Hardware Design Guide
SPB229 Application Note

1 Preface

This document provides hardware design guidelines for the SPB229 module.

2 Introduction

2.1 Overview

SPB229 is a complete WLAN/BT module with EMC shield, ready for onboard integration in a hosted environment. SPB229 enables a cost efficient ultra-low power, high performance and feature rich client solution. It provides up to 150 Mbit/s data rate when operating in the OFDM mode and up to 11 Mbit/s data rate when operating in the DSSS/CCK mode.

SPB229 integrates RF, baseband/MAC, Bluetooth Package Engine, memory, RF filters, oscillator, antenna (option) and EMC shield into a highly integrated and optimized module solution with high quality and reliability to a complete standalone solution with no need for external components.

This highly integrated solution is optimized for customer applications running on a Linux host. The host interface supports SDIO 3.0. Internal RAM comprises both code and data memory eliminating the need for external RAM, Flash or ROM memory interfaces. MAC address, trimming values etc. are stored in the on board memory.

2.2 Key Features

- Support for 802.11a/b/g/n.
- Data Rates: 20MHz channel bandwidth: 1-72Mbps; 40MHz channel bandwidth: 13-150Mbps.
- Modulation: BPSK, CCK, QPSK, 16QAM, 64QAM for WLAN and GFSK/π/4DQPSK/8DPSK/LE for BT.
- Open, WEP and WPA/WPA2 encryption.
- No external components except for the external antenna options.
- Low power consumption due to efficient PA design and power off mode.
- Supports BT-WLAN coexistence.
- Extensive DMA hardware support for data flow to reduce CPU load.
- Advanced power management for optimum power consumption at varying load.
- External interfaces 4 bit SDIO 3.0 for WLAN/BT.
- On-board High Frequency High Precision Oscillator.
- Small footprint 14 x 14 mm (196 mm2) 41-pin.
- RoHS Compliant.

3 Block Diagram

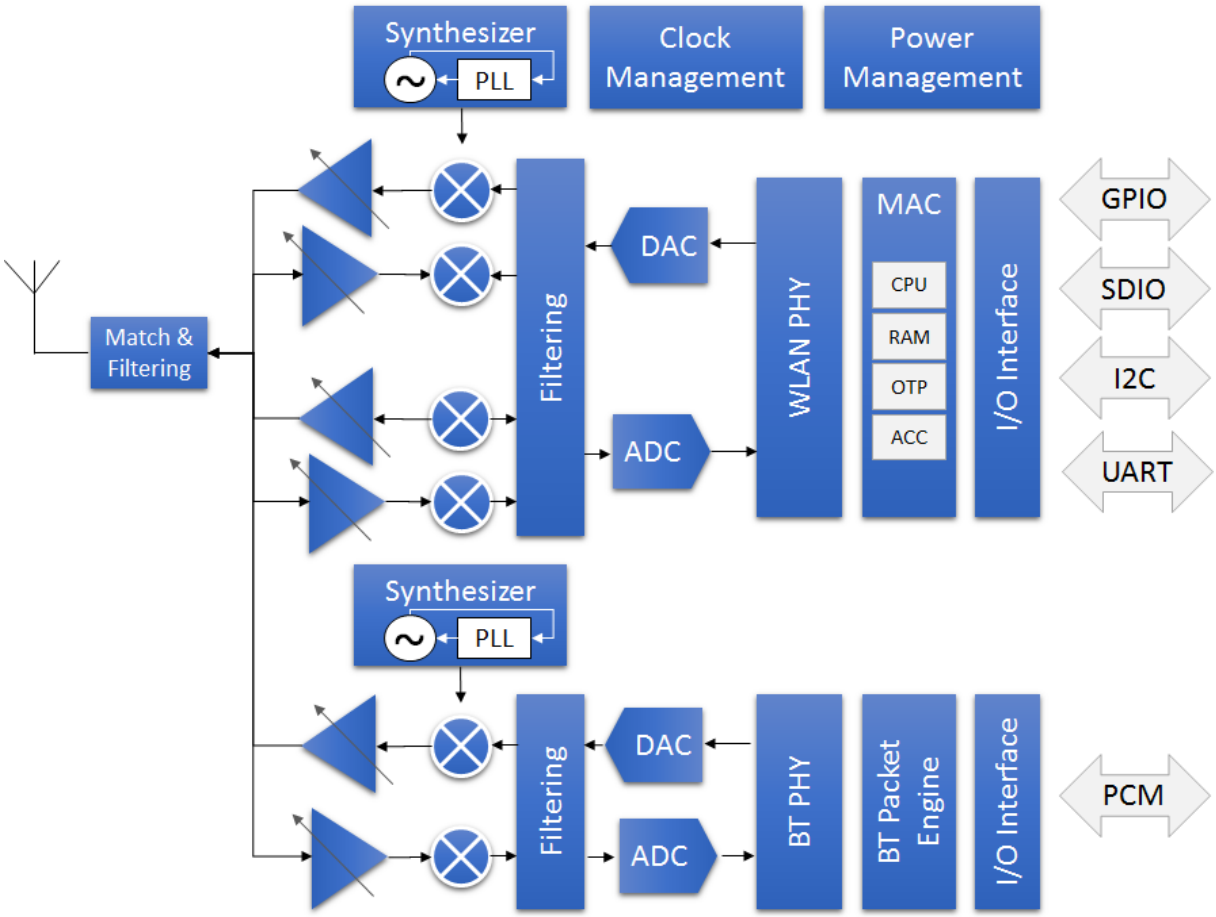

Figure 1. Block diagram.

4 Reference schematic

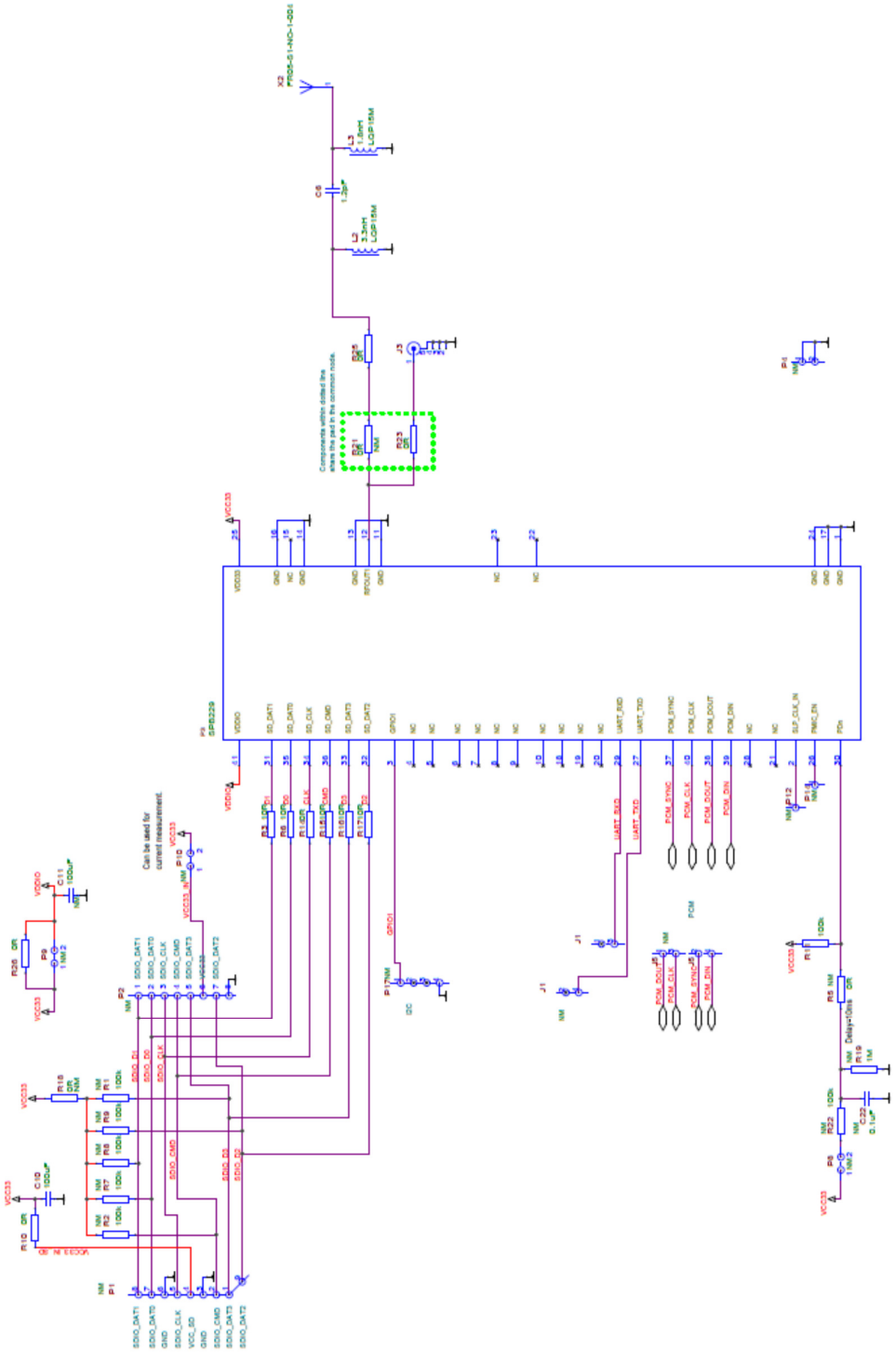

Figure 2. SPB229 reference schematic.

The output is selectable to go either to an edge-mount SMA connector or a chip antenna. The selection is done by moving resistor R21 between its two possible positions. The SMA option is intended for RF performance measurements, and the SMA connector should not be mounted if the chip antenna is used.

5 Pin Description

The SPB229 module provides the following pins.

Table 1. RF Interface

Module Pin number	Pin Name	Description
12	RFOUT1	RF input/output (default, RN- and BN-option)
15	NC	No Connect, leave open

Table 2. SDIO Host Interface

Module Pin number	Pin Name	Description
31	SD_DAT1	SDIO 4-bit mode: Data line bit [1] SDIO 1-bit mode: Interrupt
32	SD_DAT2	SDIO 4-bit mode: Data line bit [2] or Read Wait (optional) SDIO 1-bit mode: Read Wait (optional)
33	SD_DAT3	SDIO 4-bit mode: Data line bit [3] SDIO 1-bit mode: Not used
34	SD_CLK	Clock input
35	SD_DAT0	SDIO 4-bit mode: Data line bit [0] SDIO 1-bit mode: Data line
36	SD_CMD	SDIO 4-bit mode: Command SDIO 1-bit mode: Command

The SDIO Interface supports 1-bit and 4-bit SDIO transfer modes up to 100MHz clock frequency.

Table 3 PCM Interface

Module Pin number	Pin Name	Description
37	PCM_SYNC	PCM Sync pulse signal
38	PCM_DOUT	PCM Data
39	PCM_DIN	PCM Data
40	PCM_CLK	PCM Clock signal

Table 4 UART Interface

Module Pin number	Pin Name	Description
27	UART_TXD	UART TX Data
29	UART_RXD	UART RX Data

Table 5. General

Module Pin number	Pin Name	Description
2	SLP_CLK_IN	Entry point for external low frequency clock
3	GPIO1	Can be configured for Host-Module or Module-Host wake-up
4	NC	No Connect, leave open
5	NC	No Connect, leave open
6	NC	No Connect, leave open
7	NC	No Connect, leave open
8	NC	No Connect, leave open
9	NC	No Connect, leave open
10	NC	No Connect, leave open
18	NC	No Connect, leave open
19	NC	No Connect, leave open
20	NC	No Connect, leave open
21	NC	No Connect, leave open
22	NC	No Connect, leave open
23	NC	No Connect, leave open
26	PMIC_EN	Power management enable, internally pull-up to VDD33. Connect to ground to shut down. Will probably merge with PDn pin in future versions.
28	NC	No Connect, leave open
30	PDn	WiFi chip Power Down, active low

Table 6 Ground and Supply

Module Pin number	Pin Name	Description
1	GND	Ground
11	GND	Ground
13	GND	Ground
14	GND	Ground
16	GND	Ground
17	GND	Ground
24	GND	Ground
25	VDD33	Connect to 3.3V supply
41	VDDIO	Digital IO supply, can be connected to VDD33 and share decoupling.

6 Bill of Material

Table 7: SPB229 reference design BOM

Comp	Part name	MFG nr.	Description
A1	PCB		Printed circuit board
U1	SPB229		SPB229 PCB Module
C6	1.2PF 0402 C0G 50V	GRM1555C1H1R2BA01	Murata GRM15 Series Chip Monolithic Ceramic Capacitor
C10	100UF 6.3V X5R 1206	GRM31CR60J107ME39	Ceramic chip capacitor
L2	3N3 0402 0.1NH LQP15M	LQP15MN3N3B02	Murata LQP15MN3N3B02 Film Type Chip Coil
L3	1N8 0402 0.1NH LQP15M	LQP15MN1N8B02	Murata LQP15MN Film Type Chip Coil
R3, R6, R15, R16, R17	10R 0402 1%	RC0402FR-0710RL	Chip resistor 0.063W Note: 10 Ohm is only a starting value. Actual value depends on host driver strength and signal path.
R11	100K 0402 1%	RC0402FR-07100KL	Chip resistor 0.063W
R10, R14, R23, R25, R26	0R 0402	RC0402JR-070RL	Chip resistor 0.063W
X2	ANTENNA FR05-S1-NO-1-004 SMD	FR05-S1-NO-1-004	Fractus Dual-band Reach Xtend Chip Antenna
		or	
J3	SMA JACK EDGE MOUNT 132357		AmphenolConnex 132357-11

7 PCB layout

This section describes the layout of the mother board.

7.1 Hardware Options

7.1.1 Antenna Option R

The option R is using an antenna that is placed external to the module. The external antenna is either the surface mounted Fractus FR05-S1-NO-1-004 antenna or any of the three approved antennas (per table Table 11. Mounting options for the different approved antennas) connected to a RP-SMA connector on the board.

7.1.2 Antenna Option B

The antenna option B is using a surface mounted antenna already mounted on the module. This option requires a different SD-carrier board and is not considered in this version of the design guide.

7.2 Antenna option R, no antenna on the module

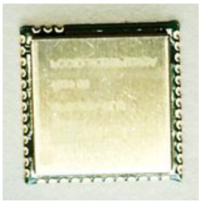

Figure 3. SPB229 option SPB229-Rxxx without antenna on module.

Use normal layout common sense. Include a pi-network in front of the antenna to add the possibility to tune its impedance to 50ohm. The module requires a 50ohm load on its RF pin. If different antenna is used, the matching components need to be revised.

The power supply is arranged as power planes on the bottom layer with vias up to the top level. The four layers of the reference pcb is shown below, where the red area is the VCC33 net and the black is the VDDIO net. Since the SD carrier is a general purpose board, all module pins are connected to pin-strips for test purposes even though for the SPB229 many of them are No Connects.

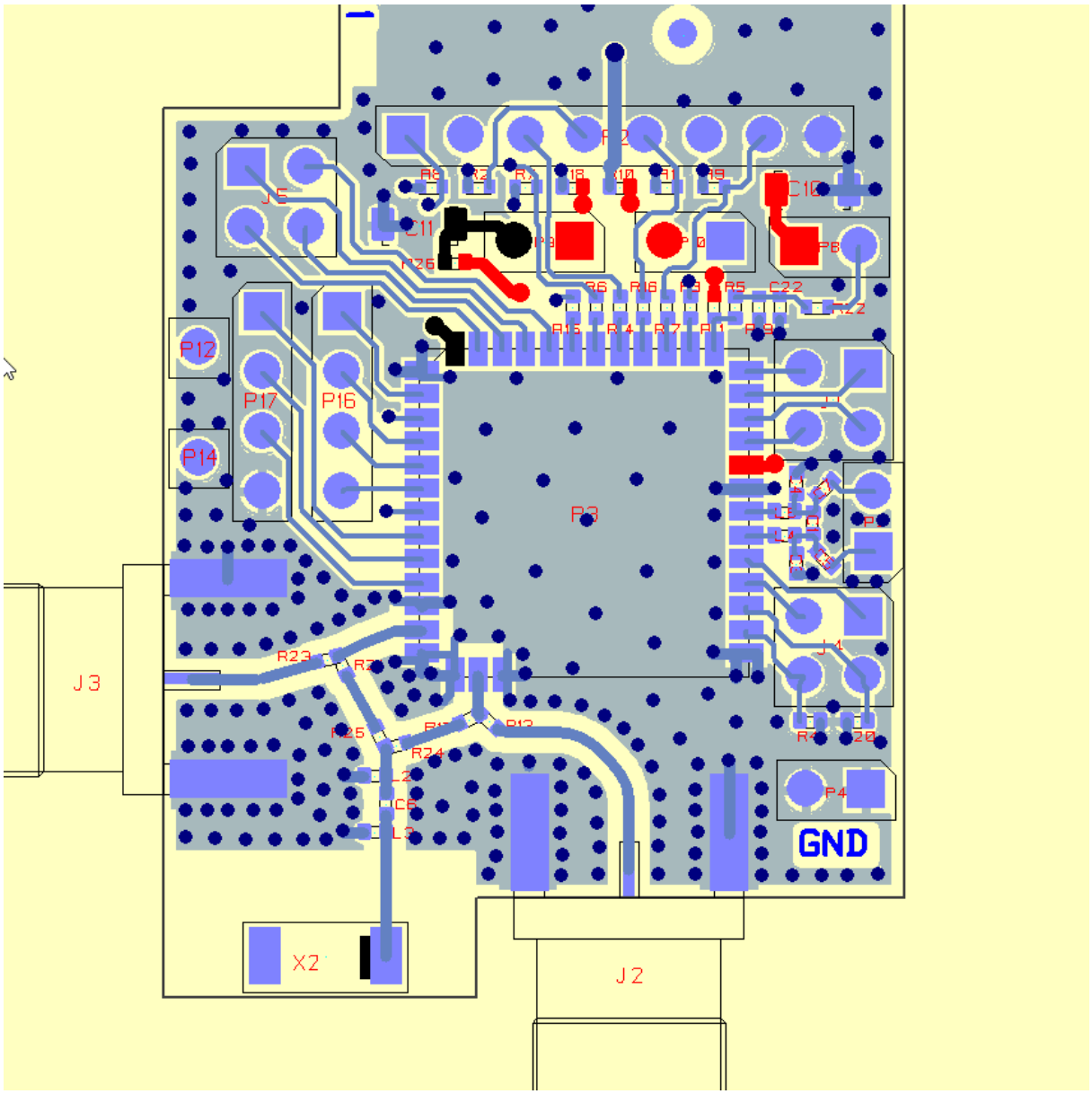

Figure 4. Top layer.

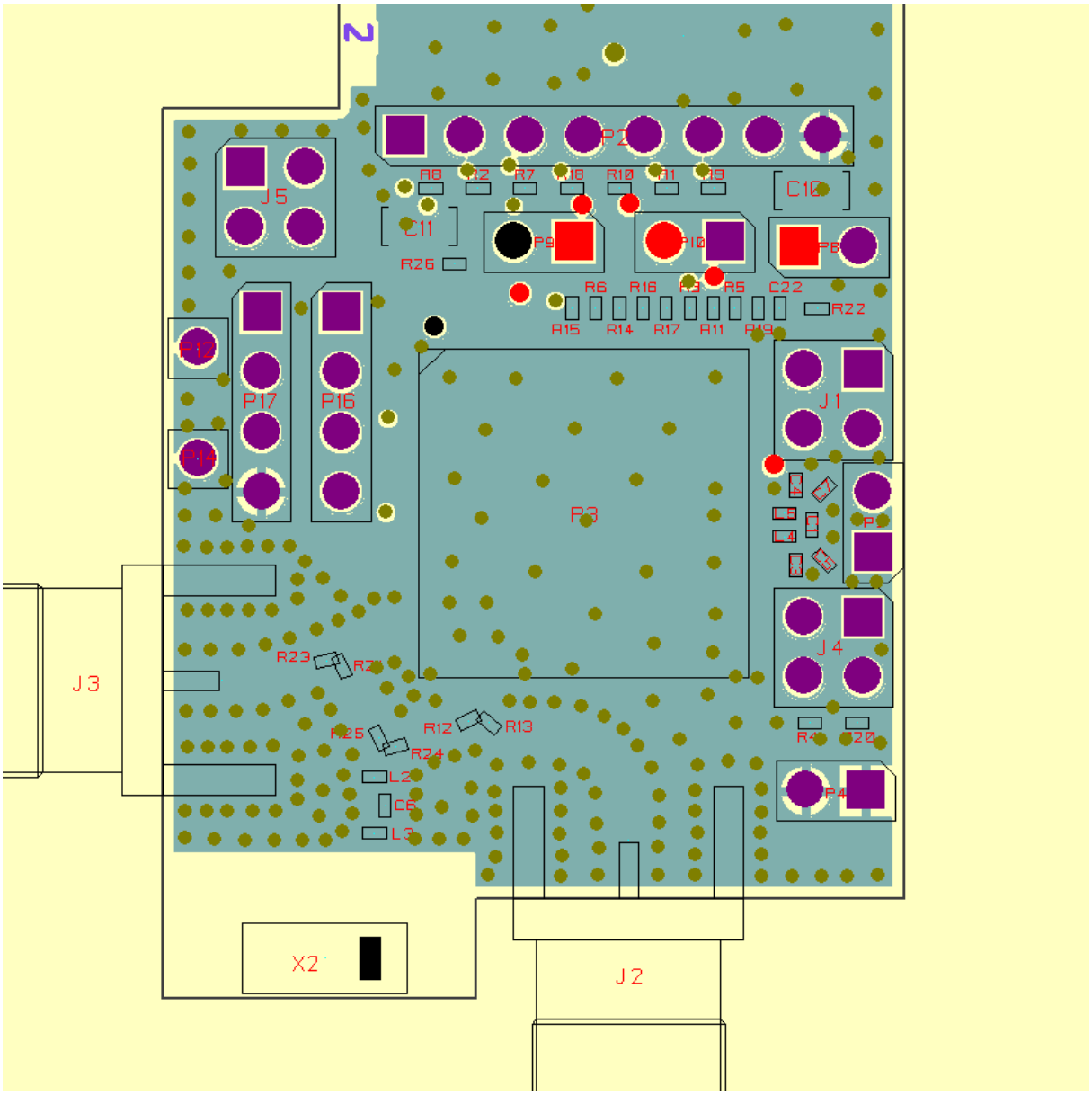

Figure 5. Second layer (RF ground).

Figure 6. Third layer, ground and supply.

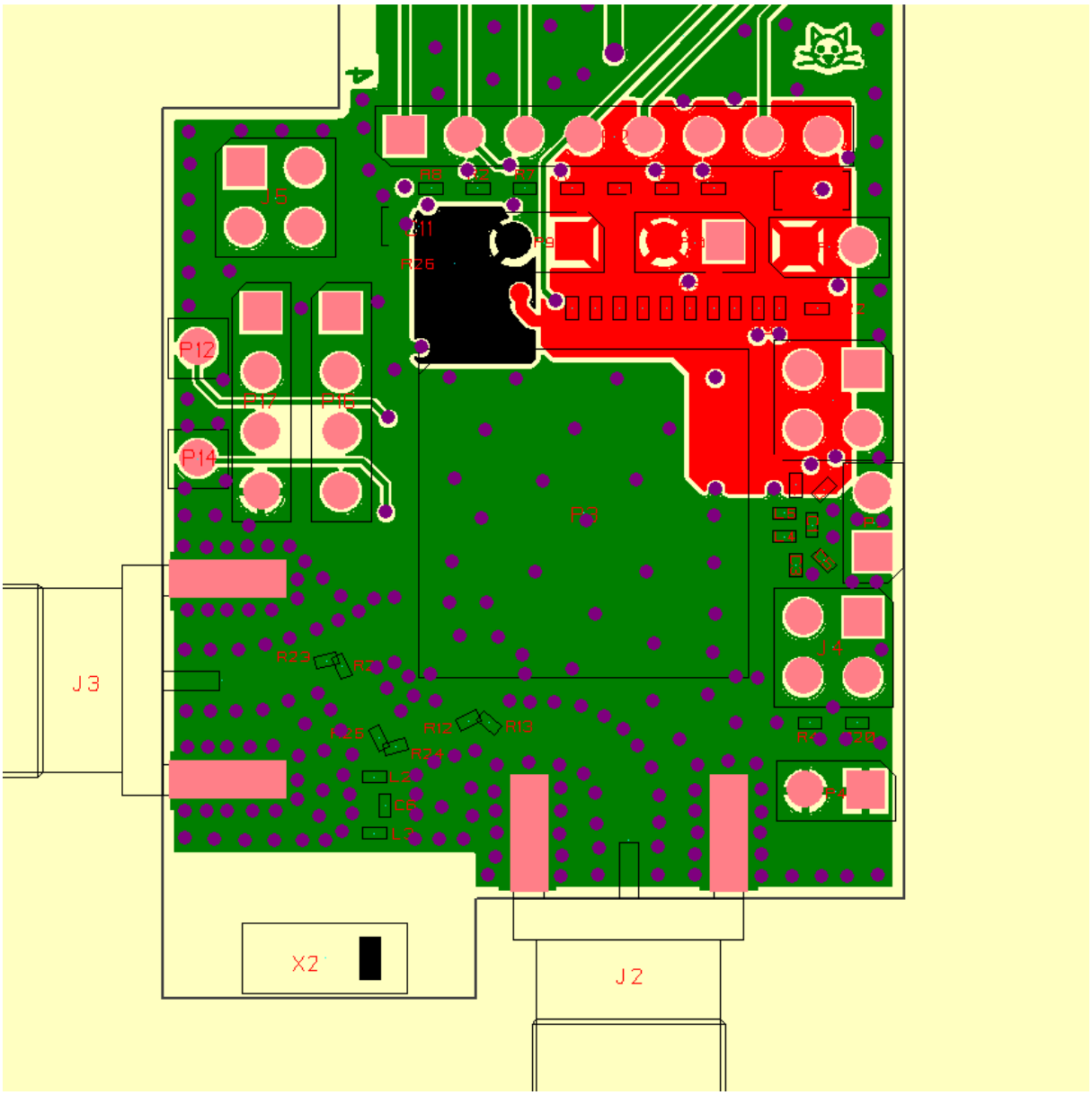

Figure 7. Bottom layer, ground and supply.

8 Options overview

EXAMPLE: **SPB229- R L C N 2**

Product Family

SPB229

Antenna Option

B= Integrated Chip Antenna

R= RF Pad

Colocation Option

L= Integrated LTE Filter

N= No LTE Filter

Operating Temperature

C= 0°C to 70°C

M= -40°C to 85°C

Package

Q= 41 pin SMD module, with castellated via pads, (Antenna Option R)

Z= 38 pin SMD module, with castellated via pads, (Antenna Option B)

Delivery Package

2= Tape & Reel

3= Tray

Colocation option N has no additional filtering for colocation with LTE units while option L has a bandpass filter on the module to filter out interfering LTE frequencies.

9 Antennas for antenna option R

The option R is using an antenna that is placed external to the module. The external antenna is either a surface mounted antenna or an antenna connected to a RP-SMA connector on the board.

The surface mounted antenna used on the SPB111 reference board is the dual band antenna FR05-S1-NO-1-004 from Fractus. It has a peak gain of 1.8dB dBi in the 2.4-2.5GHz band and 4.9dBi in the 4.9-5.875GHz band. FCC certification is being applied for with this antenna. Make sure that the layout follows the recommendations in this guideline so the antenna gain and path loss will not differ from the reference design. It is always good practice to add pads for a pi-network close to the antenna if it needs to be tuned. The product will be approved for Master Mode operation by FCC using the Fractus antenna.

The product will also be approved with the external antennas in the table below. They are using reversed polarity SMA (RP-SMA) connectors. To fulfill the 8kV air-gap ESD requirement on the RP-SMA antennas, a protection is needed to be connected between the RF trace and GND according to the picture below. Note that the product is NOT approved by FCC for Master Mode operation with any of the tree RP-SMA antennas.

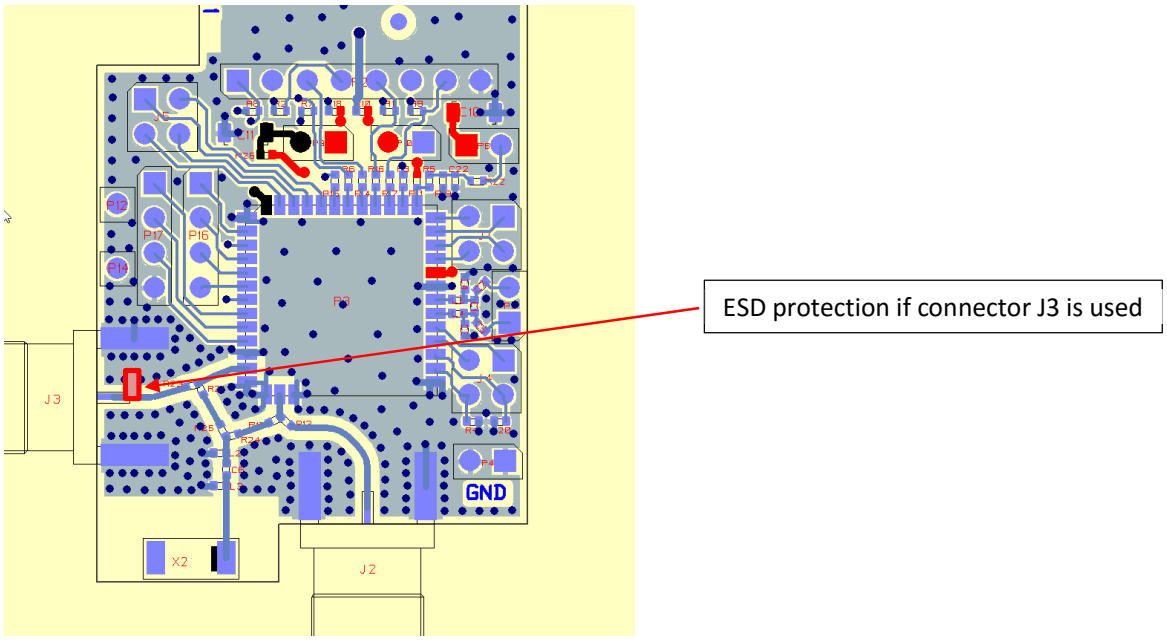

Figure 8. ESD protection needed for the RP-SMA antennas.

Antenna	Max Gain 2.4 GHz	Max Gain 5 GHz	Master Mode		Power Table (see table 17 below)	Mounting Option (see table 18 below)	
			RN	RL		RN	RL
Fractus FR05-S1-NO-1-004	1.8 dBi	4.9 dBi	Yes	No	V1	1a	1b
Taoglas GW.40.2153	3.7 dBi	2.5 dBi	No	No	V2	2a	2b
Taoglas FXP832.03.0458D	3.7 dBi	5.3 dBi	No	No	V2	2a	2b
Walsin RFDPA870900SBLB8G1	2 dBi	3 dBi	No	No	V3	2a	2b

Table 9. List of FCC approved antennas.

	2.4 GHz					5 GHz			
Power Table	**Max power level 11bg**	**Max power level 11n**	**Max power level ch 12 FCC**	**Max power level ch 13 FCC**	**Max power level BT/BLE**	**Max power level 11a**	**Max power level 11n**	**Max power level 11ac, VHT20**	**Max power level 11ac, VHT40/80**
V1	18	17	11b:18 11g:16 11n:15	11b:15 11g:14 11n:13	8	15	14	10	9
V2	16	16	11b:16 11g:14 11n:13	11b:13 11g:12 11n:11	6	15	14	10	9
V3	17	17	11b:17 11g:16 11n:15	11b:15 11g:14 11n:13	8	15	14	10	9

Table 10. List of power tables for the approved antennas (refer to previous table)

The customer will need to sign a Software Configuration Control Agreement declaring the integration responsibility of the SPB229 WLAN/BT product when it comes to making sure compliance to regulatory domain.

The RF output of the module is on pin 12. This option is referred to as option RN (R stands for antenna pad, no antenna on module while N stands for no LTE filter).

In the table below, options 1a and 2a refer to option RN, i.e. RF output on module pin 12.
Options 1b and 2b refer to option RL.

Comp	**Using the Fractus antenna**		**Using any of the three approved RP-SMA antennas**	
	Mounting Option 1a (RN)	**Mounting Option 1b (RL)**	**Mounting Option 2a (RN)**	**Mounting Option 2b (RL)**
X2	FR05-S1-NO-1-004	FR05-S1-NO-1-004	Not Mounted	Not Mounted
L3	1N8 0402 0.1NH LQP15M	1N8 0402 0.1NH LQP15M	Not Mounted	Not Mounted
C6	1.2PF 0402 C0G 50V	1.2PF 0402 C0G 50V	Not Mounted	Not Mounted
L2	3N3 0402 0.1NH LQP15M	3N3 0402 0.1NH LQP15M	Not Mounted	Not Mounted
R12	-	-	-	-
R13	-	-	-	-
R21	0R 0402	0R 0402	Not Mounted	Not Mounted
R23	Not Mounted	Not Mounted	0R 0402	0R 0402
R24	-	-	-	-
R25	0R 0402	0R 0402	Not Mounted	Not Mounted
J2	-	-	-	-
J3	Not Mounted	Not Mounted	RP-SMA	RP-SMA
ESD protection	Not Mounted	Not Mounted	Murata LQW18AN15N 15nH	Murata LQW18AN15N 15nH

Table 11. Mounting options for the different approved antennas

10 Current measurement

Current consumption can be measured by using an external 3.3V supply. This involves removing 0ohm resistor R10 and mounting a single pin strip on connector P10:2 (see Figure 4, red circle) where the external 3.3V should be applied. Ground can be made available by mounting a single pin-strip on either connector P2:8 or a double on connector P4.

11 Package Specifications

11.1 Mechanical outline, Antenna option R

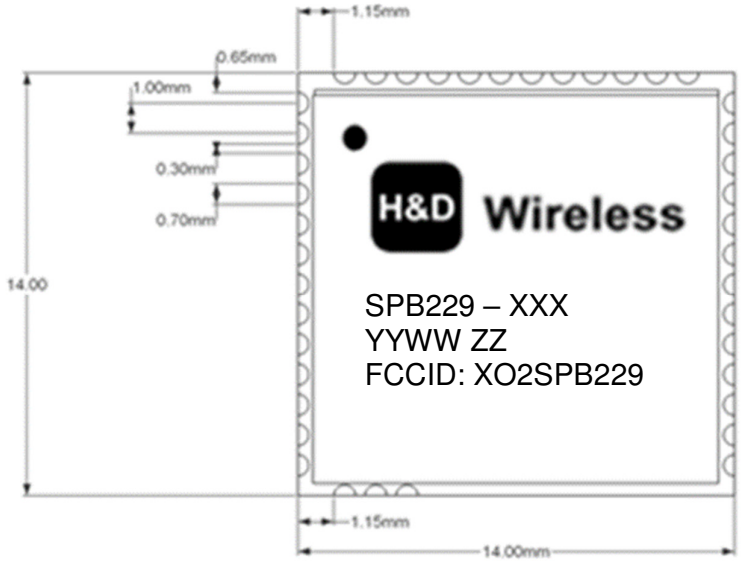

Figure 12. Package dimensions, top view.

Figure 13. Package dimensions, side view.

11.2 Mounting information

Recommended land pattern on the PCB.

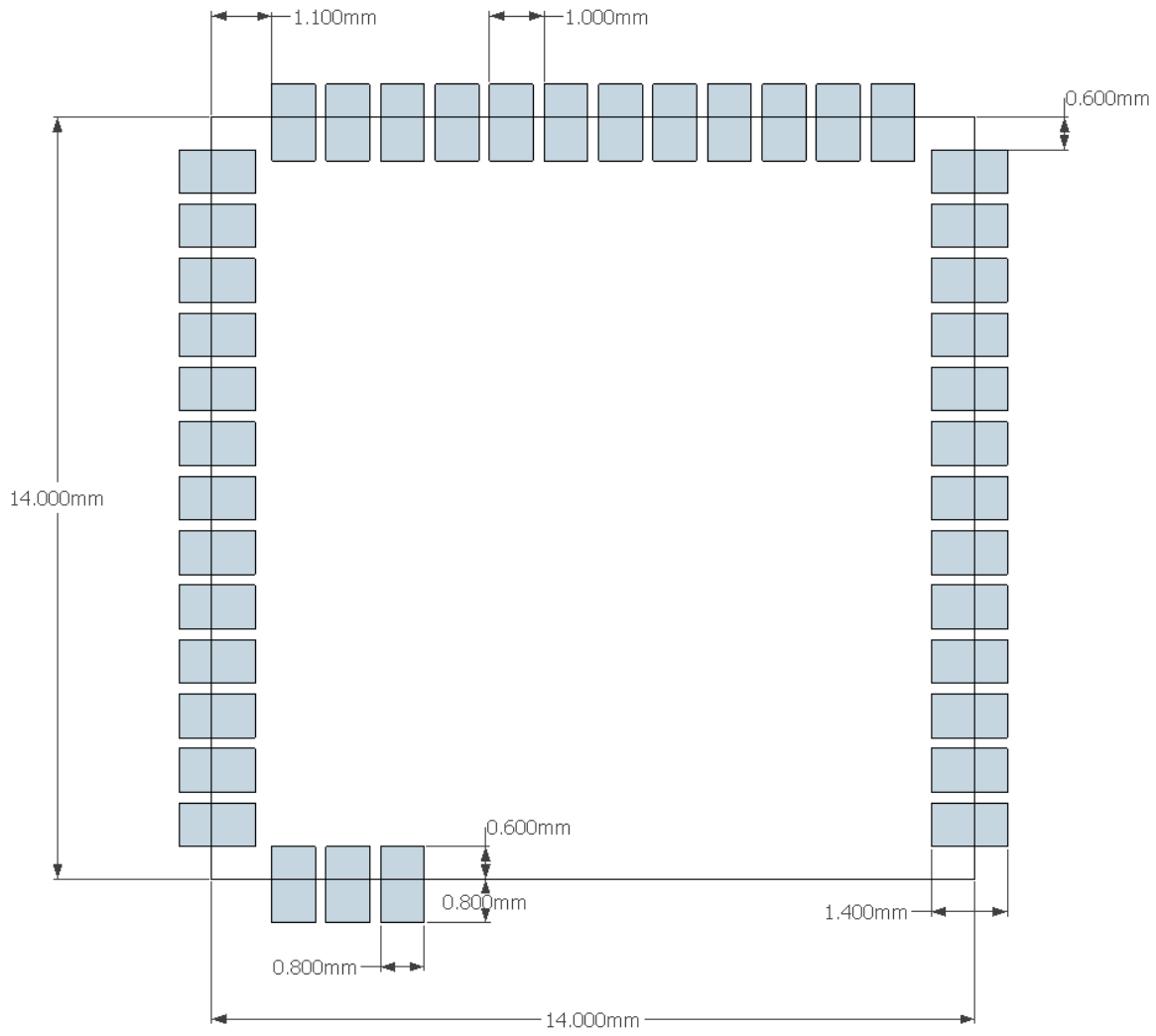

Figure 14. Recommended land pattern on the PCB, top view.

12 Reference PCB Stack-up

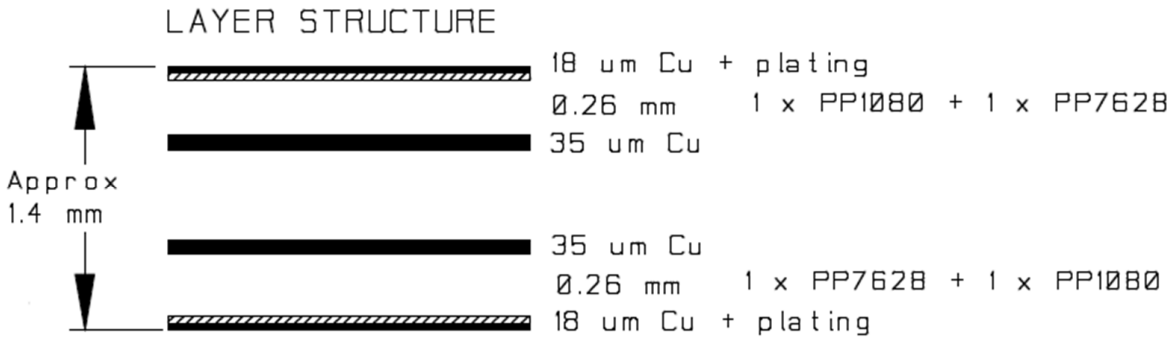

Figure 15. Reference PCB stack-up.