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WLAN Modules

Series/type: **D6101**
Ordering code: **B30810-D6101-Q819**

Date: June 19, 2008
Version: 02

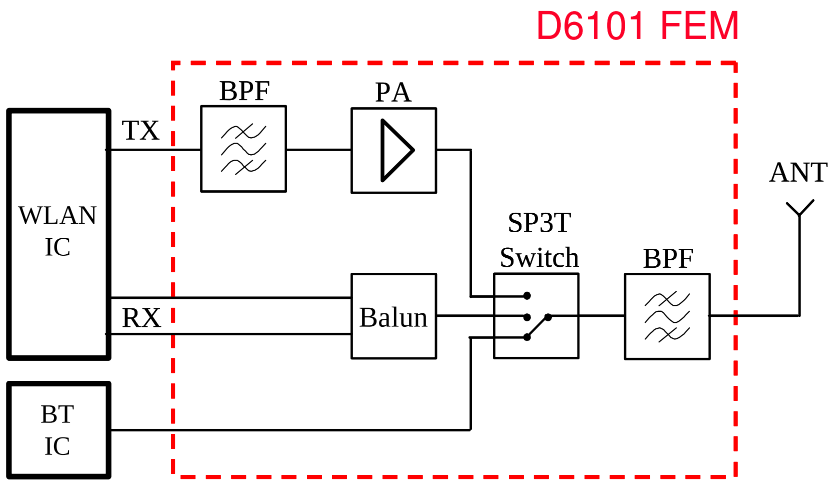
Change History

D6101_M01	07.04.08	Initial datasheet release	Alexander Chernyakov
D6101_M02	19.06.08	802.11n performance figures added	Alexander Chernyakov

Features

- Miniature fully-integrated WLAN / Bluetooth frontend module for mobile phone applications
- Covering IEEE 802.11 b/g/n (WLAN) and Bluetooth frequency band at 2.4 GHz
- Integrated fully-matched power amplifier with power detector
- Integrated high-rejection filters for co-existance of cellular and WLAN radios
- Integrated high-isolation SP3T antenna switch
- Simple application circuit with minimum external component count
- Power supply from unregulated battery voltage
- Multifunctional ceramic package suitable for **S**urface **M**ounted **T**echnology (**SMT**)
- Module provides Ni/Au-plated pads and overmold encapsulation
- RoHS compliant

Block diagram



Type	Ordering code	Marking and Package according to	Packing according to
D6101 (dev.code R041)	**B30810-D6101-Q819**	C61157-A4-A54	F61074-V8207-Z000

Electrostatic **S**ensitive **D**evice (**ESD**)

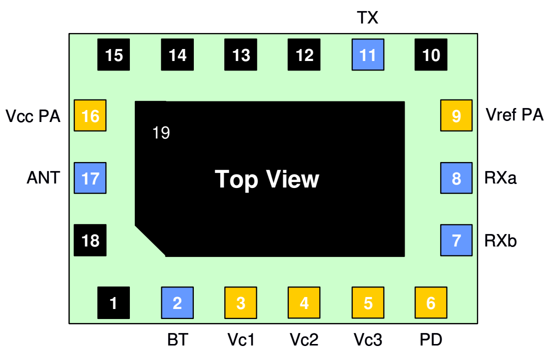
Maximum Ratings

Operation temperature range	T	-30... +85	°C
Storage temperature range	T_{stg}	-55... +125	°C
Max. input power on Tx Port	P_{in}	+5	dBm
Max. input power on RF Ports (except Tx)	P_{in}	+30	dBm
Max. control voltage (Switch)	Vctrl	+5.4	V
Max. supply voltage (PA)	Vcc	+5.4	V
Max. supply current (PA)	Imax	400	mA
Max. reference voltage (PA)	Vref	+3.0	V

ESD Ratings

Human Body Model	1000	V	JESD22-A114C
Machine Model	100	V	JESD22-A115A
Charge Device Model	500	V	JESD22-C101
Contact Discharge (ANT pin)	8	kV	IEC60001-2-4

Pin configuration



Pin assignment:

1 - GND
2 - Bluetooth
3 - Vc1 (switch control)
4 - Vc2 (switch control)
5 - Vc3 (switch control)
6 - Power detector output
7 - RXb (balanced)
8 - RXa (balanced)
9 - Vref PA
10 - GND
11 - TX
12 - GND
13 - GND
14 - GND
15 - GND
16 - Vcc PA
17 - ANT
18 - GND
19 - GND (center ground pad)

Switch Control Logic

	ANT - BT	ANT - TX	ANT - RX	All Off
Vc1	High	Low	Low	Low
Vc2	Low	High	Low	Low
Vc3	Low	Low	High	Low

Bias and Switch Characteristics

Switch control voltage High	V_{CTRL}	2.7 … 4.5	V
Switch control voltage Low	V_{CTRL}	0 ... 0.2	V
Switch control voltage High (reduced linearity)	V_{CTRL}	1.8 … 2.7*	V
Switch control current max.	I_{CTRL}	50	µA
Switching time max.	T_{SW}	100	ns
Switch IP1dB	IP1dB	+29..32	dBm
PA supply voltage	V_{CC}	3.1 … 4.5**	V
PA reference voltage	V_{REF}	2.8 +/- 0.1***	V

* IP1dB ≥ +27 dBm, IP0.1dB ≥ +24 dBm.

** unregulated battery operation is possible.

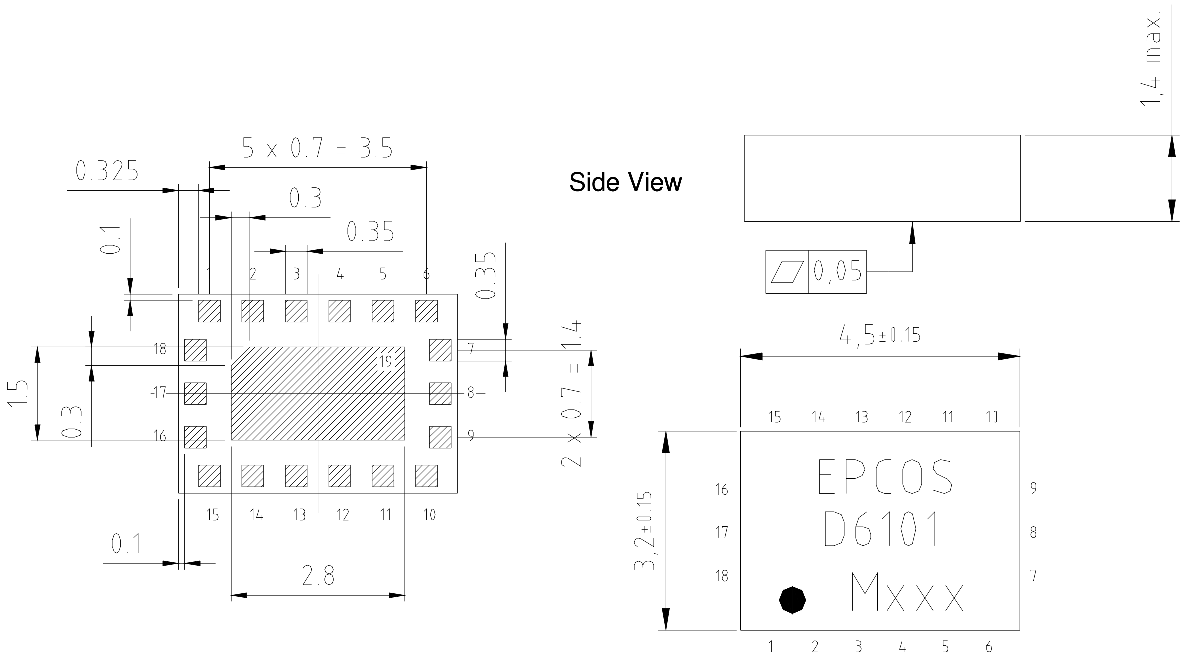
*** with an external serial resistor of 51..68 Ohm (see application schematic on page 19)

Caution

! Setting the switch in the wrong state (RX or BT) during the TX mode (PA turned on, Vref and Vcc voltages applied) may damage the FEM if the output power is high (>+17 dBm). Please make sure that the software which controls the FEM does not allow this state during system operation or calibration. Alternatively, using the modified application circuit (see page 20) will force this state not to happen on hardware level. !

Mechanical Drawing

(ceramic package MC190E)

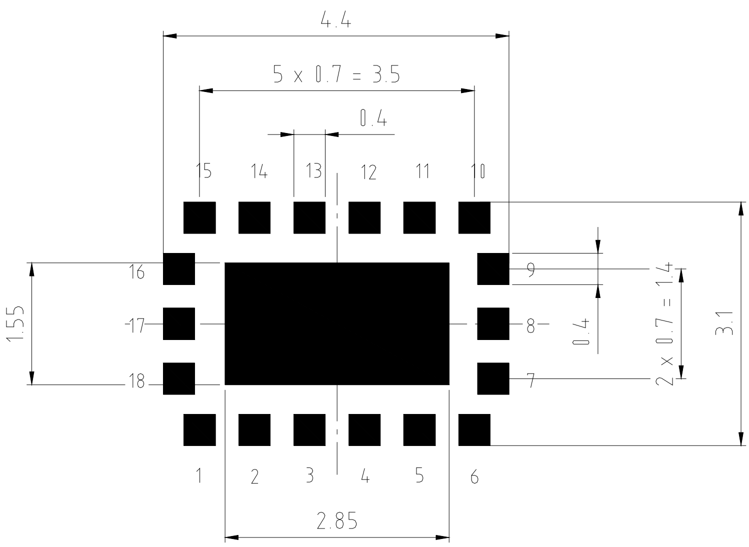


Side View

Bottom View

Top View

Recommended Board Footprint



All dimensions in mm.

Characteristics Bluetooth TX / RX Mode

Operating temperature range: T = -30 ... +85℃
Terminating impedances on all RF ports: Z = 50Ω

	min.	typ.	Max.	
Insertion loss				
2400 – 2500 MHz	-	3.3	4.0	dB
Amplitude Ripple				
2400 – 2500 MHz	-	-	1.5	dB
Return loss (TX/RX)				
2400 – 2500 MHz	10	15	-	dB
Return loss (ANT)				
2400 – 2500 MHz	10	15	-	dB
Frequency response				
DC – 824 MHz	48	60	-	dB
824 – 960 MHz	48	55	-	dB
960 – 1570 MHz	43	47	-	dB
1570 – 1580 MHz	43	47	-	dB
1580 – 1710 MHz	43	47	-	dB
1710 – 1850 MHz	43	50	-	dB
1850 – 1910 MHz	43	50	-	dB
1910 – 1990 MHz	42	50	-	dB
1990 – 2170 MHz	25	35	-	dB
3200 – 3500 MHz	-	15	-	dB
4800 – 5850 MHz	30	40	-	dB
7200 – 7500 MHz	18	25	-	dB

Characteristics WLAN RX Mode

Operating temperature range: T = -30 ... +85°C

Terminating impedances on all RF ports: Z = 50Ω

	min.	Typ.	Max.	
Insertion loss				
2400 – 2500 MHz	-	3.8	4.4	dB
Amplitude Ripple				
2400 – 2500 MHz	-	-	1.5	dB
Return loss (RX)				
2400 – 2500 MHz	10	15	-	dB
Return loss (ANT)				
2400 – 2500 MHz	10	15	-	dB
Frequency response				
DC – 824 MHz	48	60	-	dB
824 – 960 MHz	48	55	-	dB
960 – 1570 MHz	43	47	-	dB
1570 – 1580 MHz	43	47	-	dB
1580 – 1710 MHz	43	47	-	dB
1710 – 1850 MHz	43	50	-	dB
1850 – 1910 MHz	43	50	-	dB
1910 – 1990 MHz	40	50	-	dB
1990 – 2170 MHz	25	35	-	dB
3200 – 3500 MHz	-	15	-	dB
4800 – 5850 MHz	-	30	-	dB

Characteristics WLAN TX Mode *

Operating temperature range: T = -30 ... +85℃

Terminating impedances on all RF ports: Z = 50Ω

	Min.	Typ.	Max.	
Insertion gain				
2400 – 2500 MHz	24	27	-	dB
Gain variation (full band)				
2400 – 2500 MHz	-	-	2.0	dB
Return loss (TX)				
2400 – 2500 MHz	-	6	-	dB
Return loss (ANT)				
2400 – 2500 MHz	10	15	-	dB
Frequency response				
DC – 960 MHz	-20	-40	-	dB
960 – 1570 MHz	-30	-40	-	dB
1570 – 1580 MHz	-30	-40	-	dB
1580 – 1710 MHz	-25	-35	-	dB
1710 – 1850 MHz	-20	-30	-	dB
1850 – 1910 MHz	-20	-25	-	dB
1910 – 1990 MHz	-15	-22	-	dB
1990 – 2170 MHz	-10	-22	-	dB
3200 – 3500 MHz	-	7	-	dB
4800 – 5000 MHz	-	-45	-	dB
7200 – 7500 MHz	-	-35	-	dB
Output power in 802.11g mode, EVM < 3.3%				
54 Mbps OFDM				
Vcc=3.3V, Vref=2.8V, Ta=25℃	13	15	-	dBm
Added EVM in 802.11g mode				
54 Mbps OFDM @ +15dBm Pout				
Vcc=3.3V, Vref=2.8V, Ta=25℃	-	3.3	-	%

Output power in 802.11b mode 11 Mbps CCK Vcc=3.3V, Vref=2.8V, Ta=25°C	15	17	-	dBm
ACPR in 802.11b mode (1st/2nd sidelobe) 1 Mbps CCK @ +18dBm output Vcc=3.3V, Vref=2.8V, Ta=25°C	-	-	-30 / -50	dBc
Output power in 802.11n mode 40 MHz channel, 150 Mbps OFDM, 64 QAM 5/6 Vcc=3.3V, Vref=2.8V, Ta=25°C	-	14	-	dBm
Current consumption 54 Mbps OFDM @ +15 dBm Pout Vcc=3.3V, Vref=2.8V, Ta=25°C	-	130	180	mA
11 Mbps CCK @ +17 dBm Pout Vcc=3.3V, Vref=2.8V, Ta=25°C	-	150	220	mA
1dB compression point (at ANT pin) 54 Mbps OFDM signal Vcc=3.3V, Vref=2.8V, Ta=25°C	+17.0	+18.5	-	dBm
Tx Harmonics 1 Mbps CCK @ +18dBm Pout Vcc=3.3V, Vref=2.8V, Ta=25°C 4800 – 5000 MHz	-	-48	-42	dBm
7200 – 7500 MHz	-	-48	-42	dBm
Quiescent current Vcc=3.3V, Vref=2.8V, Ta=25°C	-	100	-	mA
Power detector voltage Vcc=3.3V, Vref=2.8V, Ta=25°C Pout=+10 dBm	0.2	0.4	-	V
Pout=+17 dBm	-	0.9	1.2	V

* Data shown for R5=68 Ohm (application circuits on pages 19..20)

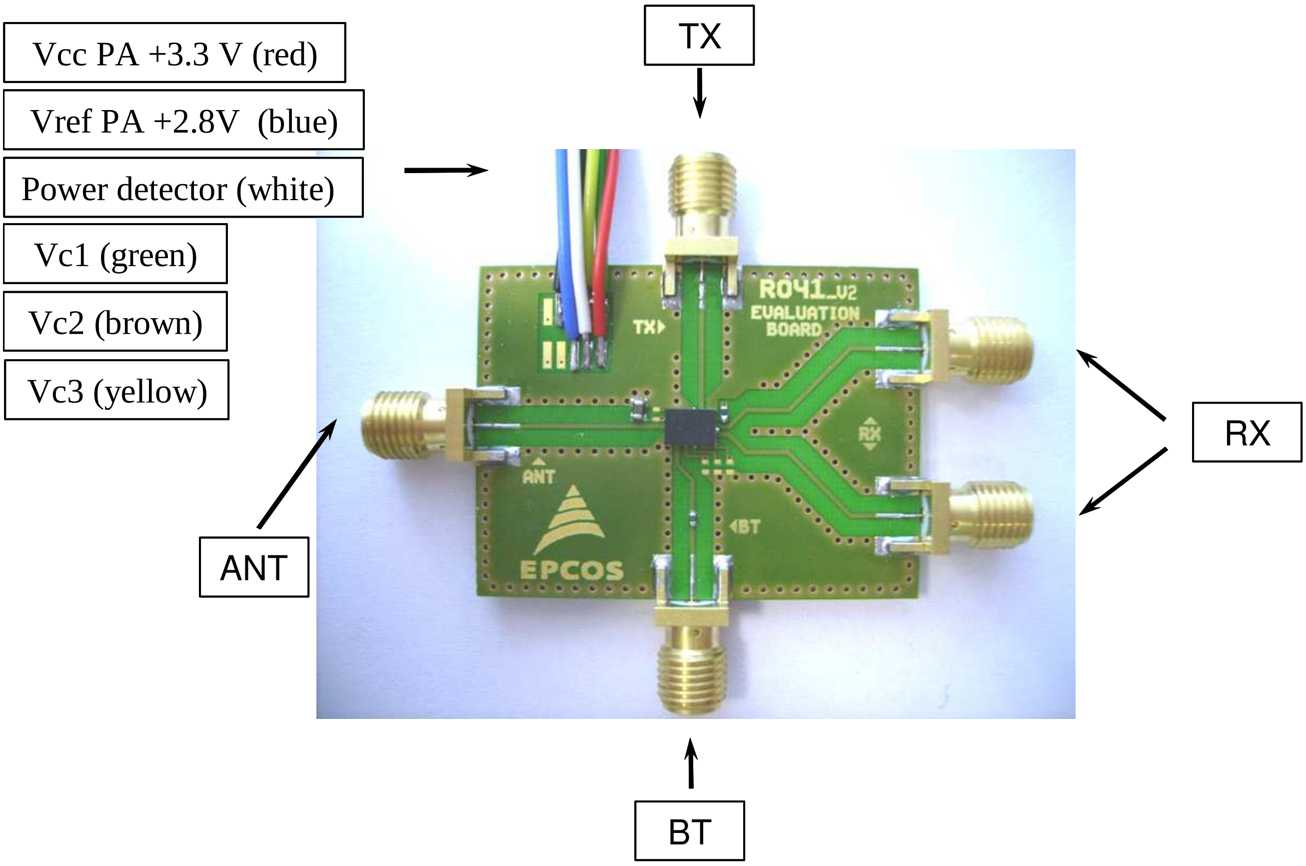
Characteristic Isolations

Operating temperature range: T = -30 ... +85℃

Terminating impedances on all RF ports: Z = 50Ω

	Min.	Typ.	Max.	
Isolation WLAN TX – WLAN RX				
2400 – 2500 MHz	20	-	-	dB
Isolation WLAN TX – BT				
2400 – 2500 MHz	20	-	-	dB
Isolation BT – WLAN RX				
2400 – 2500 MHz	25	-	-	dB
Isolation WLAN TX – ANT (Tx off)				
2400 – 2500 MHz	20	-	-	dB
Isolation WLAN RX – ANT (Rx off)				
2400 – 2500 MHz	20	-	-	dB
Isolation BT – ANT (BT off)				
2400 – 2500 MHz	20	-	-	dB

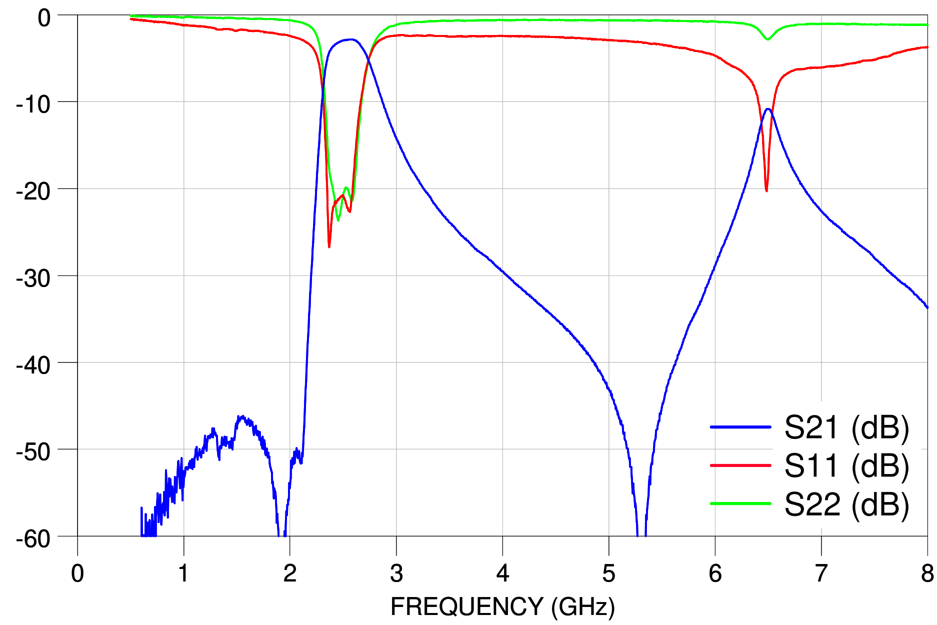
Evaluation Board



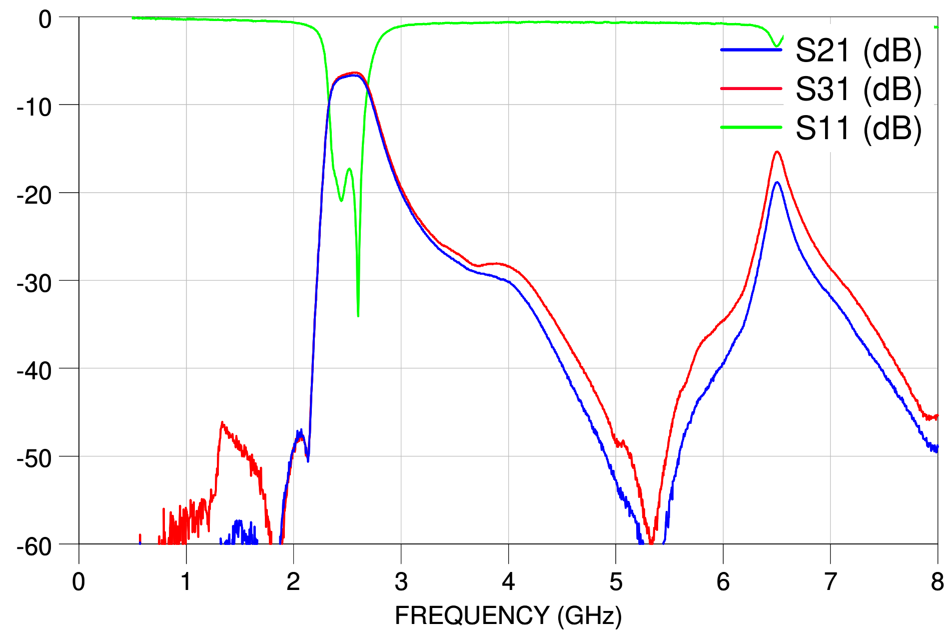
Evaluation PCB loss:

BT path	0.3 dB
RXa path	0.4 dB
RXb path	0.4 dB
TX path	0.3 dB

Typical characteristics Bluetooth TX / RX Mode (PCB loss included)

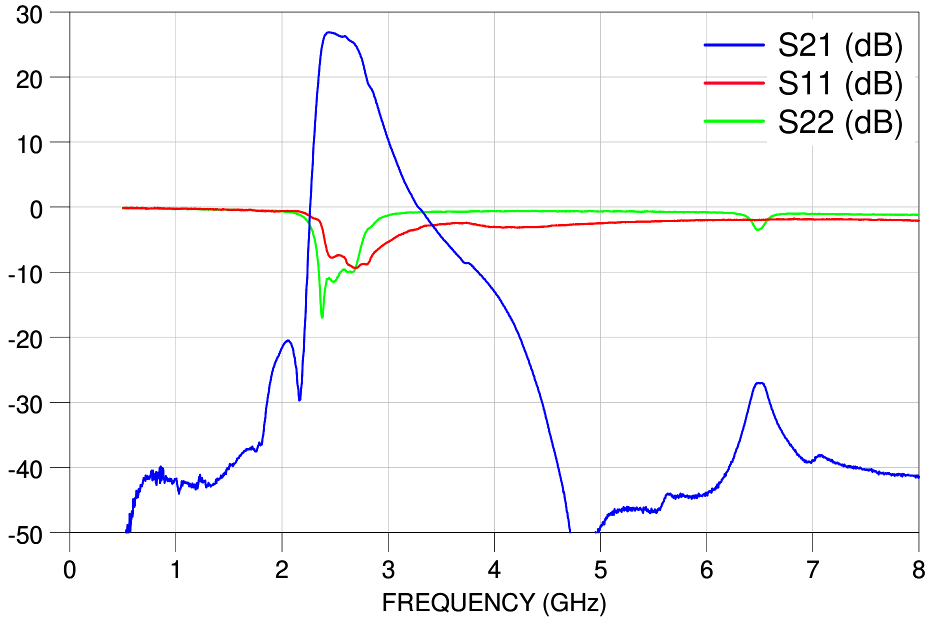


Typical characteristics WLAN RX Mode (PCB loss included)[1]

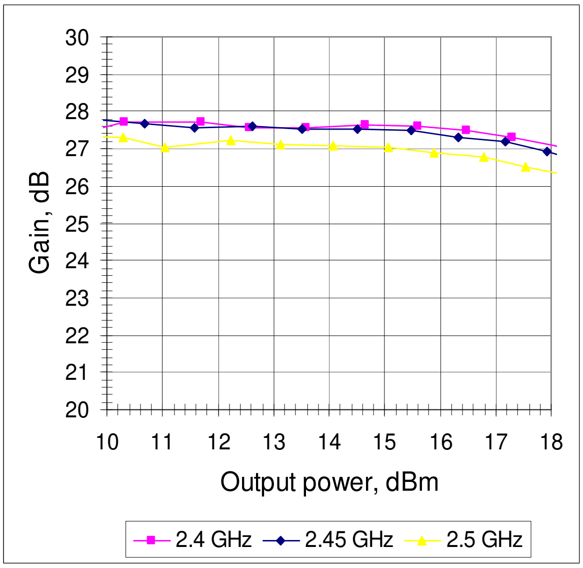


[1] - single-ended measurements. Actual insertion loss is 3 dB better when measuring balanced

Typical characteristics WLAN TX Mode (PCB loss included)*
(Vcc=3.3V, Vref=2.8V, Ta=25℃)

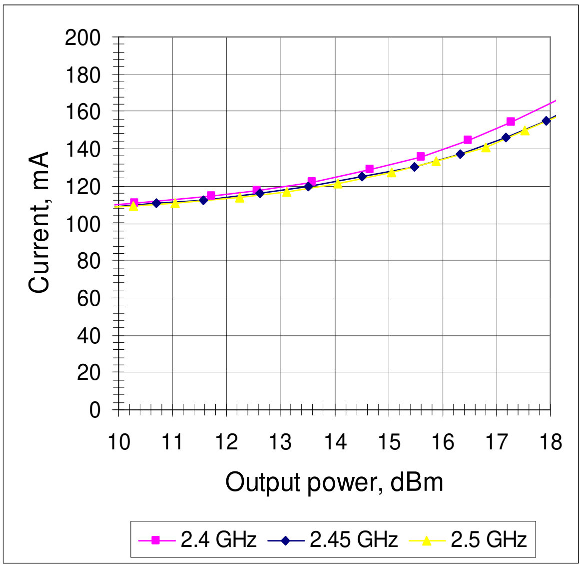


Typical Tx Gain*
(Measurement Conditions: 802.11g mode / 54 Mbps OFDM, duty cycle 99%,
Vcc=3.3V, Vref=2.8V, Ta=25℃, f=2.45 GHz)



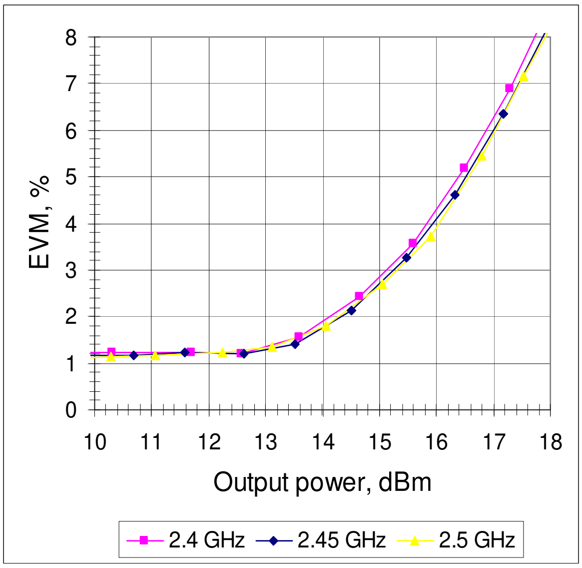
Typical Tx Power Consumption*

(Measurement Conditions: 802.11g mode / 54 Mbps OFDM, duty cycle 99%, Vcc=3.3V, Vref=2.8V, Ta=25°C, f=2.45 GHz).



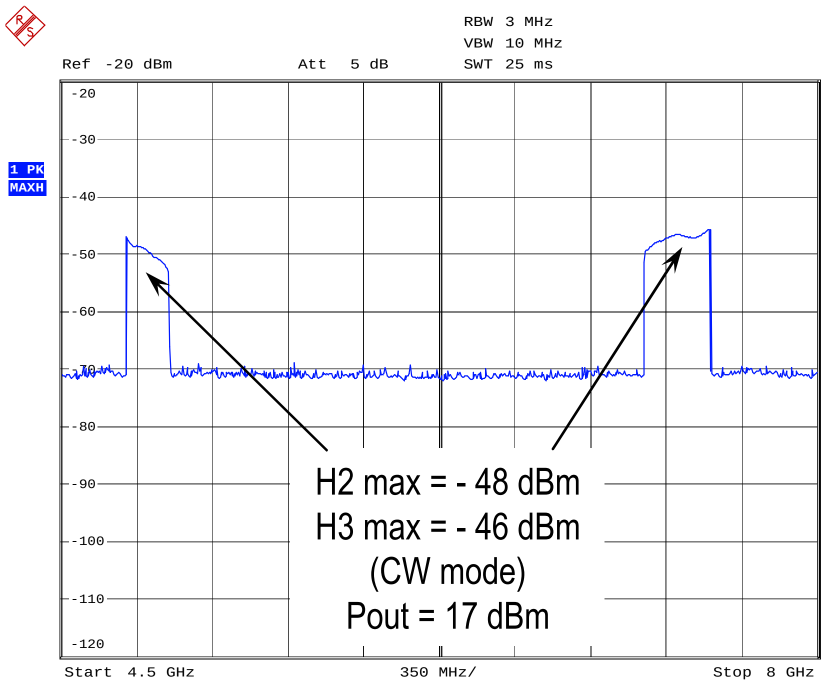
Typical EVM Performance*

(Measurement Conditions: 802.11g mode / 54 Mbps OFDM, duty cycle 99%, Vcc=3.3V, Vref=2.8V, Ta=25°C, f=2.45 GHz)



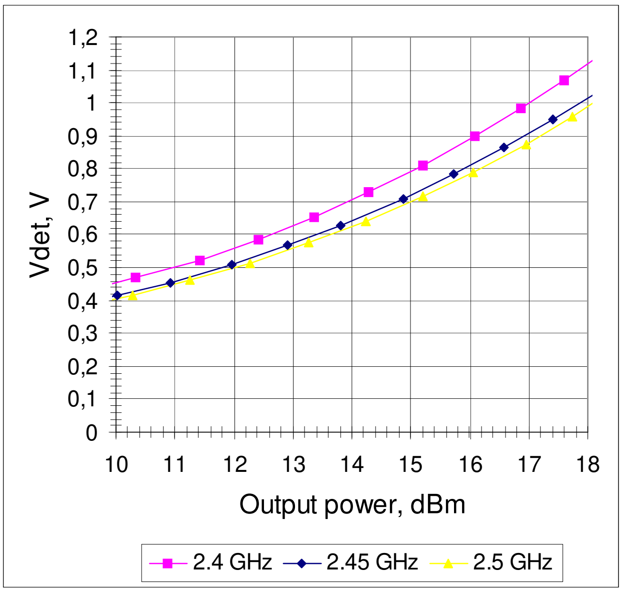
Typical Tx Harmonics*

(Measurement Conditions: Pout=+17dBm, frequency sweep (CW) 2.4..2.5 GHz Vcc=3.3V, Vref=2.8V, Ta=25°C)



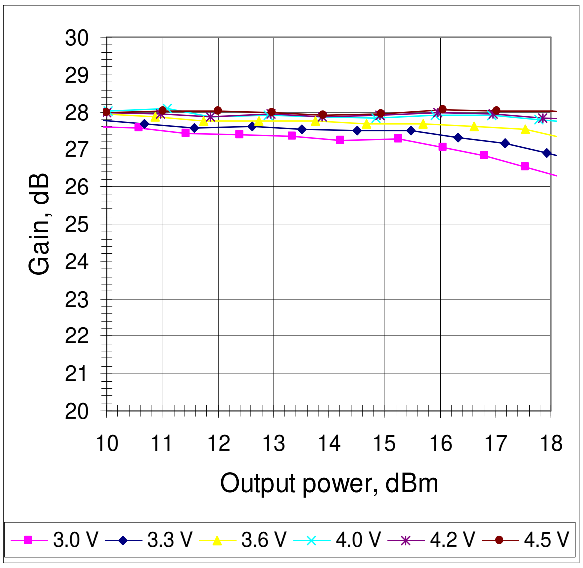
Typical Power Detector Output Voltage*

(Measurement Conditions: 802.11g mode / 54 Mbps OFDM, duty cycle 99%, Vcc=3.3V, Vref=2.8V, Ta=25°C, f=2.45 GHz).



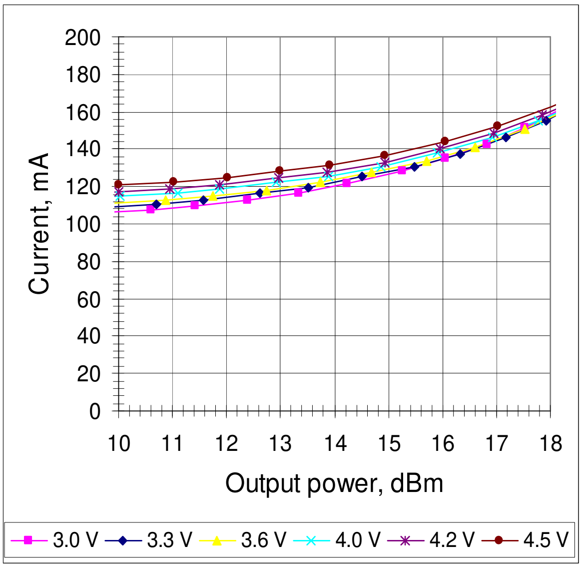
TX gain versus PA_Vcc variation (3.0..4.5V)*

(Measurement Conditions: 802.11g mode / 54 Mbps OFDM, duty cycle 99%, Vref=2.8V, Ta=25°C, f=2.45 GHz).

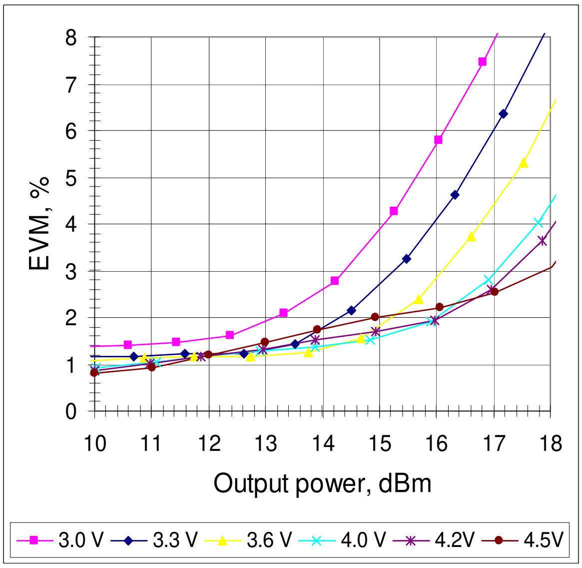


TX current consumption versus PA_Vcc variation (3.0..4.5V)*

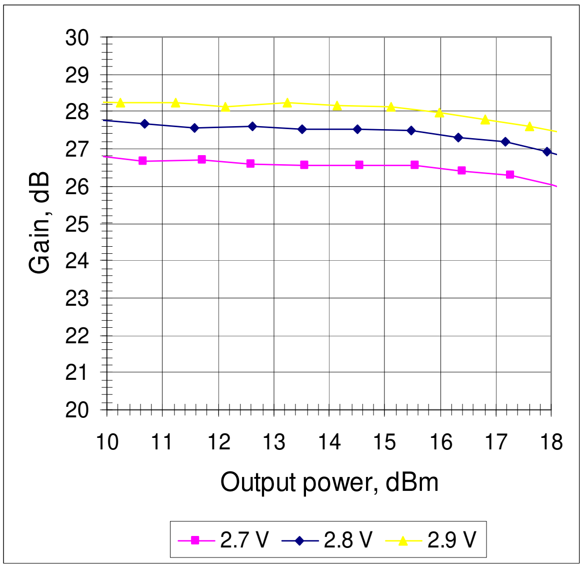
(Measurement Conditions: 802.11g mode / 54 Mbps OFDM, duty cycle 99%, Vref=2.8V, Ta=25°C, f=2.45 GHz).



TX EVM versus PA Vcc variation (3.0..4.5V)*
(Measurement Conditions: 802.11g mode / 54 Mbps OFDM, duty cycle 99%, Vref=2.8V, Ta=25℃, f=2.45 GHz).

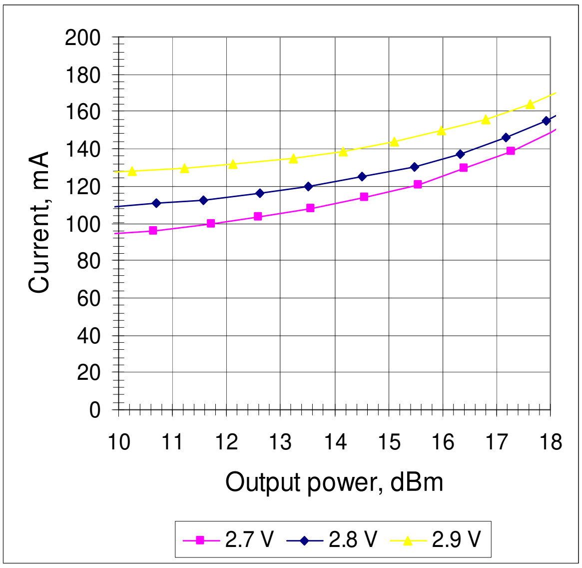


TX gain versus Vref variation*
(Measurement Conditions: 802.11g mode / 54 Mbps OFDM, duty cycle 99%, Vcc=3.3V, Ta=25℃, f=2.45 GHz).



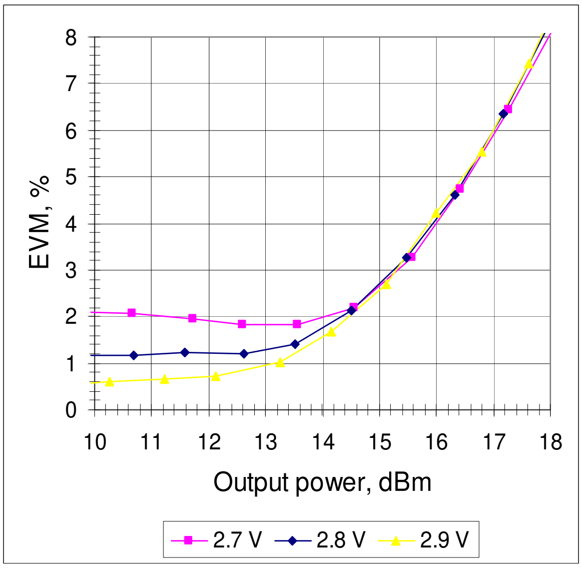
TX current consumption versus Vref variation*

(Measurement Conditions: 802.11g mode / 54 Mbps OFDM, duty cycle 99%, Vcc=3.3V, Ta=25℃, f=2.45 GHz).



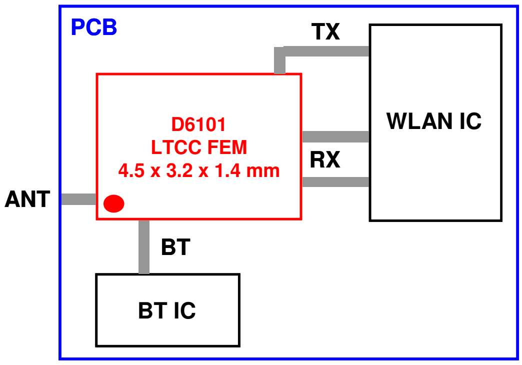
TX EVM versus Vref variation*

(Measurement Conditions: 802.11g mode / 54 Mbps OFDM, duty cycle 99%, Vcc=3.3V, Ta=25℃, f=2.45 GHz).



* Data shown with R5=68 Ohm (application circuits on pages 19..20)

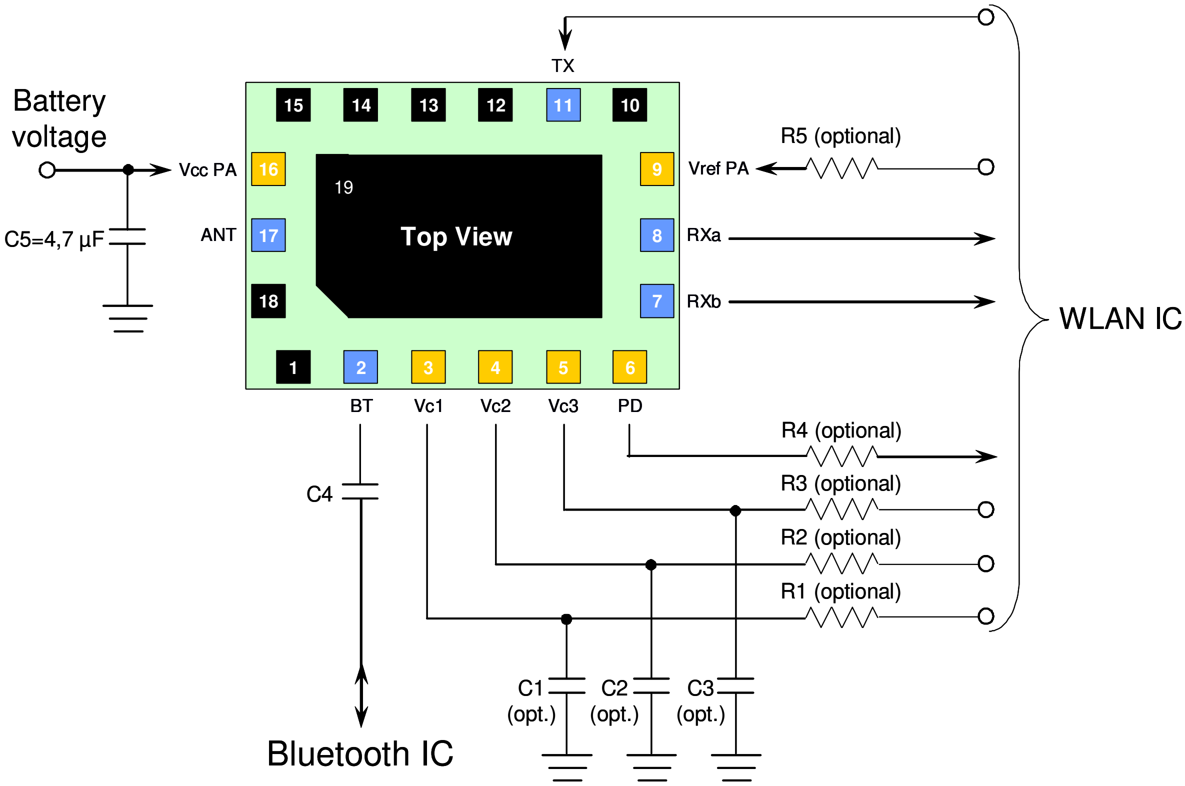
Reference Design Example



The D6101 front-end module is intended for mobile phone applications, where size is a critical parameter.

The D6101 FEM allows to realize a simple and very compact reference design with minimum BOM count for Bluetooth and WLAN application. A common antenna is shared between the WLAN and the Bluetooth radios.

Application Circuit



All RF ports are 50 Ohm matched. WLAN RX ports are matched to 100 Ohm differential impedance.

All RF ports except for Bluetooth RX/TX are internally DC-decoupled. For the Bluetooth port an external DC-decoupling capacitors may be required (this pin is coupled with DC voltage).

For PA power supply, one external capacitor (C5=4.7uF) should be connected to the PA Vcc pin. If such a large capacitor is already used somewhere else in the reference design, it might be redundant.

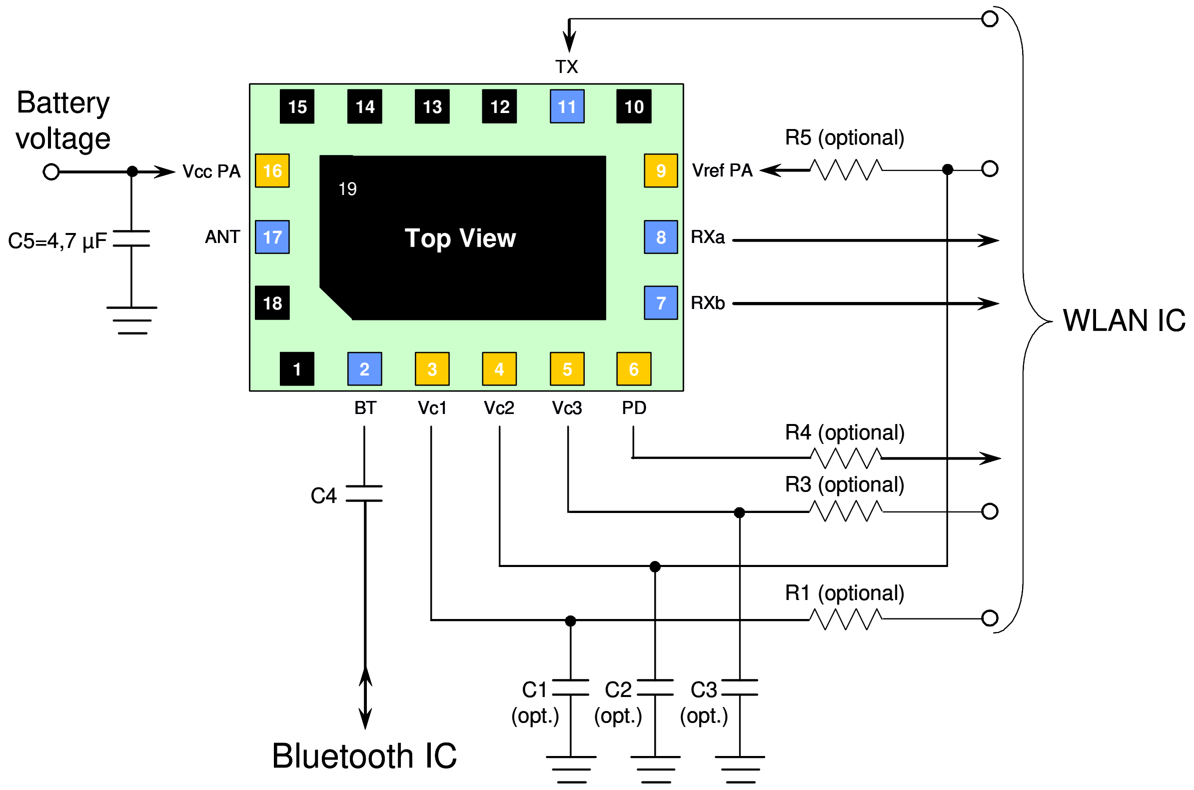
The Vcc pin (PA power supply) can be operated from an unregulated battery voltage. The PA reference voltage pin (Vref) needs a stabilized voltage provided either from an external LDO voltage regulator or directly taken from the power management IC of the WLAN chipset. Usually an additional series resistor (R5) between the D6101 FEM and the voltage regulator is required to set the correct voltage level on the Vref pin. If the available regulated voltage is in the range of 2.8±0.1V, the recommended R5 value is 51..68 Ohm. The R5 value can be reduced for better linearity or increased for better efficiency.

The switch control lines may need additional external RC elements (R1..R3, C1..C3) acting as low-pass filters to shape the switching transients coming from the WLAN IC (depending on the switching characteristics, these R,C may be not required).

The power detect signal filtering is integrated inside the FEM (10 kOhm, 5 pF, IF bandwidth = 20 MHz). An additional series resistor (R4) might be applied to set the right detector voltage level for a specific WLAN chipset.

Alternative application circuit

Setting the switch in the wrong state (RX or BT) during the TX mode (PA turned on, Vref and Vcc voltages applied) may damage the FEM if the output power is high (>+17 dBm). This happens due to a very strong reflected signal from the turned off switch, which can damage the power amplifier circuitry. In case it can not be guaranteed that this forbidden control pin combination does not happen during the system operation or calibration the following modified application circuit has to be used:



TX control pin of the switch (Vc2) should be connected with the line used to turn the PA on and off. In this case, the switch TX control will be always “high” when the PA is on. This significantly reduces the level of the signal reflected to the PA output and guarantees that the PAs are not damaged.

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