

## Features

- Frequency Range 2.4 GHz to 2.5 GHz
- Supply Voltage 2.7V to 3.6V
- 32 dB Power Gain
- 23 dBm Linear Output Power for IEEE 802.11b Mode Operation
- EVM < 2.0% at 19 dBm Output Power for IEEE 802.11g Mode Operation
- On-chip Power Detector with 20 dB Dynamic Range
- Power-down Mode and Biasing Control
- Input and Interstage Matching Fully On-chip
- Low Profile Lead-free Plastic Package QFN16 (3 × 3 × 0.9 mm)

## Applications

- IEEE 802.11b DSSS WLAN
- IEEE 802.11g OFDM WLAN
- PC Cards, PCMCIA, Access Points
- 2.4 GHz ISM Band Application

## 1. Description

This power amplifier (PA) is designed for high-performance 802.11b and 802.11g multi-mode applications such as Mini PCI and PCMCIA for portable devices and access points. The low profile plastic package with internal input matching to 50Ω and on-chip interstage matching minimizes the PCB board-space and allows simplified integration with very few passive components. The on-chip power detector provides a voltage linear to the output power, while the standby/bias control logic provides power-saving and shutdown options. The PA is realized as a three stage PA with internal interstage matching and an open-collector output structure.

The power amplifier is designed using Atmel's Silicon-Germanium (SiGe2) process and provides excellent linearity and noise performance, high gain, and good power-added efficiency.



## High Gain Power Amplifier for 802.11b/g WLAN Systems

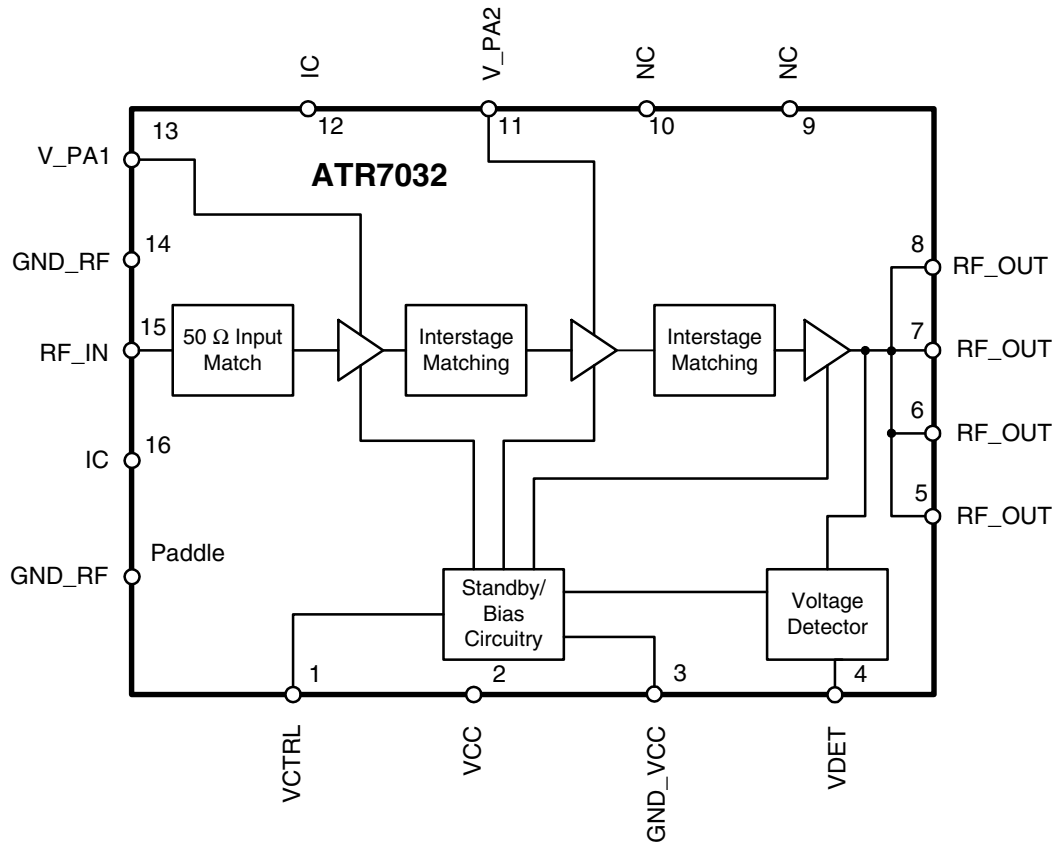
**ATR7032**

**Preliminary**

Rev. 4846B-WLAN-04/05



Figure 1-1. Block Diagram



## 2. Pin Configuration

Figure 2-1. Pinning QFN16

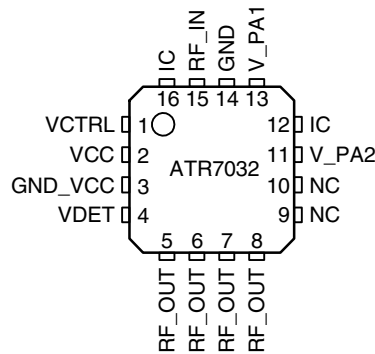


Table 2-1. Pin Description

Pin	Symbol	Function
1	VCTRL	Power-up/biasing control voltage
2	VCC	Supply voltage
3	GND_VCC	Ground
4	VDET	Power detector voltage
5	RF_OUT	RF output
6	RF_OUT	RF output
7	RF_OUT	RF output
8	RF_OUT	RF output
9	NC	Not connected
10	NC	Not connected
11	V_PA2	Supply voltage PA stage 2
12	IC	Internally connected, on-chip matching; must not be externally connected
13	V_PA1	Supply voltage PA stage 1
14	GND	Ground
15	RF_IN	RF input
16	IC	Internally connected, on-chip matching; must not be externally connected
Slug	–	Ground

### 3. Absolute Maximum Ratings

Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Parameters	Test Conditions	Symbol	Value	Unit
Supply voltage		$V_{CC}$	TBD	V
Supply current		$I_{CC}$	600	mA
Junction temperature		$T_j$	150	°C
Storage temperature		$T_{Stg}$	-40 to +125	°C
Input RF power		$P_{IN}$	12	dBm
Control voltage power up/down and biasing		$V_{CONTR}$	0 to +3.0	V
ESD protection, all pins	EIA/JESD22-A114-B	$V_{ESD}$	500	V

Note: 1. The part may not survive all maximums applied simultaneously.

### 4. Operating Range

Parameters	Symbol	Value	Unit
Supply voltage range	$V_{CC}$	2.7 to 3.6	V
Ambient temperature range	$T_{amb}$	-40 to +85	°C
Frequency range	f	2400 to 2500	MHz

### 5. Electrical Characteristics

Test Conditions measured on Atmel’s evaluation board (unless otherwise stated):  $V_{CC} = 3.3V$ , Frequency = 2.45 GHz,  $T_{amb} = 25^\circ C$

No.	Parameters	Test Conditions	Pin	Symbol	Min.	Typ.	Max.	Unit	Type*
1.0	Control voltage range	PA operating mode		$V_{CONTR}$	1		2	V	A
1.1		Power down mode		$V_{CONTR}$			0.2		A
1.2	Current consumption	Quiescent		$I_{CQ}$		90		mA	A
1.3		Power down mode		$I_{PD}$			10	µA	A

\*) Type means: A = 100% tested, B = 100% correlation tested, C = Characterized on samples, D = Design parameter

## 6. Electrical Characteristics – Unmodulated Carrier

Test Conditions measured on Atmel's evaluation board (unless otherwise stated):  $V_{CC} = 3.3V$ , Frequency = 2.45 GHz,  $T_{amb} = 25^{\circ}C$

No.	Parameters	Test Conditions	Pin	Symbol	Min.	Typ.	Max.	Unit	Type*
2.0	Saturated output power	For reference		$P_{SAT}$		28.5		dBm	A
2.1	P1dB output power			P1dB		27		dBm	A
2.2	Harmonic rejection	$P_{OUT} = 23$ dBm		2f <sub>out</sub> 3f <sub>out</sub>		-45 -30		dBc dBc	C C
2.3	Small signal gain	$I_{CQ}$ , small signal condition		GL		32		dB	A
2.4	Gain variation	$I_{CQ}$ , small signal condition 2.4 to 2.5 GHz -40 to +85°C		$G_{varfreq}$ $G_{vartemp}$	-1 -1.5		+1 +1.5	dB dB	A C
2.5	Reverse isolation	$I_{CQ}$ , small signal condition		ISOr		40		dB	C
2.6	Input 50Ω VSWR	$I_{CQ}$ , small signal condition		VSWR <sub>IN</sub>		2:1			C
2.7	Output 50Ω VSWR	$I_{CQ}$ , small signal condition, with external matching		VSWR <sub>OUT</sub>		2:1			C

\*) Type means: A = 100% tested, B = 100% correlation tested, C = Characterized on samples, D = Design parameter

## 7. Electrical Characteristics – 11 Mbps CCK Modulation

Test Conditions measured on Atmel's evaluation board (unless otherwise stated):  $V_{CC} = 3.3V$ , Frequency = 2.45 GHz,  $T_{amb} = 25^{\circ}C$ , 11 Mbps CCK modulation with Gaussian transmit filtering of BT = 0.4, conforming to IEEE 802.11b

No.	Parameters	Test Conditions	Pin	Symbol	Min.	Typ.	Max.	Unit	Type*
3.0	Maximum linear output power	ACPR1 ≥ 33 dBc, ACPR2 ≥ 55 dBc		$P_{LIN}$		23		dBm	A
3.1	Linear power gain	$P_{OUT} = P_{LIN}$ , ACPR1 ≥ 33 dBc, ACPR2 ≥ 55 dBc		GL		32		dB	A
3.2	Current consumption	$P_{OUT} = P_{LIN}$ , ACPR1 ≥ 33 dBc, ACPR2 ≥ 55 dBc		$I_{CC}$		220		mA	A

\*) Type means: A = 100% tested, B = 100% correlation tested, C = Characterized on samples, D = Design parameter

## 8. Electrical Characteristics – 54 Mbps OFDM Modulation

Test Conditions measured on Atmel's evaluation board (unless otherwise stated):  $V_{CC} = 3.3V$ , Frequency = 2.45 GHz,  $T_{amb} = 25^{\circ}C$ , 54 Mbps OFDM modulation, conforming to IEEE 802.11g; 0.7% EVM measurement equipment noise floor is included in the EVM measurement result.

No.	Parameters	Test Conditions	Pin	Symbol	Min.	Typ.	Max.	Unit	Type*
4.0	Error vector magnitude	$P_{OUT} = 19$ dBm		EVM		2.0		%	A
4.1	Linear power gain	$P_{OUT} = 19$ dBm		GL		32		dB	A
4.2	Current consumption	$P_{OUT} = 19$ dBm		$I_{CC}$		150		mA	A

\*) Type means: A = 100% tested, B = 100% correlation tested, C = Characterized on samples, D = Design parameter

## 9. Power Detector

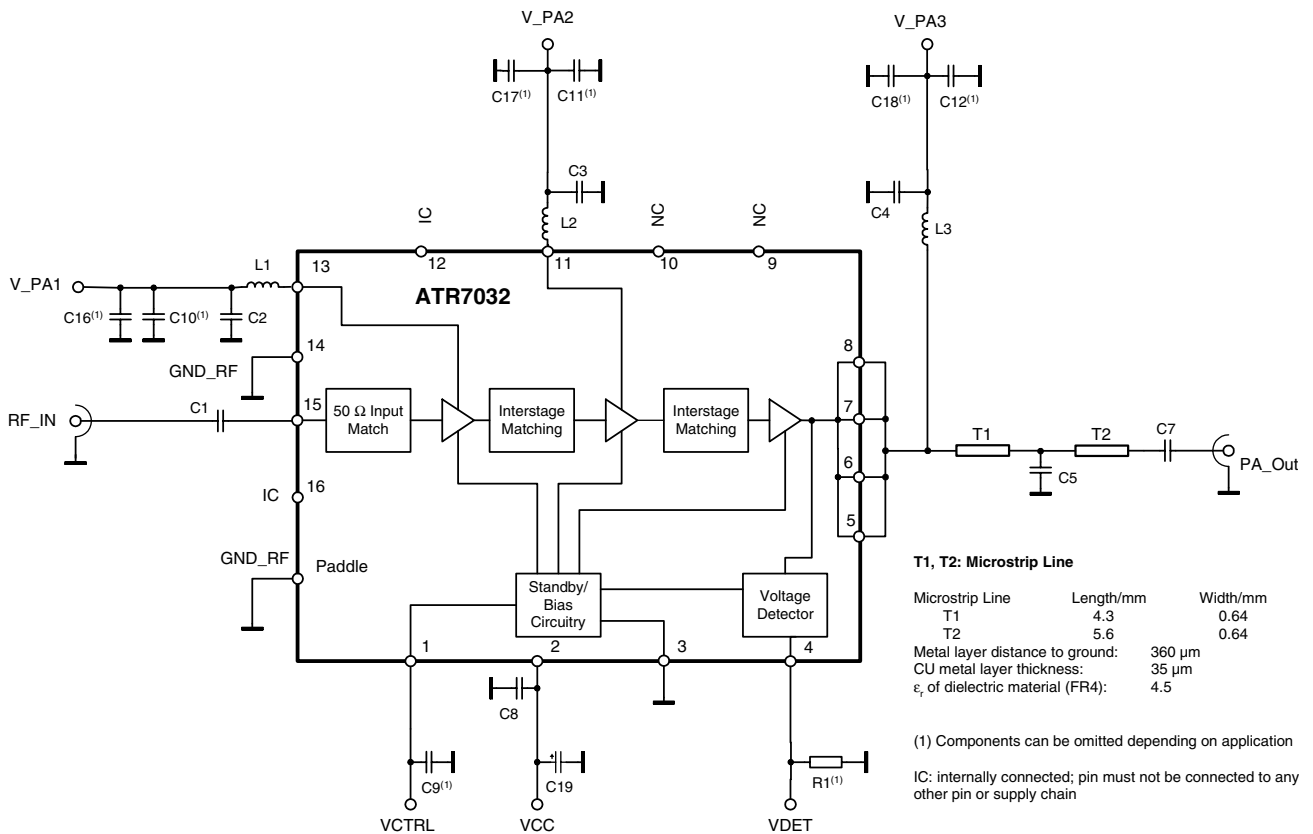
Test Conditions measured on Atmel's evaluation board (unless otherwise stated):  $V_{CC} = 3.3V$ , Frequency = 2.45 GHz,  $T_{amb} = 25^{\circ}C$

No.	Parameters	Test Conditions	Pin	Symbol	Min.	Typ.	Max.	Unit	Type*
5.0	Detector voltage range	$P_{OUT} = 5$ to 25 dBm		$V_{DET}$	0		2	V	A
5.1	Settling time	$P_{OUT} = 5$ to 25 dBm		$t_{SET}$		0.5		$\mu s$	C
5.2	Detector accuracy	$P_{OUT} = 5$ to 25 dBm $V_{CC} = 2.7$ to 3.6V $T_{amb} = -40$ to $+85^{\circ}C$		$\Delta P_{OUT}$		$\pm 0.7$		dB	C

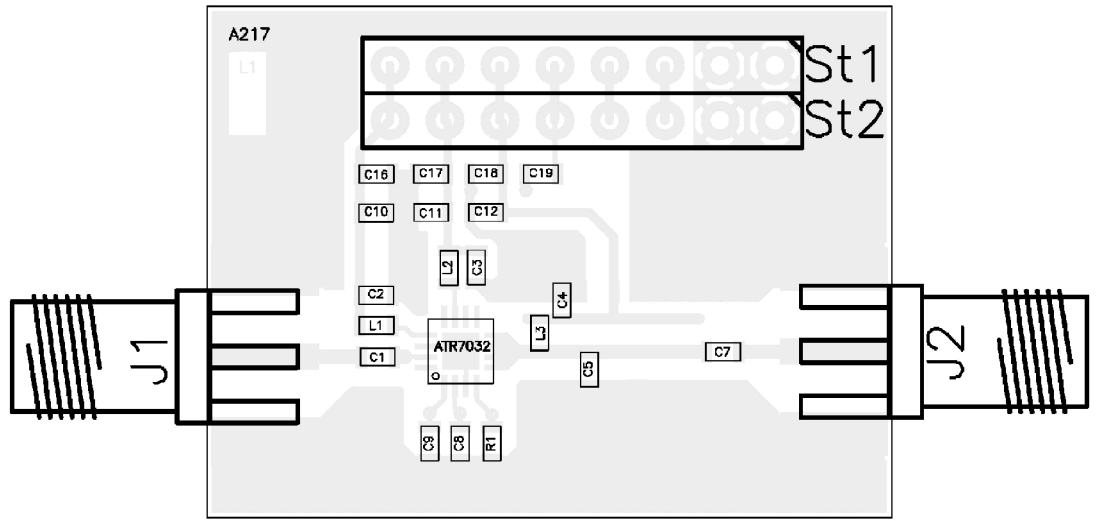
\*) Type means: A = 100% tested, B = 100% correlation tested, C = Characterized on samples, D = Design parameter

## 10. Application Circuit

Figure 10-1. Application Board Schematic



**Figure 10-2.** Application Board Layout



**Table 10-1.** Bill of Materials for Application Board

Component	Reference	Value	Size
Capacitor	C <sub>1</sub>	4p7	0603
Capacitor	C <sub>2</sub>	56p	0603
Capacitor	C <sub>3</sub>	56p	0603
Capacitor	C <sub>4</sub>	56p	0603
Capacitor	C <sub>5</sub>	1p8	0603
Capacitor	C <sub>7</sub>	4p7	0603
Capacitor	C <sub>8</sub>	4p7	0603
Capacitor	C <sub>9</sub>	4p7	0603
Capacitor	C <sub>10</sub> <sup>(1)</sup>	10n	0603
Capacitor	C <sub>11</sub> <sup>(1)</sup>	10n	0603
Capacitor	C <sub>12</sub> <sup>(1)</sup>	10n	0603
Capacitor	C <sub>16</sub> <sup>(1)</sup>	1μ	0603
Capacitor	C <sub>17</sub> <sup>(1)</sup>	1μ	0603
Capacitor	C <sub>18</sub> <sup>(1)</sup>	1μ	0603
Capacitor	C <sub>19</sub> <sup>(1)</sup>	1μ	0603
Resistor	R <sub>1</sub>	22k	0603
Inductor	L <sub>1</sub>	15n	0603
Inductor	L <sub>2</sub>	15n	0603
Inductor	L <sub>3</sub>	15n	0603

Note: 1. Components can be omitted depending on application

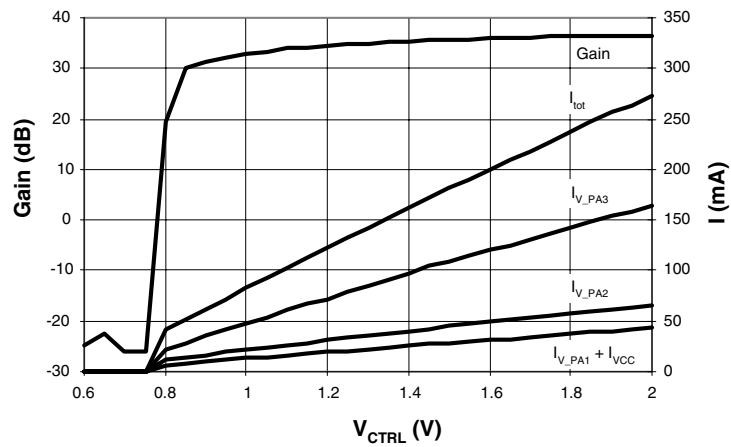
## 10.1 Evaluation Board Set-up Instructions

After connection of all cables (RF and DC):

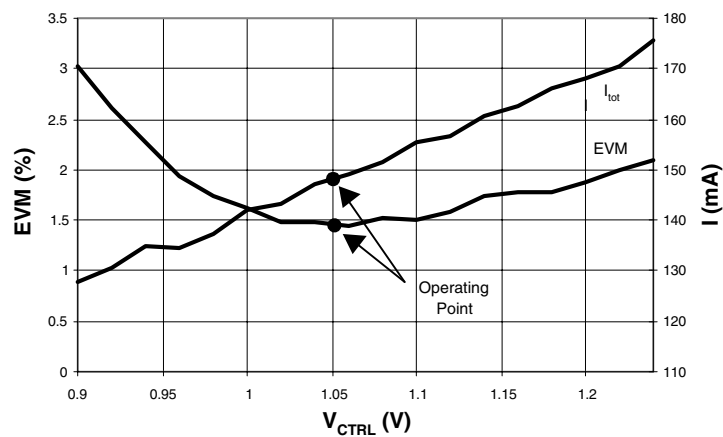
- $V_{CC}$ ,  $V_{V\_PA1}$ ,  $V_{V\_PA2}$ ,  $V_{RF\_Out} = 3.3V$
- Increase  $V_{CTRL}$  until 90 mA quiescent current without RF signal is reached (~ 1.05V)
- Increase input power until desired linear output power is reached

## 11. Typical Operating Characteristics

**Figure 11-1.** Typical Gain and Current versus Control Voltage:  
 Frequency = 2450 MHz;  $P_{In} = -40$  dBm;  $V_{V\_PA1} = V_{V\_PA2} = V_{RF\_Out} = V_{CC} = 3.3V$

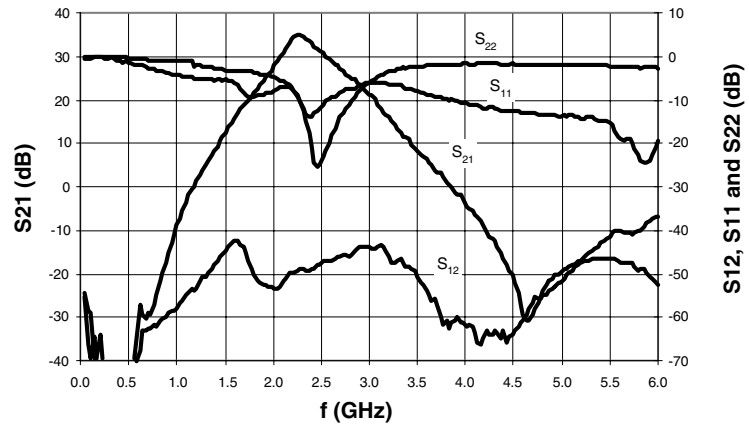


**Figure 11-2.** Typical Operating Point for 54 Mbps OFDM Modulation: Frequency = 2450 MHz;  
 $P_{Out} = 19$  dBm;  $V_{V\_PA1} = V_{V\_PA2} = V_{RF\_Out} = V_{CC} = 3.3V$

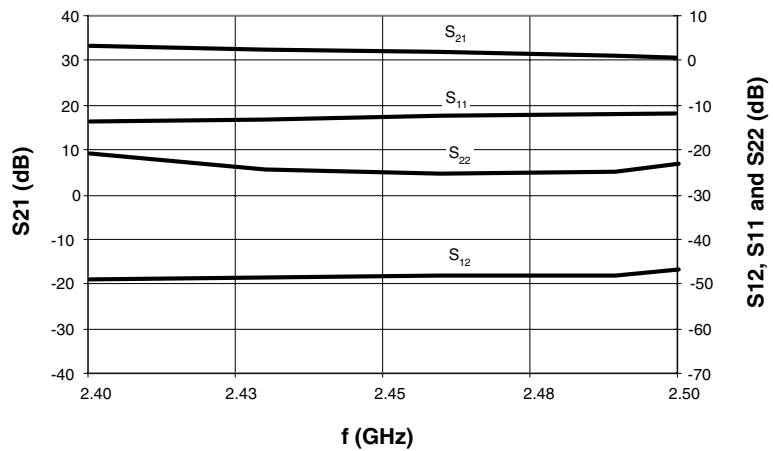




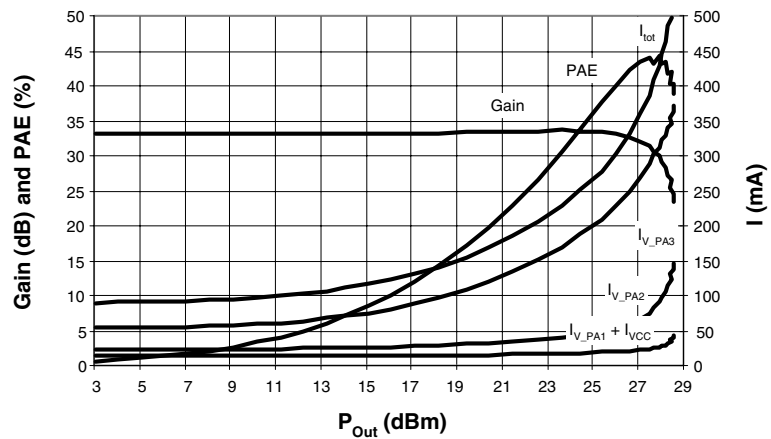
**Figure 11-3.** Typical S-Parameter at Operating Point:  $V_{CTRL} = 1.05V$ ;  $I_{CQ} = 90\text{ mA}$ ;  
 $V_{V\_PA1} = V_{V\_PA2} = V_{RF\_Out} = V_{CC} = 3.3V$



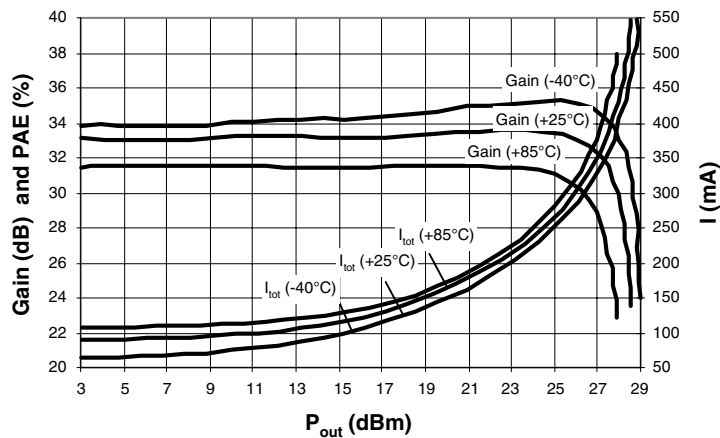
**Figure 11-4.** Typical S-Parameter at Operating Point (Detail):  $V_{CTRL} = 1.05V$ ;  $I_{CQ} = 90\text{ mA}$ ;  
 $V_{V\_PA1} = V_{V\_PA2} = V_{RF\_Out} = V_{CC} = 3.3V$



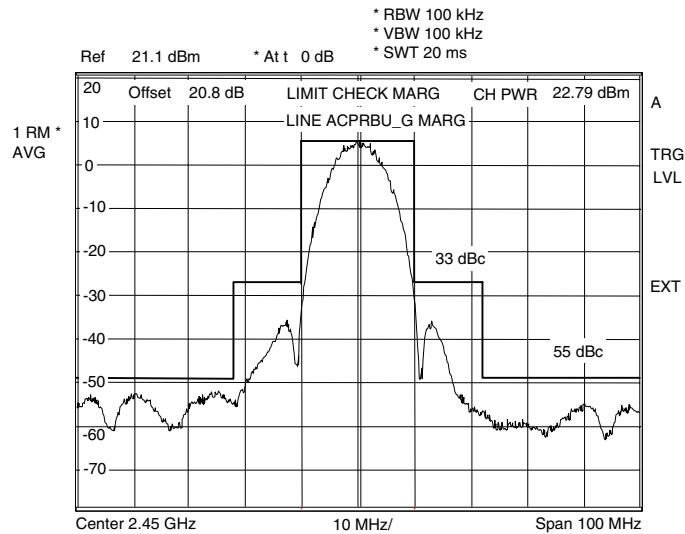
**Figure 11-5.** Typical Power-sweep with Unmodulated Carrier at Operating Point:  
 Frequency = 2450 MHz;  $V_{CTRL} = 1.05V$ ;  $I_{CQ} = 90\text{ mA}$ ;  
 $V_{V\_PA1} = V_{V\_PA2} = V_{RF\_Out} = V_{CC} = 3.3V$



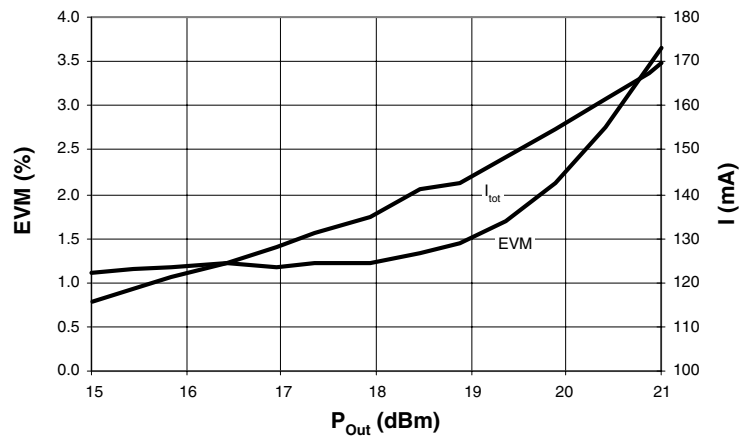
**Figure 11-6.** Typical Power-sweep with Unmodulated Carrier at Operating Point (Temperature Behaviour): Frequency = 2450 MHz;  $V_{CTRL} = 1.05V$ ;  $I_{CQ} = 90\text{ mA}$ ;  
 $V_{V\_PA1} = V_{V\_PA2} = V_{RF\_Out} = V_{CC} = 3.3V$



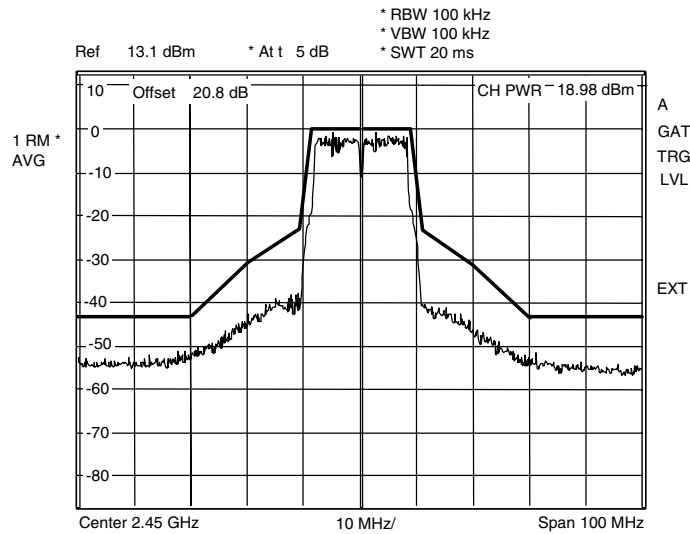
**Figure 11-7.** Typical Spectral Plot Conforming Compliance to 802.11b Spectral Mask for 11 Mbps CCK Modulation at Operating Point:  $P_{Out} = 23$  dBm; Frequency = 2450 MHz;  $V_{CTRL} = 1.05$ V;  $I_{CC} = 220$  mA;  $V_{V\_PA1} = V_{V\_PA2} = V_{RF\_Out} = V_{CC} = 3.3$ V



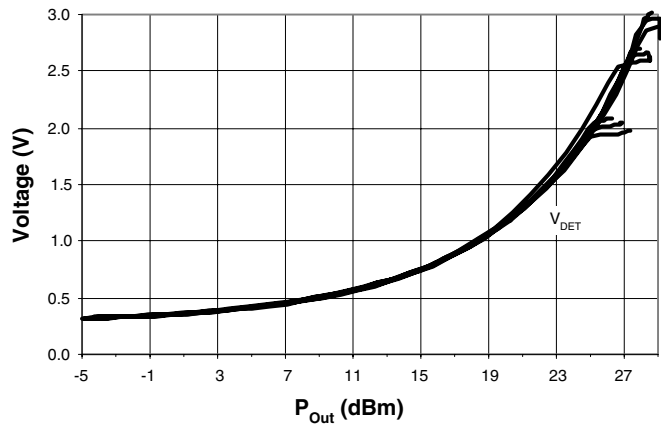
**Figure 11-8.** Typical Power-sweep with 54 Mbps OFDM Modulation at Operating Point: Frequency = 2450 MHz;  $V_{CTRL} = 1.05$ V;  $I_{CQ} = 90$  mA;  $V_{V\_PA1} = V_{V\_PA2} = V_{RF\_Out} = V_{CC} = 3.3$ V



**Figure 11-9.** Typical Spectral Plot Conforming Compliance to 802.11g Spectral Mask for 54 Mbps OFDM Modulation at Operating Point:  
 $P_{Out} = 23 \text{ dBm}$ ; Frequency = 2450 MHz;  $V_{CTRL} = 1.05\text{V}$ ;  $I_{CC} = 150 \text{ mA}$ ;  
 $V_{V\_PA1} = V_{V\_PA2} = V_{RF\_Out} = V_{CC} = 3.3\text{V}$

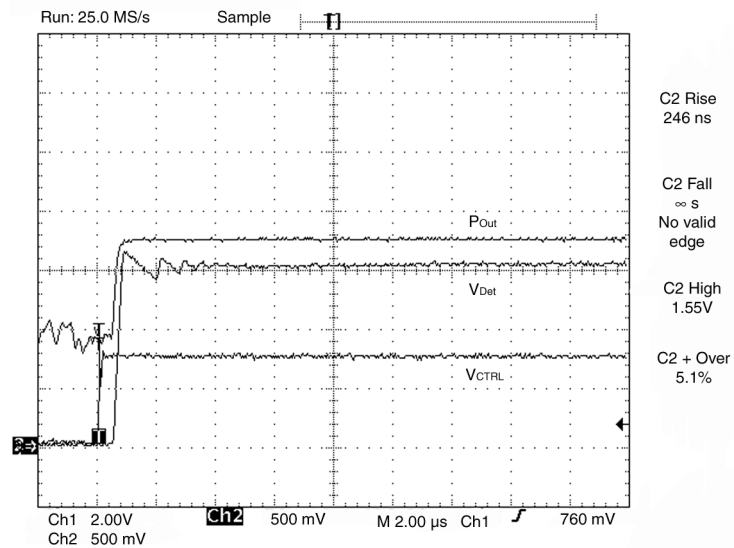


**Figure 11-10.** Typical Detector Voltage versus  $P_{Out}$  for Unmodulated Carrier (Temperature and VCC parameterized): Frequency = 2450 MHz;  $V_{CTRL} = 1.05 \text{ V}$ ;  $I_{CQ} = 90 \text{ mA}$ ;  
 $V_{V\_PA1} = V_{V\_PA2} = V_{RF\_Out} = V_{CC} = 2.7\text{V}, 3.3\text{V}, 3.6\text{V}$ ;  $T_{amb} = -40^\circ\text{C}, 25^\circ\text{C}, 85^\circ\text{C}$



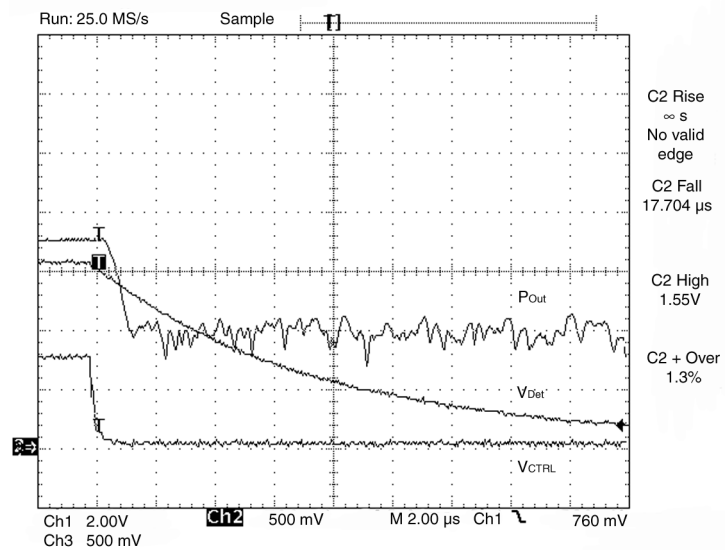
**Figure 11-11. Power Detector Response (Rising Edge):**

$P_{Out} = 23 \text{ dBm}$ ; Frequency = 2450 MHz;  $V_{CTRL} = 1.05\text{V}$ ;  $I_{CQ} = 90 \text{ mA}$ ;  
 $V_{V\_PA1} = V_{V\_PA2} = V_{RF\_Out} = V_{CC} = 3.3\text{V}$



**Figure 11-12. Power Detector Response (Falling Edge):**

$P_{Out} = 23 \text{ dBm}$ ; Frequency = 2450 MHz;  $V_{CTRL} = 1.05\text{V}$ ;  $I_{CQ} = 90 \text{ mA}$ ;  
 $V_{V\_PA1} = V_{V\_PA2} = V_{RF\_Out} = V_{CC} = 3.3\text{V}$



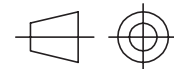
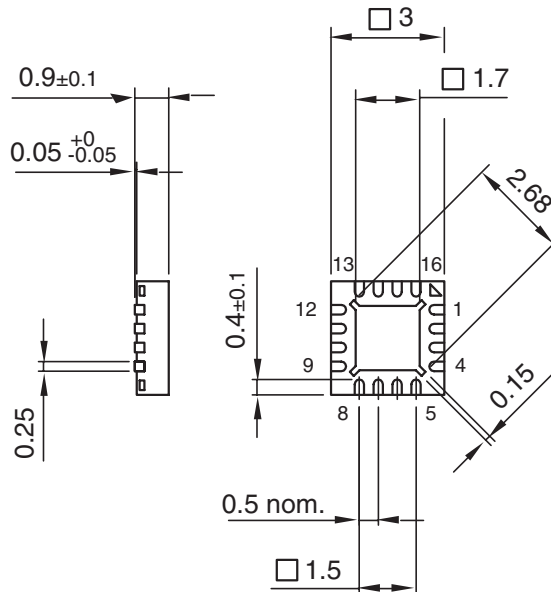
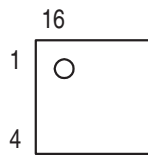
## 12. Ordering Information

Extended Type Number	Package	Remarks	MOQ
ATR7032-PVPW	QFN16, 3 × 3	Taped and 80 mm reeled, RoHs compliant	6000 pcs.
ATR7032-PVQW	QFN16, 3 × 3	Taped and 330 mm reeled, RoHs compliant	1500 pcs.
ATR7032-DEV-BOARD	–	Evaluation board	1

## 13. Package Information

Package: QFN 16 - 3x3  
 Exposed pad 1.7x1.7  
 (acc. JEDEC OUTLINE No. MO-220)  
 Dimensions in mm

Not indicated tolerances  $\pm 0.05$



technical drawings  
 according to DIN  
 specifications

Drawing-No.: 6.543-5115.01-4

Issue: 1; 07.03.05

Assembly Chip PAC



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