Features

- **Frequency Range 2.4 GHz to 2.5 GHz**
- **Supply Voltage 2.7 V to 3.6 V**
- **21 dBm Linear Output Power for IEEE 802.11b Mode**
- **3.5% EVM at 15.5 dBm Output Power for IEEE 802.11g Mode**
- **On-chip Power Detector with 20 dB Dynamic Range**
- **Power-down Mode and Biasing Control**
- **No External Components for Input Matching**
- **Low Profile Plastic Package QFN16 (4 × 4 × 0.9 mm)**

Benefits

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

Electrostatic sensitive device.
Observe precautions for handling.

Description

Circuitry

The PA's is designed for low current-consumption 802.11b and 802.11g multi-mode applications such as Mini-PCI and PCMCIA for portable devices. The low profile plastic package with internal input matching to 50 Ω 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 as well as a linear adjustment of output power. The PA is realized as a two stage PA with internal interstage-matching and an open-collector output structure.

Process

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

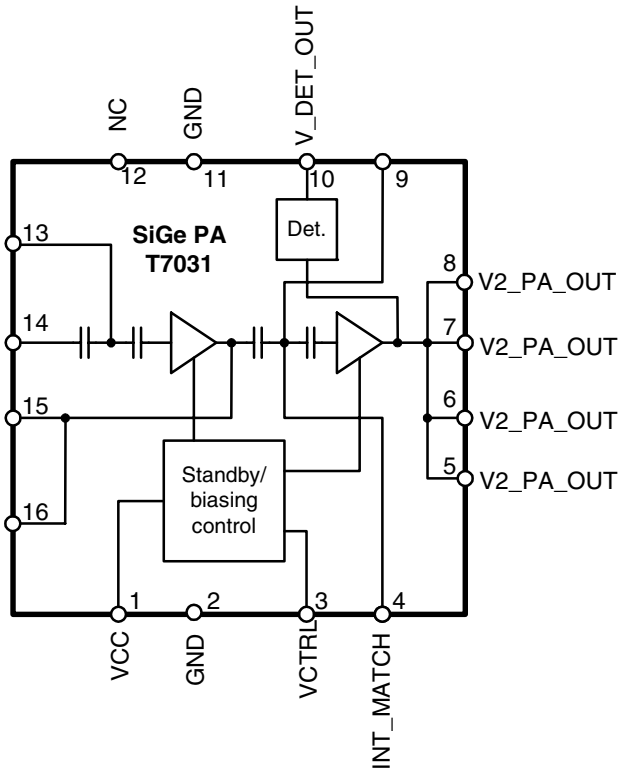
2.4-GHz SiGe Power Amplifier for 802.11b/g WLAN Systems

T7031

Preliminary

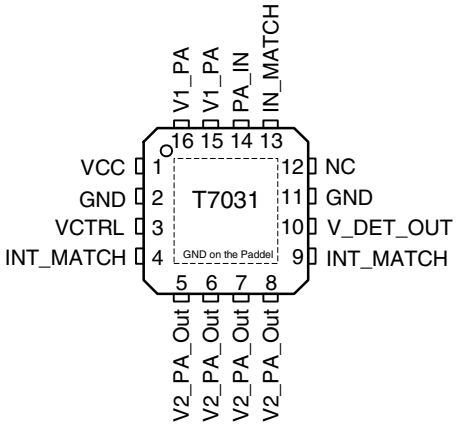
Rev. 4564F–WLAN–07/04

Figure 1. Block Diagram



Pin Configuration

Figure 2. Pinning QFN16



Pin Description

Pin	Symbol	Function
1	VCC	Supply voltage
2	GND	Ground
3	VCTRL	Power-up/biasing control voltage
4	INT_MATCH	Interstage matching (must not be connected)
5	V2_PA_Out	Power amplifier output and supply voltage for 2nd power amplifier stage
6	V2_PA_Out	Power amplifier output and supply voltage for 2nd power amplifier stage
7	V2_PA_Out	Power amplifier output and supply voltage for 2nd power amplifier stage
8	V2_PA_Out	Power amplifier output and supply voltage for 2nd power amplifier stage
9	INT_MATCH	Interstage matching (must not be connected)
10	V_DET_OUT	Power detector output
11	GND	Ground
12	NC	Not connected
13	IN_MATCH	Input matching (must not be connected)
14	PA_IN	Power amplifier input
15	V1_PA	Supply voltage for 1st power amplifier stage
16	V1_PA	Supply voltage for 1st power amplifier stage
Slug	–	Ground

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	Symbol	Value	Unit
Supply voltage, no RF voltage applied	V_{CC}	6	V
Supply current	I_{CC}	200	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_{CTRL}	0 to 3	V

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

Thermal Resistance

Parameters	Symbol	Value	Unit
Junction ambient	R_{thJA}	45	K/W

Operating Range

Parameters	Symbol	Value	Unit
Supply voltage range	V_{CC}	2.7 to 3.6	V
Ambient temperature range	T_{amb}	-30 to +80	°C

Electrical Characteristics

No.	Parameters	Test Conditions	Pin	Symbol	Min.	Typ.	Max.	Unit	Type*
1.0	Supply voltage			V_{CC}	2.7	3.3	3.6	V	A
1.1	Frequency Range			f	2400		2500	MHz	A
1.2	Control voltage range	PA operating mode		V_{CTRL}	1		2	V	A
1.3		Power-down Mode		V_{CTRL}			0.2	V	A
1.4	Current Consumption	Quiescent		I_{CQ}		75		mA	A
1.5		Power-down mode		I_{PD}			10	µA	A

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

Electrical Characteristics - Unmodulated Carrier

Test conditions (unless otherwise stated): V_{CC} = 3.3 V, Frequency = 2.45 GHz, T_{amb} = 25°C

No.	Parameters	Test Conditions	Pin	Symbol	Min.	Typ.	Max.	Unit	Type*
2.0	Saturated output power	For reference		P_{SAT}		24		dBm	A
2.1	P1dB output Power			P1dB		23		dBm	A
2.2	2nd harmonic rejection	P_{OUT} = 18 dBm, with external matching		$2f_{OUT}$		30		dB	A
2.3	Small signal gain	I_{CQ}, small signal condition		GL		22		dB	A
2.4	Reverse isolation	I_{CQ}, small signal condition		ISOr		40		dB	A
2.5	Input 50 Ω VSWR	I_{CQ}, small signal condition		VSWRin			2:1		C
2.6	Output 50 Ω VSWR	I_{CQ}, small signal condition, with external matching		VSWRout			2:1		C

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

Electrical Characteristics - 11 Mbps CCK Modulation

Test conditions (unless otherwise stated): V_{CC} = 3.3 V, Frequency = 2.45 GHz, T_{amb} = 25° C, IEEE 802.11b conform 11 Mbps CCK modulation with gaussian transmit filtering

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}		21		dBm	A
3.1	Linear power gain	$P_{OUT} = P_{LIN}$ ACPR1 ≥ 33 dBc ACPR2 ≥ 55 dBc		GL		22		dB	A
3.2	Current Consumption	$P_{OUT} = P_{LIN}$ ACPR1 ≥ 33 dBc ACPR2 ≥ 55 dBc		I_{CC}		130		mA	A

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

Electrical Characteristics - 54 Mbps OFDM Modulation

Test conditions (unless otherwise stated): V_{CC} = 3.3 V, Frequency = 2.45 GHz, T_{amb} = 25° C, IEEE 802.11g conform 54 Mbps OFDM modulation, 0.7% EVM measurement equipment noise floor included in EVM measurement result.

No.	Parameters	Test Conditions	Pin	Symbol	Min.	Typ.	Max.	Unit	Type*
4.0	Error vector magnitude	P_{OUT} = 15.5 dBm		EVM		3.5		%	C
4.1	Linear power gain	P_{OUT} = 15.5 dBm		GL		22		dB	A
4.2	Current consumption	P_{OUT} = 15.5 dBm		I_{CC}		85		mA	A

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

Power Detector

Test conditions (unless otherwise stated): V_{CC} = 3.3 V, Frequency = 2.45 GHz, T_{amb} = 25° C

No.	Parameters	Test Conditions	Pin	Symbol	Min.	Typ.	Max.	Unit	Type*
5.0	Detector voltage range	P_{OUT} = 2 to 22 dBm		V_{DET}	0		2	V	A
5.1	Settling time			t_{SET}		0.5		µs	C

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

Typical Operating Characteristics

Figure 3. Typical Gain and Current versus Control Voltage
Frequency = 2450 MHz, P_{IN} = -40 dBm, V_{CC} = 3.3 V

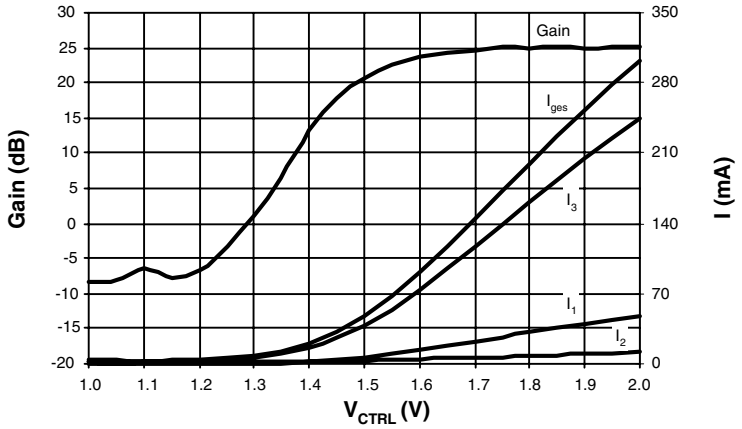


Figure 4. S-parameter, Magnitude

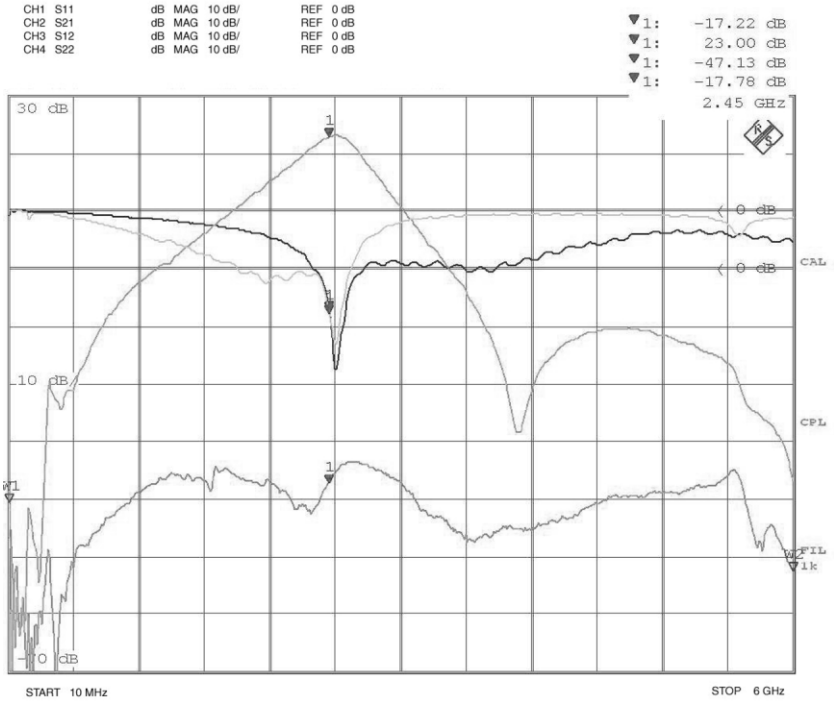


Figure 5. S-parameters, Magnitude and Phase

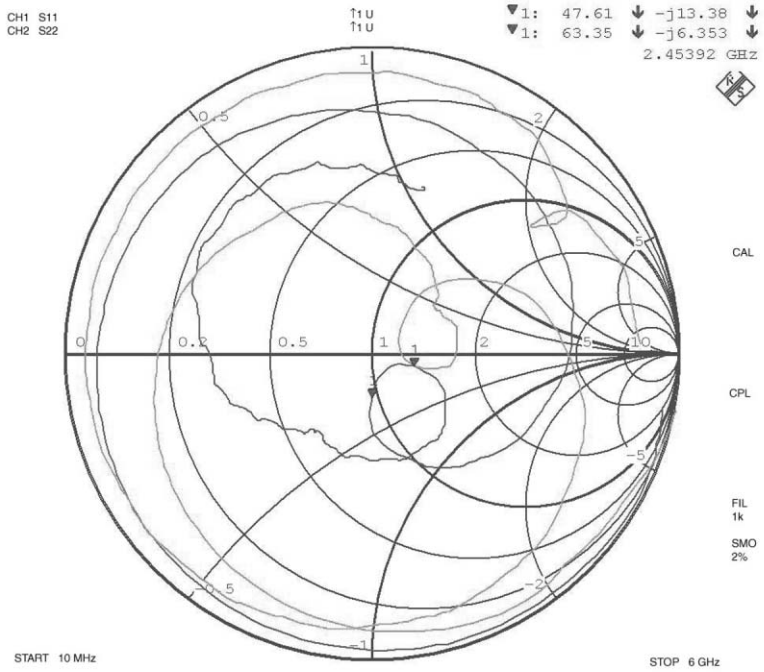


Figure 6. Power-sweep, CW-mode
Frequency = 2450 MHz, V_{CC} = 3.3 V, V_{CTRL} = 1.56 V

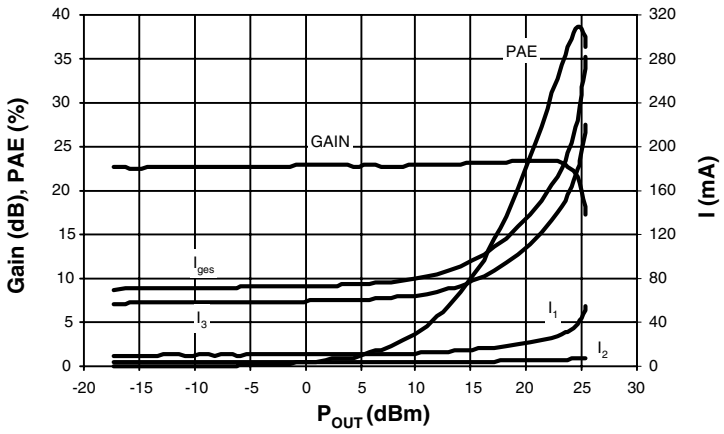


Figure 7. CCK-modulation Spectrum Conforming Compliance to 802.11b Spectral Mask (3/5 db Additional Margin at ACPR 1/2 Compared to Limit Given by IEEE802.11b Standard) at P_{OUT} = 21 dBm, V_{CC} = 3.3 V, V_{CTRL} = 1.56 V

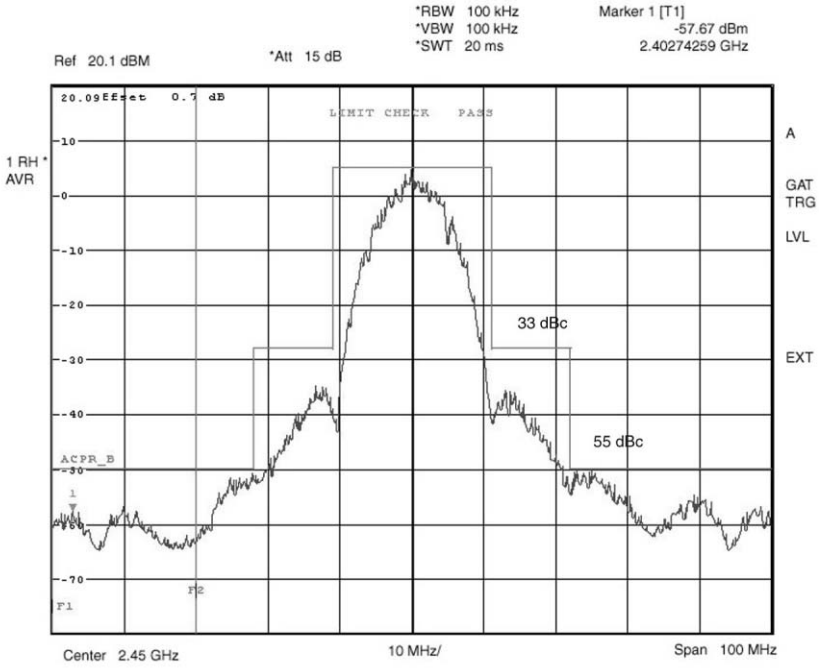


Figure 8. Frequency-sweep at P_{IN} = -1.9 dBm, V_{CC} = 3.3 V, V_{CTRL} = 1.56 V (ACPR Limit), CW-mode

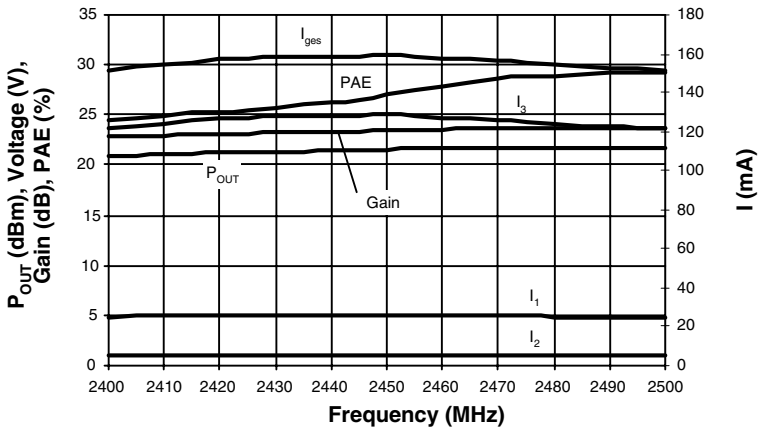


Figure 9. V_{CTRL}-sweep at Maximum Linear P_{OUT} (ACPR Limit), CW-mode, Frequency = 2450 MHz, P_{IN} = -1.9 dBm, V_{CC} = 3.3 V

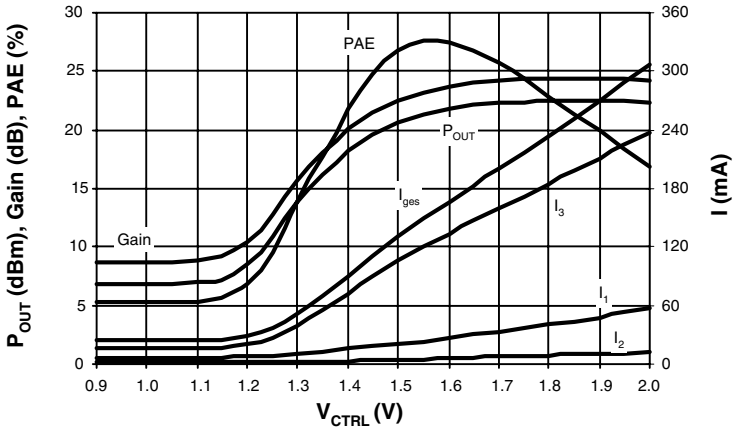


Figure 10. Error Vector Magnitude (EVM) for 54 MBit OFDM-modulation, Power Added Efficiency (PAE), Gain versus P_{OUT}

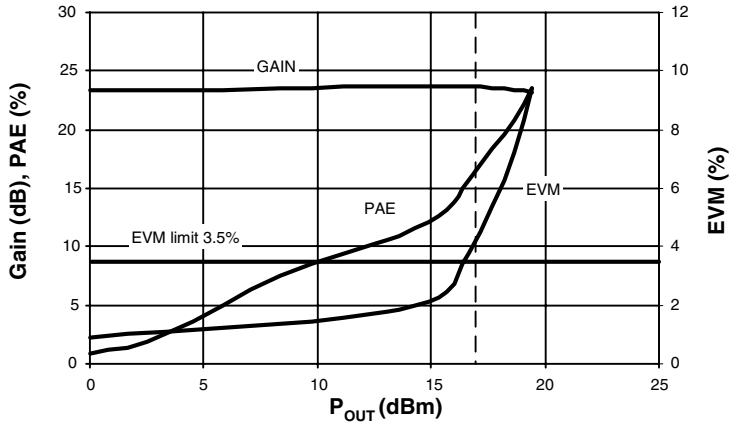


Figure 11. Frequency-sweep at EVM = 3.5% (EVM limit), CW-mode P_{IN} = -6.3 dBm, V_{CC} = 3.3 V, V_{CTRL} = 1.56 V

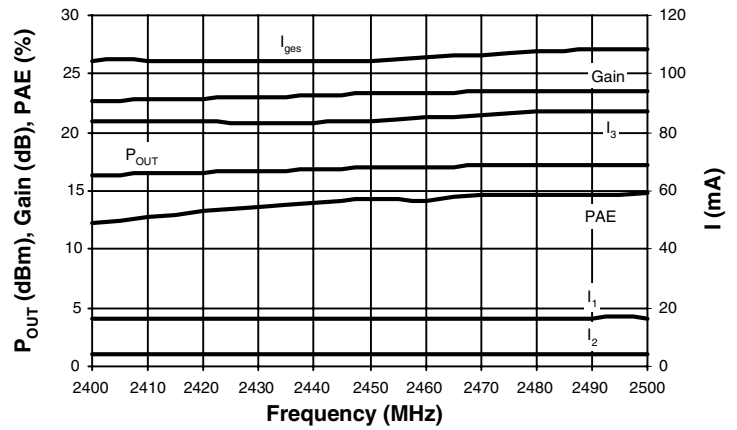


Figure 12. V_{CTRL}-sweep at EVM = 3.5% (EVM limit), CW-mode
Frequency = 2450 MHz, P_{IN} = -6.3 dBm, V_{CC} = 3.3 V

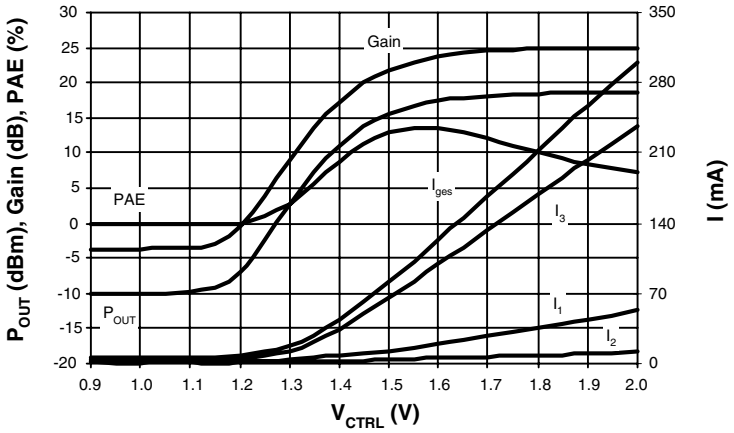


Figure 13. Power Detector Voltage versus P_{OUT} (Unmodulated Carrier), CW-Mode
Frequency = 2450 MHz, V_{CC} = 3.3 V, V_{CTRL} = 1.56 V

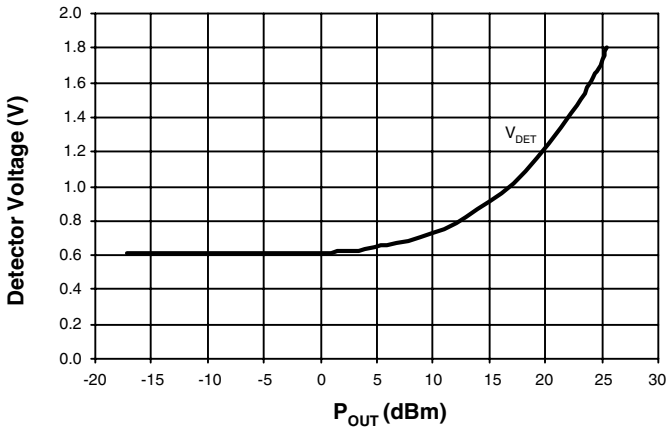


Figure 14. Power Detector Response Rising Edge

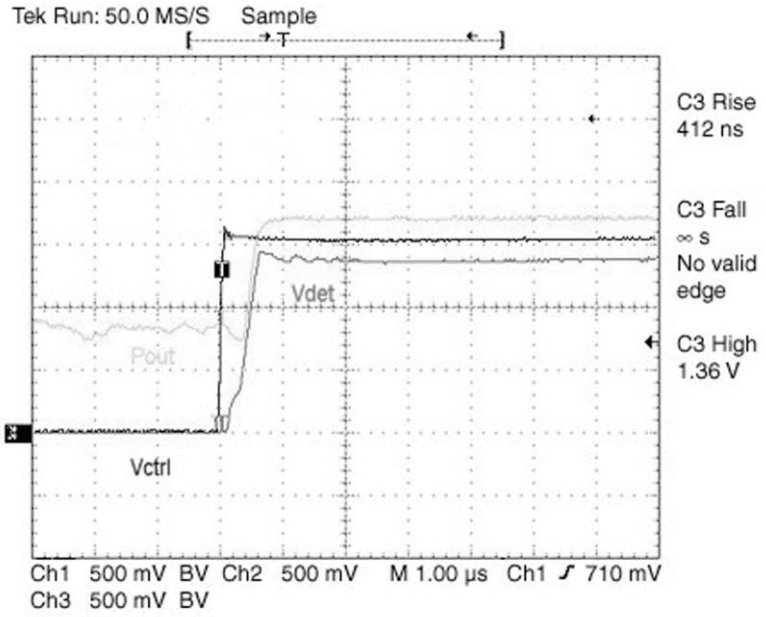
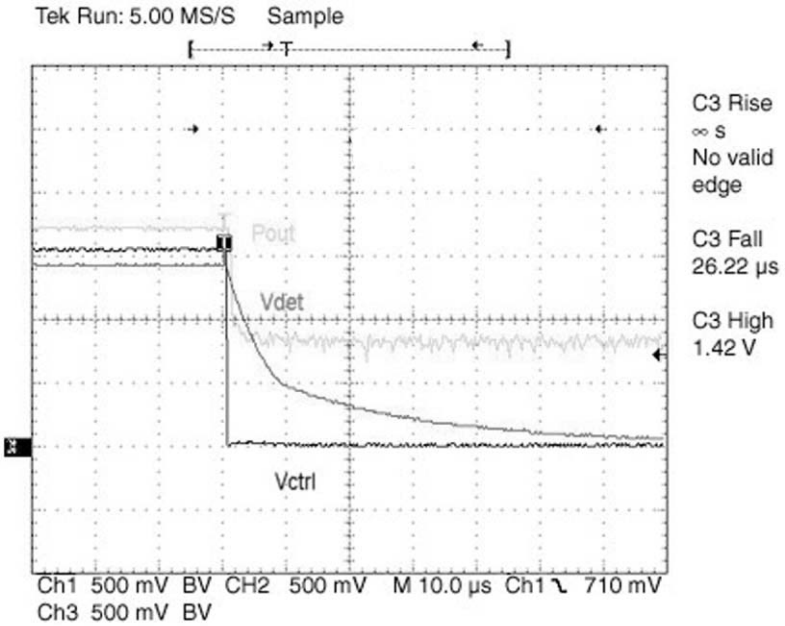
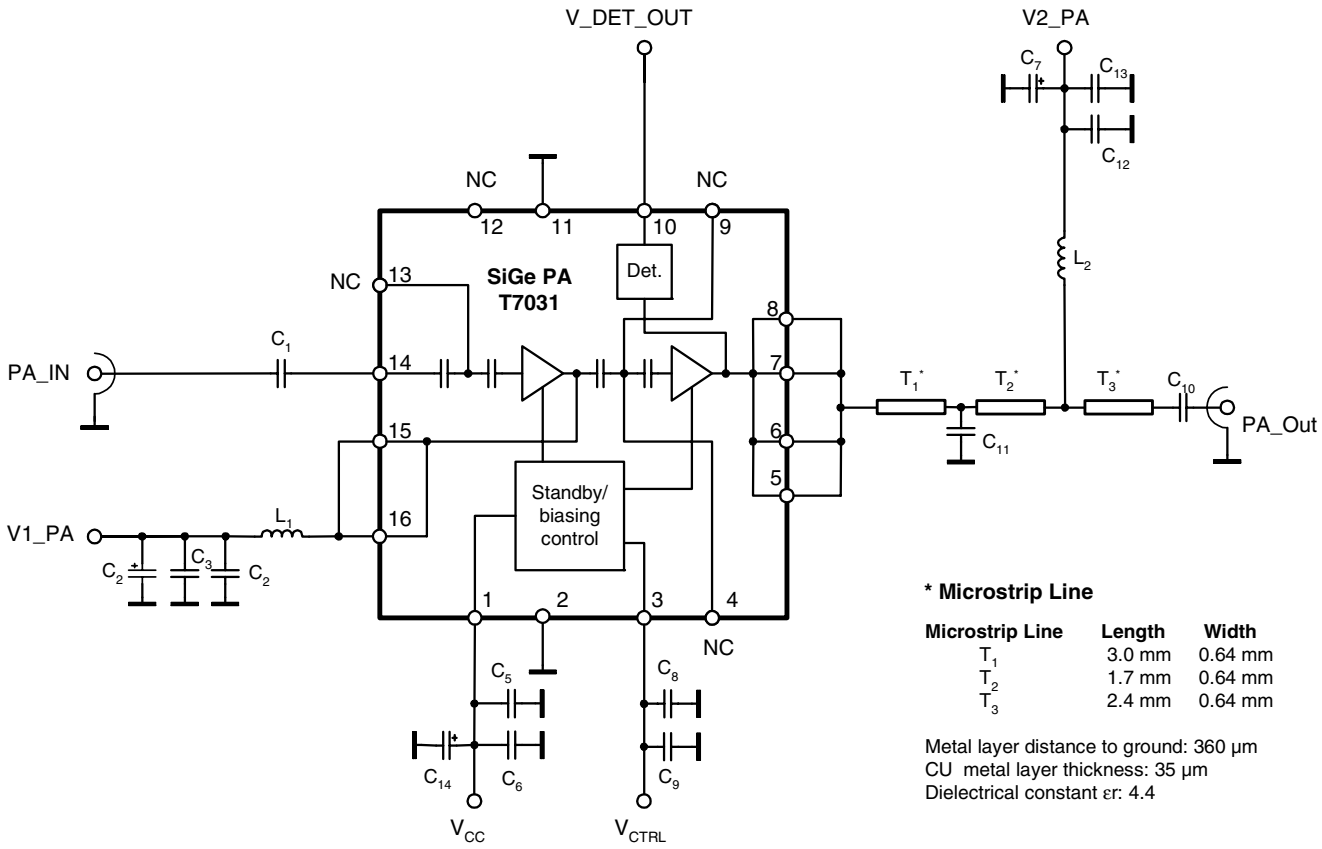


Figure 15. Power Detector Response Falling Edge



Evaluation Board Schematic

Figure 16. Schematic of the Evaluation Board



*** Microstrip Line**

Microstrip Line	Length	Width
T_1	3.0 mm	0.64 mm
T_2	1.7 mm	0.64 mm
T_3	2.4 mm	0.64 mm

Metal layer distance to ground: 360 µm
CU metal layer thickness: 35 µm
Dielectrical constant εr: 4.4

Evaluation Board Bill of Materials

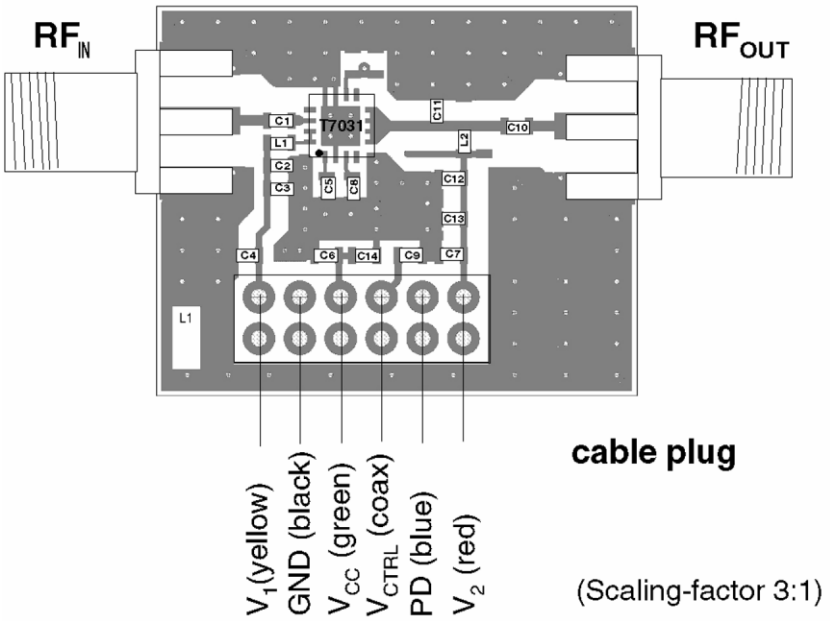
Table 1. Bill of Materials of the Evaluation Board

Component	Reference	Value	Size
Capacitor	C_1	4p7	0603
Capacitor	C_2	56p	0603
Capacitor	C_3	1n	0603
Capacitor	C_4 (1)	1µ	0603
Capacitor	C_5	4p7	0603
Capacitor	C_6 (1)	1n	0603
Capacitor	C_7 (1)	1µ	0603
Capacitor	C_8	4p7	0603
Capacitor	C_9 (1)	1n	0603
Capacitor	C_{10}	4p7	0603
Capacitor	C_{11}	2p2	0603
Capacitor	C_{12}	56p	0603
Capacitor	C_{13}	1n	0603
Capacitor	C_{14} (1)	1µ	0603
Inductor	L_1	22n	0603
Inductor	L_2	15n	0603

Note: 1. Can be omitted at optimum DC supply

Evaluation Board Layout

Figure 17. Layout of the Evaluation Board



Evaluation Board Set-up Institutions

After connection of all cables (RF and DC):

- V_{CC}, V_1, V_2 = 3.3 V
- Increase V_{CTRL} until 75 mA quiescent current is reached (V_{CTRL} ~ 1.55 V, at frequency = 2450 MHz, P_{IN} = -40 dBm)
- Unmodulated measurements:
  - Measure gain, P_{OUT}, PAE, currents, V_{DET} versus P_{IN}, V_{CTRL}, V_{CC}, frequency
- Modulated measurements: increase input power until desired linear output power is reached; this means in case of
  - 11 Mbps CCK Modulation →APCR measurement: P_{OUT} ~ 21 dBm
  - 54 Mbps OFDM Modulation →measurement of EVM (Error Vector Magnitude): P_{OUT} ~ 15.5 dBm

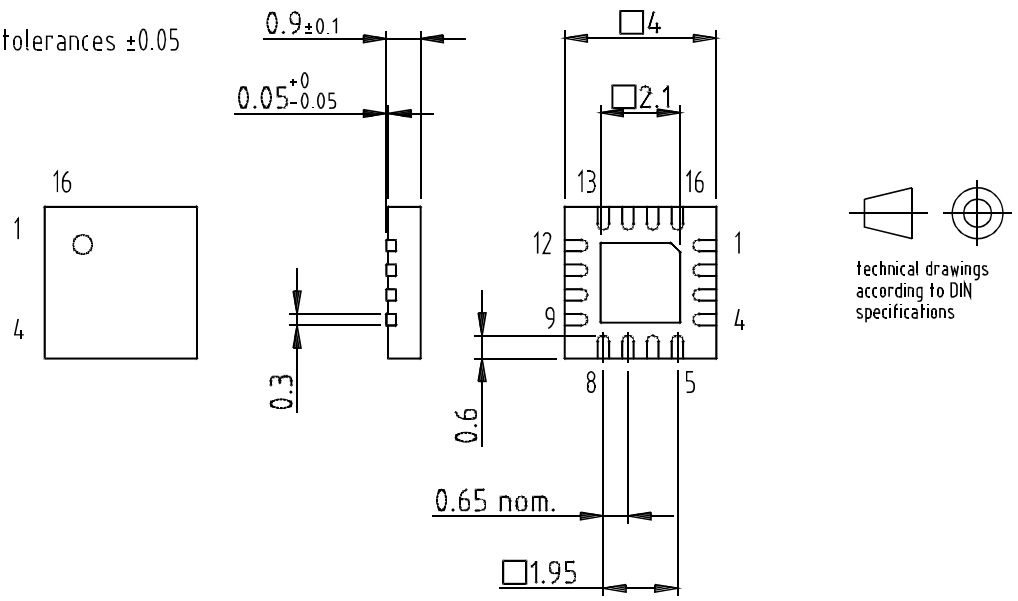
Ordering Information

Extended Type Number	Package	Remarks	MOQ
T7031-PEP	QFN16 - 4 x 4	Taped and reeled	1500 pcs.
T7031-PEQ	QFN16 - 4 x 4	Taped and reeled	6000 pcs.
T7031-PEPM	QFN16 - 4 x 4	Taped and reeled Pb free, halogen free	1500 pcs.
T7031-PEQM	QFN16 - 4 x 4	Taped and reeled Pb free, halogen free	6000 pcs.
Demoboard-T7031	–	Evaluation board	1

Package Information

Package: QFN 16 - 4x4
Exposed pad 2.1x2.1
(acc. JEDEC OUTLINE No. MO-220)
Dimensions in mm

Not indicated tolerances ±0.05



Drawing-No.: 6.543-5090.01-4
Issue: 2; 24.01.03

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