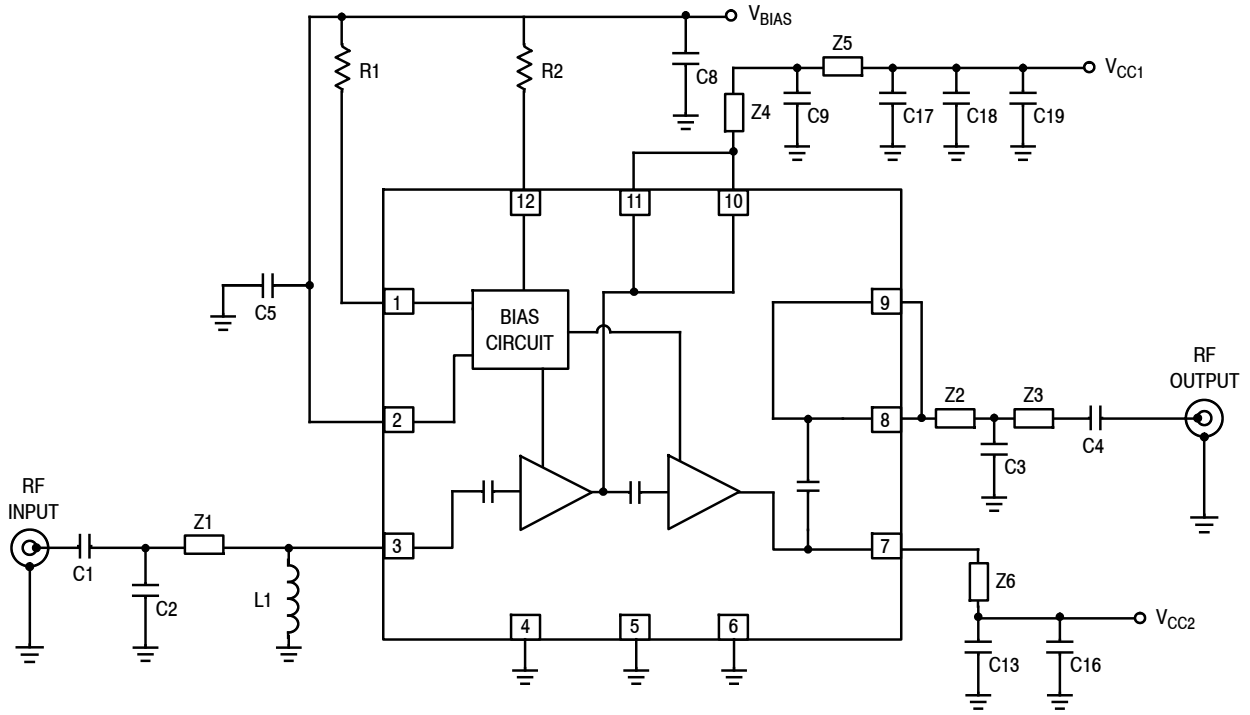


Figure 10. P1dB versus Frequency versus Temperature, CW



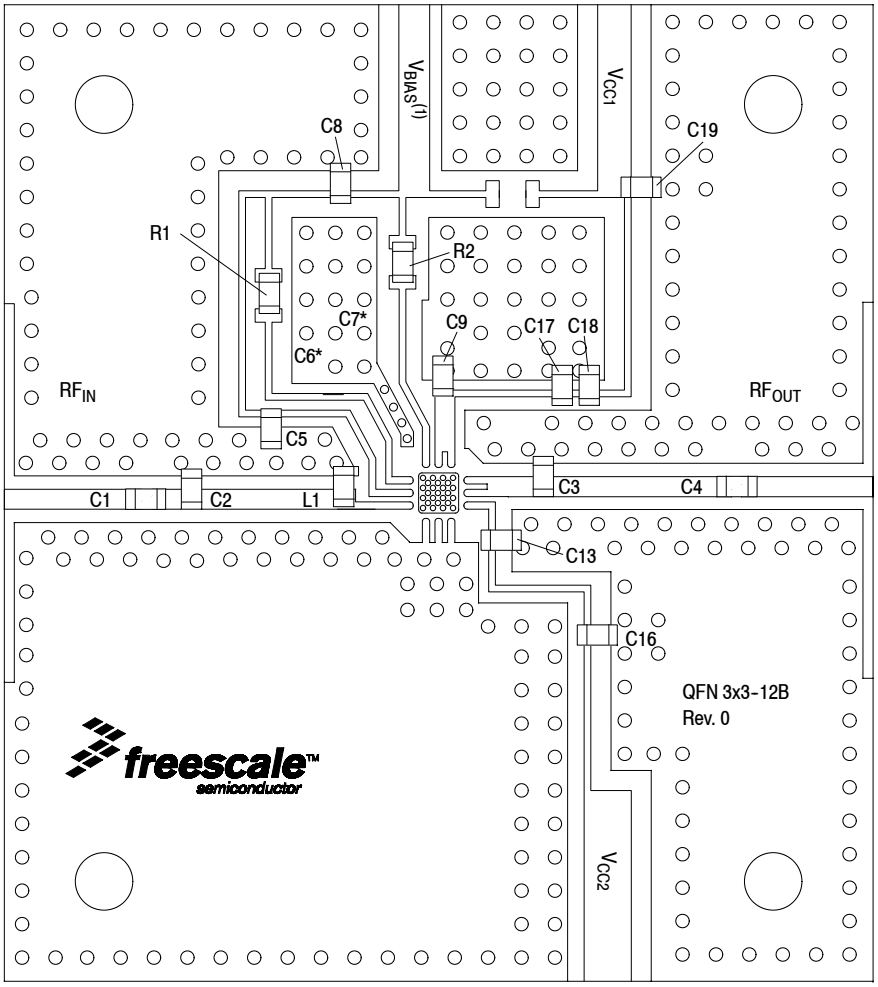
Z1	0.218″ x 0.030″ Microstrip	Z4	0.080″ x 0.030″ Microstrip
Z2	0.068″ x 0.030″ Microstrip	Z5	0.155″ x 0.010″ Microstrip
Z3	0.250″ x 0.030″ Microstrip	Z6	0.045″ x 0.010″ Microstrip

Figure 11. MMA20312BV Test Circuit Schematic — W-CDMA, 5 Volt Operation

Table 8. MMA20312BV Test Circuit Component Designations and Values — W-CDMA, 5 Volt Operation

Part	Description	Part Number	Manufacturer
C1, C5	22 pF Chip Capacitors	06033J220GBS	AVX
C2, C3	1.8 pF Chip Capacitors	06035J1R8BBS	AVX
C4	5.6 pF Chip Capacitor	06035J5R6BBS	AVX
C6, C7	Components Not Placed		
C8, C18	1 μF Chip Capacitors	GRM188R61A105KA61	Murata
C9	100 pF Chip Capacitor	GRM1885C1H101JA01	Murata
C13	10 pF Chip Capacitor	06035J100GBS	AVX
C16, C19	10 μF Chip Capacitors	GRM188R60J106ME47	Murata
C17	0.1 μF Chip Capacitor	GRM188R71H104KA93	Murata
L1	1.8 nH Chip Inductor	LL1608-FS1N8S	TOKO
R1	330 Ω Chip Resistor	RR0816Q-331-D	Susumu
R2	1500 Ω Chip Resistor	RR0816Q-152-D	Susumu
PCB	0.01″, ε_r = 3.38	680-338	Isola

Note: Component numbers C6 and C7 are labeled on board but not placed. C10, C11, C12, C14 and C15 are intentionally omitted.



(1) V_{BIAS} [Board] supplies V_{BA1}, V_{BA2} and V_{BIAS} [Device].
Note: Component numbers C6* and C7* are labeled on board but not placed.

Figure 12. MMA20312BV Test Circuit Component Layout — W-CDMA, 5 Volt Operation

Table 8. MMA20312BV Test Circuit Component Designations and Values — W-CDMA, 5 Volt Operation

Part	Description	Part Number	Manufacturer
C1, C5	22 pF Chip Capacitors	06033J220GBS	AVX
C2, C3	1.8 pF Chip Capacitors	06035J1R8BBS	AVX
C4	5.6 pF Chip Capacitor	06035J5R6BBS	AVX
C6, C7	Components Not Placed		
C8, C18	1 μF Chip Capacitors	GRM188R61A105KA61	Murata
C9	100 pF Chip Capacitor	GRM1885C1H101JA01	Murata
C13	10 pF Chip Capacitor	06035J100GBS	AVX
C16, C19	10 μF Chip Capacitors	GRM188R60J106ME47	Murata
C17	0.1 μF Chip Capacitor	GRM188R71H104KA93	Murata
L1	1.8 nH Chip Inductor	LL1608-FS1N8S	TOKO
R1	330 Ω Chip Resistor	RR0816Q-331-D	Susumu
R2	1500 Ω Chip Resistor	RR0816Q-152-D	Susumu
PCB	0.01″, ε_r = 3.38	680-338	Isola

Note: Component numbers C10, C11, C12, C14 and C15 are intentionally omitted.

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

TYPICAL CHARACTERISTICS — W-CDMA

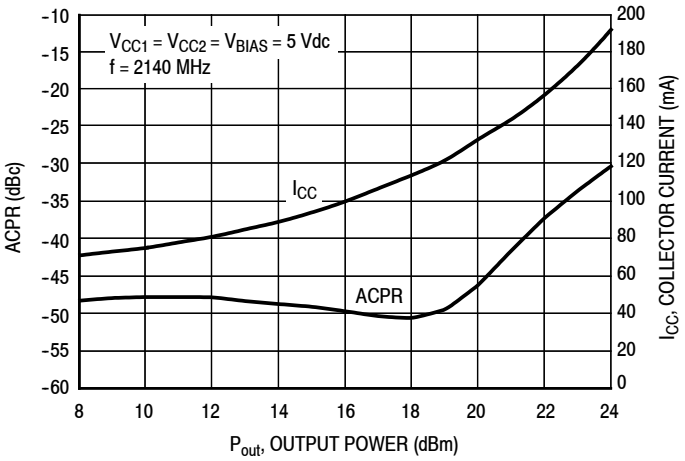


Figure 13. ACPR versus Collector Current versus Output Power

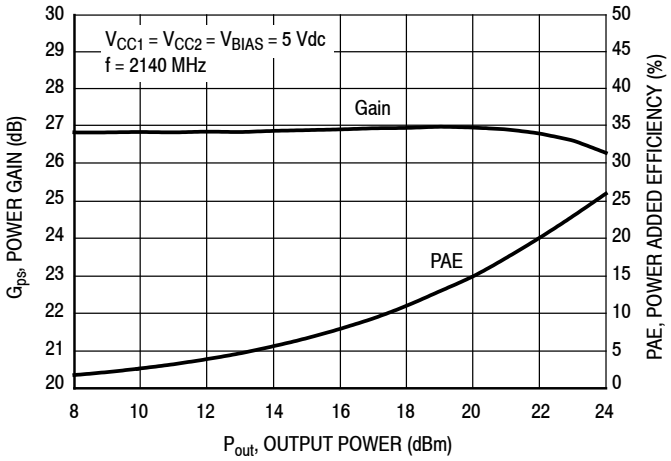


Figure 14. Power Gain versus Power Added Efficiency versus Output Power

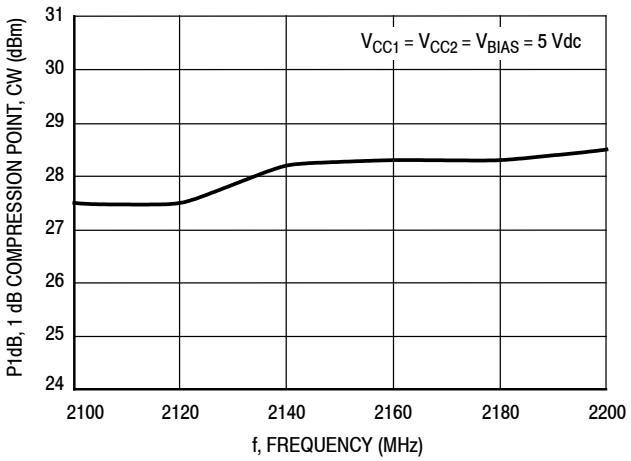
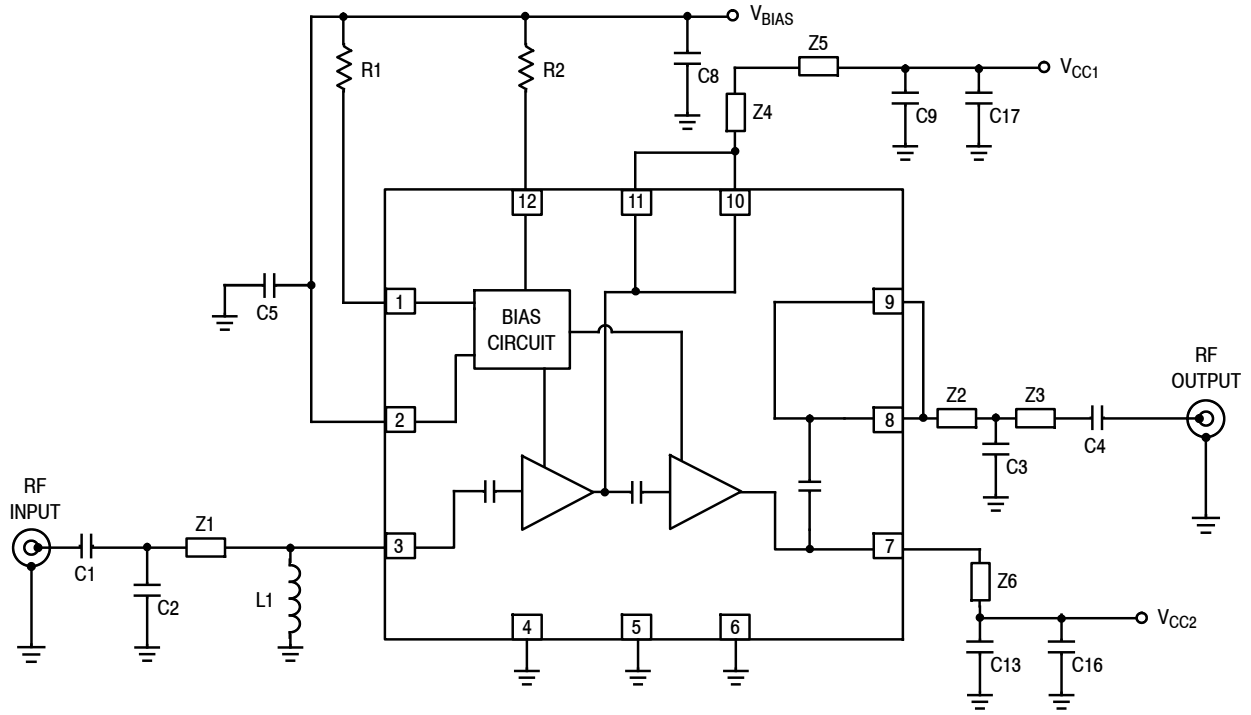


Figure 15. P1dB versus Frequency, CW



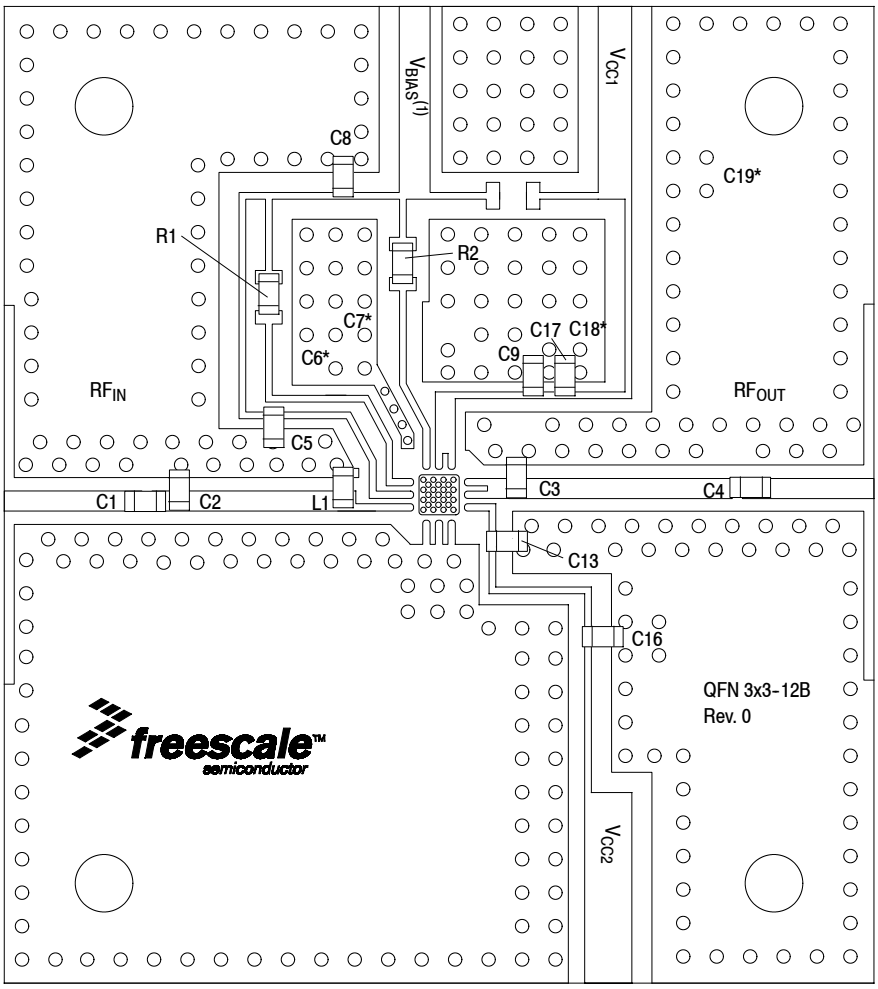
Z1	0.250″ x 0.030″ Microstrip	Z4	0.080″ x 0.030″ Microstrip
Z2	0.124″ x 0.030″ Microstrip	Z5	0.048″ x 0.010″ Microstrip
Z3	0.195″ x 0.030″ Microstrip	Z6	0.045″ x 0.010″ Microstrip

Figure 16. MMA20312BV Test Circuit Schematic — IS-95, 3.3 Volt Operation

Table 9. MMA20312BV Test Circuit Component Designations and Values — IS-95, 3.3 Volt Operation

Part	Description	Part Number	Manufacturer
C1, C5, C9	22 pF Chip Capacitors	06033J220GBS	AVX
C2	2.2 pF Chip Capacitor	06035J2R2BBS	AVX
C3	2.4 pF Chip Capacitor	06035J2R4BBS	AVX
C4	4.7 pF Chip Capacitor	06035J4R7BBS	AVX
C6, C7, C18, C19	Components Not Placed		
C8, C17	1 μF Chip Capacitors	GRM188R61A105KA61	Murata
C13	10 pF Chip Capacitor	06035J100GBS	AVX
C16	4.7 μF Chip Capacitor	GRM188R60J106ME47	Murata
L1	1.5 nH Chip Inductor	LL1608-FS1N5S	TOKO
R1	82 Ω Chip Resistor	RR0816Q-820-D	Susumu
R2	510 Ω Chip Resistor	RR0816Q-511-D	Susumu
PCB	0.01″, ε_r = 3.38	680-338	Isola

Note: Component numbers C6, C7, C18 and C19 are labeled on board but not placed. C10, C11, C12, C14 and C15 are intentionally omitted.



(1) V_{BIAS} [Board] supplies V_{BA1}, V_{BA2} and V_{BIAS} [Device].
Note: Component numbers C6*, C7*, C18* and C19* are labeled on board but not placed.

Figure 17. MMA20312BV Test Circuit Component Layout — IS-95, 3.3 Volt Operation

Table 9. MMA20312BV Test Circuit Component Designations and Values — IS-95, 3.3 Volt Operation

Part	Description	Part Number	Manufacturer
C1, C5, C9	22 pF Chip Capacitors	06033J220GBS	AVX
C2	2.2 pF Chip Capacitor	06035J2R2BBS	AVX
C3	2.4 pF Chip Capacitor	06035J2R4BBS	AVX
C4	4.7 pF Chip Capacitor	06035J4R7BBS	AVX
C6, C7, C18, C19	Components Not Placed		
C8, C17	1 μF Chip Capacitors	GRM188R61A105KA61	Murata
C13	10 pF Chip Capacitor	06035J100GBS	AVX
C16	4.7 μF Chip Capacitor	GRM188R60J106ME47	Murata
L1	1.5 nH Chip Inductor	LL1608-FS1N5S	TOKO
R1	82 Ω Chip Resistor	RR0816Q-820-D	Susumu
R2	510 Ω Chip Resistor	RR0816Q-511-D	Susumu
PCB	0.01″, ε_r = 3.38	680-338	Isola

Note: Component numbers C10, C11, C12, C14 and C15 are intentionally omitted.

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

TYPICAL CHARACTERISTICS — IS-95

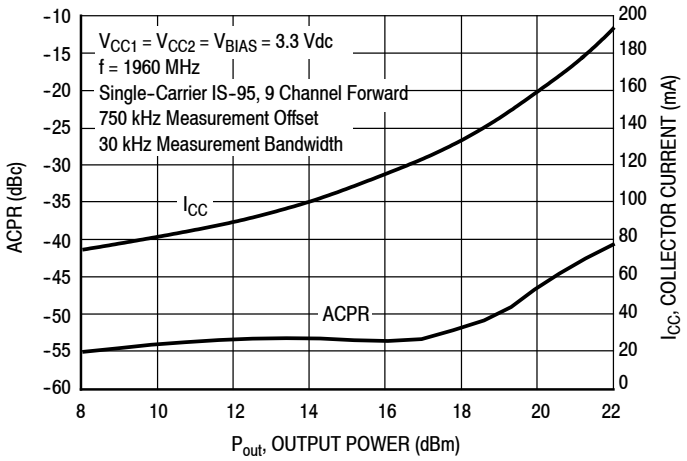


Figure 18. ACPR versus Collector Current versus Output Power

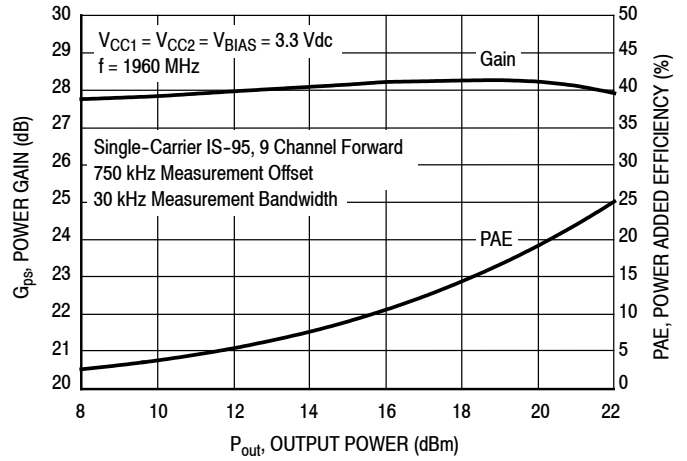


Figure 19. Power Gain versus Power Added Efficiency versus Output Power

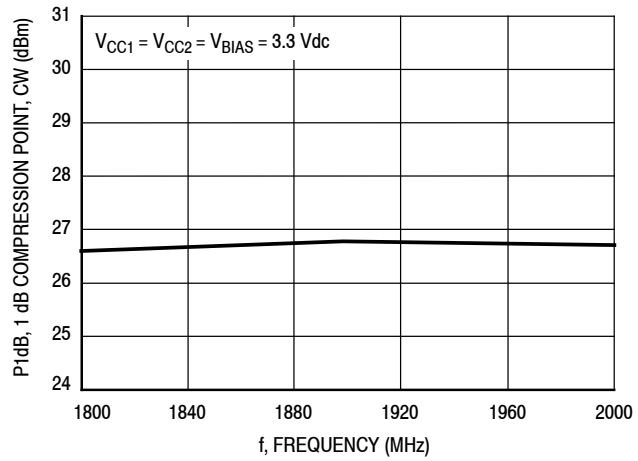


Figure 20. P1dB versus Frequency, CW

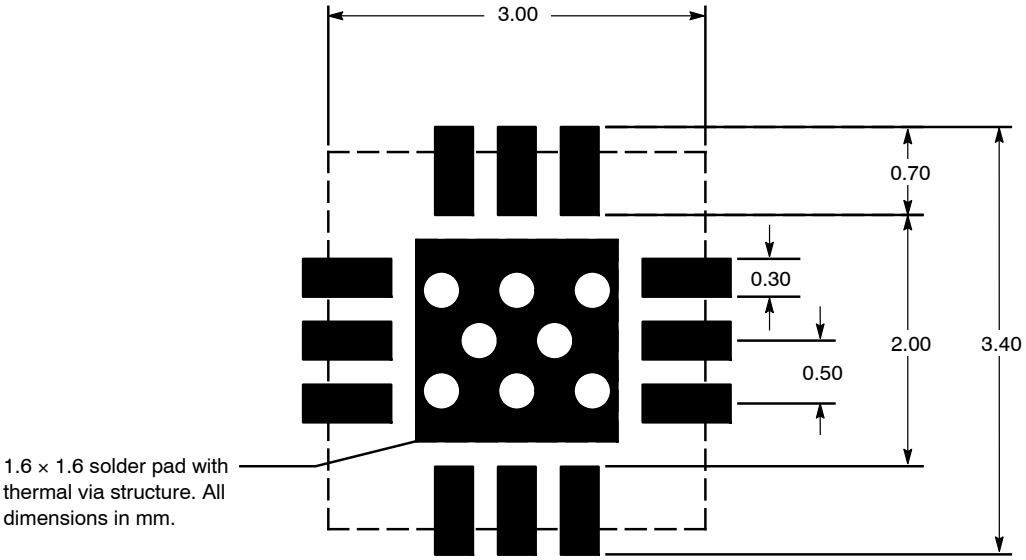
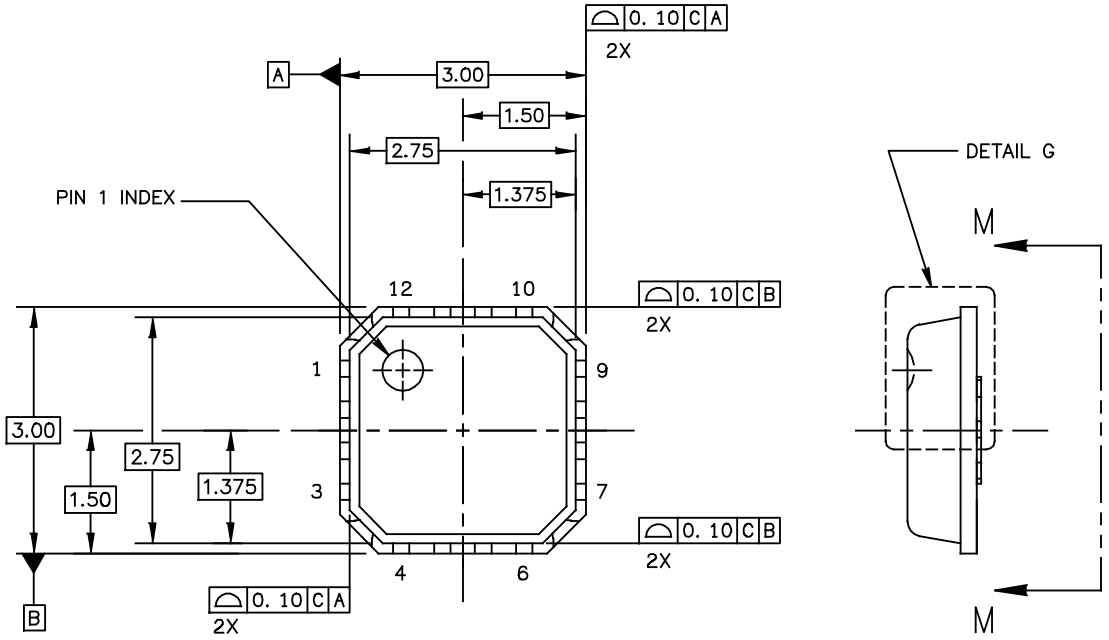
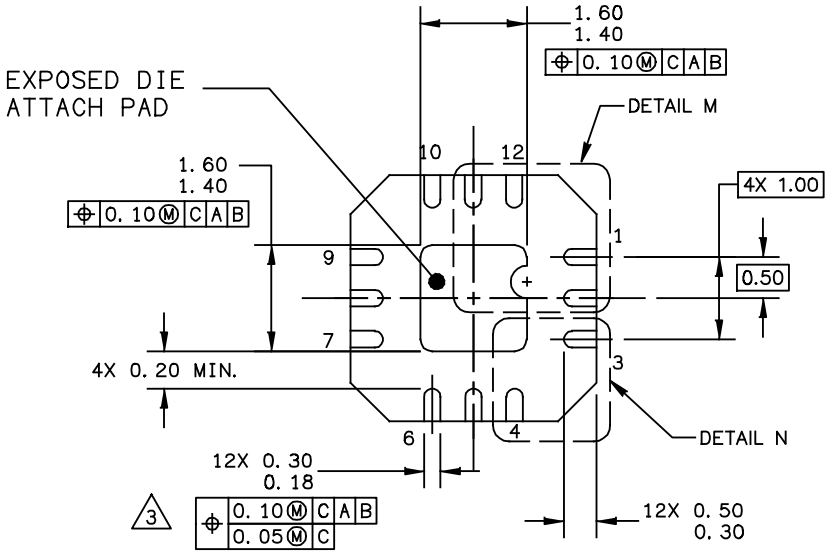


Figure 21. PCB Pad Layout for QFN 3 × 3

Figure 22. Product Marking

PACKAGE DIMENSIONS





VIEW M–M

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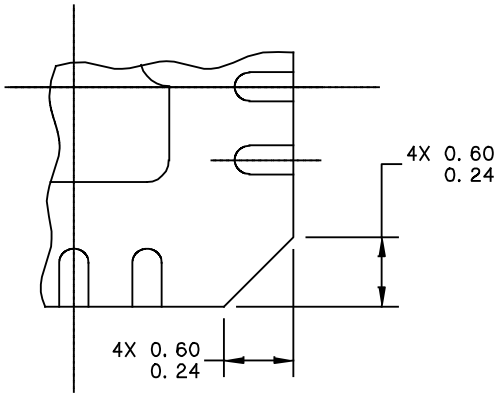
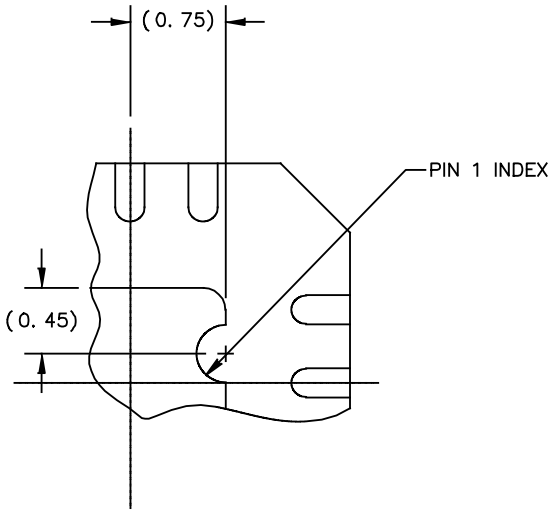
TITLE: THERMALLY ENHANCED QUAD FLAT NON–LEADED PACKAGE (QFN) 12 TERMINAL, 0.5 PITCH (3X3X0.85)	DOCUMENT NO: 98ASA00227D	REV: O
	CASE NUMBER: 2131–01	14 MAY 2010
	STANDARD: NON–JEDEC	



DETAIL N
CORNER CONFIGURATION



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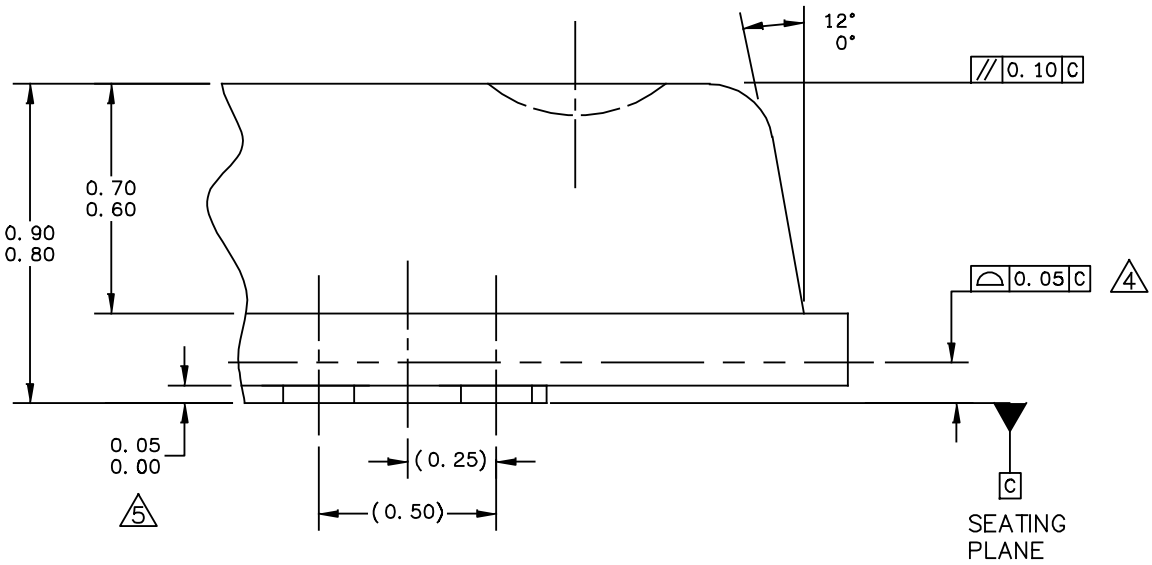

DETAIL G
VIEW ROTATED 90° CW

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

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 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 Software & Tools 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	Aug. 2011	• Initial Release of Data Sheet
1	Dec. 2011	• Updated minimum operating voltage from 3.3 V to 3 V to reflect actual device capability, p. 1 • All references to “V_{CTRL}” in the data sheet tables, test circuit schematics and component layouts is replaced with “V_{BIAS}”. V_{BIAS} is the supply voltage which sets the internal bias conditions via pins 1, 2, and 12, pp. 1–3, 5–7, 9, 10, 12. Footnote “(1) V_{BIAS} [Board] supplies V_{BA1}, V_{BA2} and V_{BIAS} [Device]” added to test circuit component layouts, pp. 4, 8, 11.
2	Sept. 2014	• Table 2, Maximum Ratings: updated Junction Temperature from 150°C to 175°C to reflect recent test results of the device, p. 1 • Added Failure Analysis information, p. 17

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