BRD9057A: SiWx917M 4-Layer Reference Design Manual

This document describes the SiW917M low-cost, 4-layer reference design and provides reference RF measurement results. The associated schematic & layout source files, bill-of-material (BOM), Gerbers and PDF exports are available on the SiWx917 branch in the Silicon Labs Hardware Design Examples.

KEY FEATURES

- Brief description of the SiWx917M 4-layer reference design
- Reference RF performance and regulatory pre-compliance test results

Table of Contents

1. Introduction

The BRD9057A SiWx917M 4-layer reference design is virtually provided for customers, meaning its design files (schematic & layout CAD source files, BOM, PDF, Gerbers, etc.) are available in the Silicon Labs Hardware Design Examples repository at https://github.com/SiliconLabs/hardware_design_examples, but the board itself is not orderable.

The design is provided in a Radio Board form factor, therefore it can be connected to the Wireless Starter Kit Mainboard or the Wireless Pro Kit Mainboard to get access to debug interface, Virtual COM port, buttons, LEDs, and additional features from expansion boards.

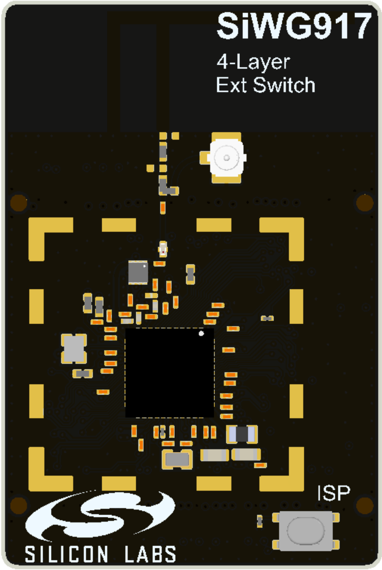


Figure 1.1. 3D view of BRD9057A

To minimize costs, the PCB is based on a 4 layer stack-up with no micro vias, and integrates an on-board inverted-F PCB trace antenna. The overall SiWx917 layout footprint was also reduced compared to the existing 6-layer Radio Board reference designs (such as the BRD4338A), resulting approximately 30 x 45 mm PCB size.

Based on the regulatory pre-compliance tests performed by Silicon Labs, the module is compliant with with FCC and CE regulations at up to ~+17 dBm Wi-Fi TX power and up to ~+16 dBm BLE TX power with the high-performance RF chain. The TX low-power RF chains are compliant at +6 dBm and -3 dBm.

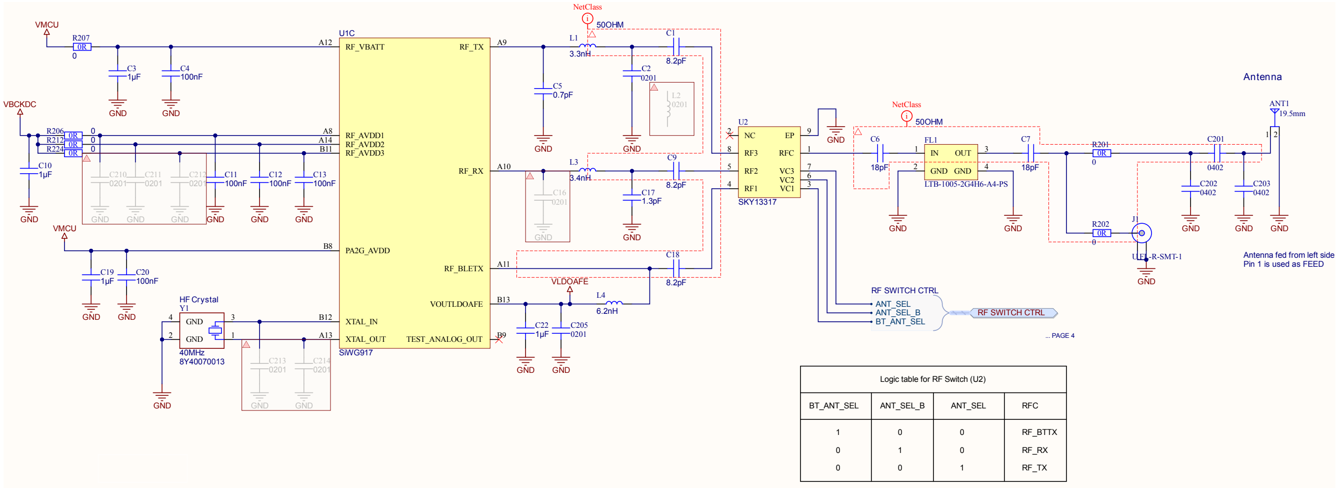
Note:

- The power values are to be interpered at the antenna port and not at the RF pin of the SoC.
- The FCC compliant power levels correspond to datasheet values, except for the high-performance BLE chain where 1 dB back-off is necessary.
- For safer FCC margins, it is recommended to back-off the power of the high-performance RF chains by an extra 1 dB.

2. Schematic Design

The RF front-end consists of:

- Matching networks for the
  - TX High Performance RF chain (RF_TX pin, C5, L1)
  - RX & BLE Low-Power 0 dBm RF Chain (RF_RF pin, L3, C17)
  - BLE Low-Power +8 dBm RF Chain with external biasing (RF_BLETX pin, L4)
- An external RF switch
- A band-pass ceramic filter
- DC-block capacitors (C1, C6, C7, C9, C18)
- An inverted-F antenna (IFA) and a u.FL connector (The termination can be configured by populating either R201 or R202 with a 0R resistor)
- An extra C205 = 4 pF filter capacitor to reduce the radiated harmonics of the + 8 dBm PA.



Logic table for RF Switch (U2)			
BT_ANT_SEL	ANT_SEL_B	ANT_SEL	RFC
1	0	0	RF_BTTX
0	1	0	RF_RX
0	0	1	RF_TX

Figure 2.1. RF Section of the 4-Layer reference design

Because the matching network layout and PCB stack-up are differing from the 6-layer reference designs, the optimum matching network component values are also slightly differing:

Table 2.1. RF Matching Network Component Values

Schematic Reference Designator	Component Value	Part Number	Manufacturer
C2	DNP	N/A	N/A
C5	0.7 pF	GRM0335C1HR70WA01	Murata
C17	0.9 pF	GRM0335C1HR90WA01	Murata
L1	3.5 nH	LQP03HQ3N5B02	Murata
L3	4.0 nH	LQP03HQ4N0B02	Murata

The RF matching network design procedure is described in AN1423: SiWx917 RF Matching and Layout Design Guide.

In case of degraded TX power and RX sensitivity, follow the RF matching network lab tuning procedure described in AN1495: Optimizing RF Performance for the SiWx917 Wireless-MCU Family.

3. Layout Design

The PCB layout is based on the low-cost stack-up depicted in the following figure. Note that the traces in the RF paths are (grounded) coplanar waveguides with ~50 Ω characteristic impedance.

Board Stack Report					
Stack Up		**Layer Stack**			
Layer	**Board Layer Stack**	**Name**	**Material**	**Thickness**	**Constant**
1		Top Paste			
2		Top Overlay			
3		Top Solder	Solder Resist	0.010mm	3.5
4		Top Layer	Copper	0.035mm	
5		Dielectric 1		0.179mm	4.56
6		Signal Layer 2	Copper	0.035mm	
7		Dielectric 3		1.030mm	4.6
8		Signal Layer 3	Copper	0.035mm	
9		Dielectric 2		0.179mm	4.56
10		Bottom Layer	Copper	0.035mm	
11		Bottom Solder	Solder Resist	0.010mm	3.5
12		Bottom Overlay			
13		Bottom Paste			
	Height : 1.547mm				

Figure 3.1. Layer Stack-up

Inner Layer 1 is adjacent to the Top Layer and is filled with GND pour to realize a uniform GND reference and low impedance return path for the GND return currents.

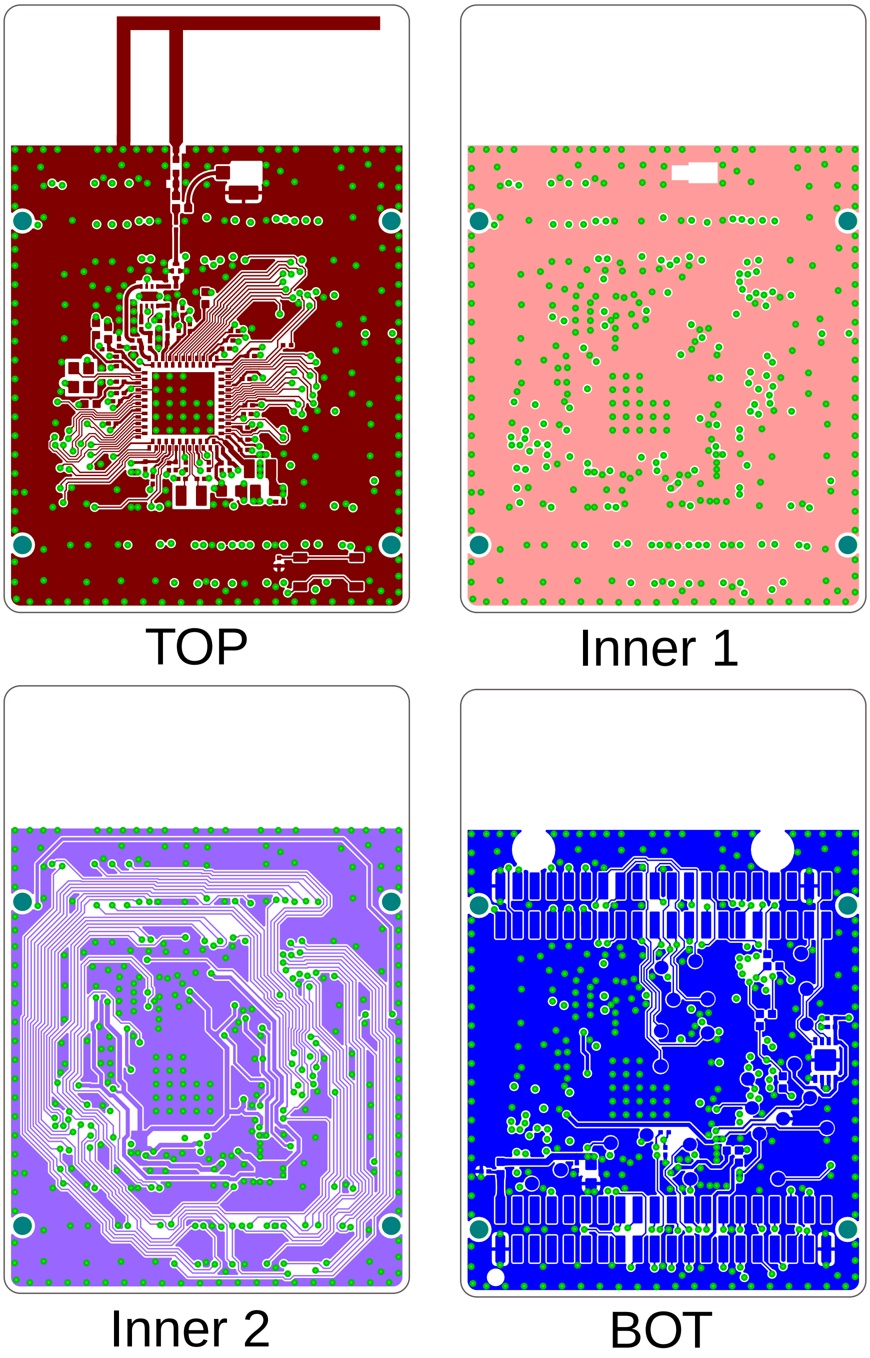


Figure 3.2. PCB Layout Design

For detailed recommendations on how to design the layout, refer to: AN1423: SiWx917 RF Matching and Layout Design Guide

4. Pre-certification radiated harmonic measurements

Spectrum Analyzer settings: RBW = 1 MHz, VBW = 1 Hz (~1 sec time window), Trace mode = Max hold, Detector = Average

Table 4.1. WLAN Radiated TX Harmonics (Power Index = 17 → TX Power ≈ +17 dBm)

		Measured maximums of the radiated power in EIRP [dBm]						Measured maxi-mums in EIRP [dBm]	Margin [dB]	FCC 15.247 limit in EIRP [dBm]
Cut:		XY		XZ		YZ				
Polarization		H	V	H	V	H	V			
2412 MHz	2nd harm.	-47.8	-49.6	-46.1	-44.4	-45.3	-47.4	-44.3	3.2	-41.2
	3rd harm.	-49.8	-49.3	-43.4	-44.9	-46.5	-46.4	-43.4	—	—
2437 MHz	2nd harm.	-49.7	-49.6	-47.4	-42.6	-43.8	-43.4	-42.8	1.6	-41.2
	3rd harm.	-48.1	-47.6	-42.6	-43.8	-43.4	-43.5	-42.6	1.4	-41.2
2462 MHz	2nd harm.	-49.7	-50.0	-47.5	-41.2	-43.5	-47.4	-41.2	0	-41.2
	3rd harm.	-47.9	-47.3	-42.7	-41.9	-46.7	-42.2	-41.9	0.7	-41.2

Table 4.2. BLE High-Performance RF Chain Radiated TX Harmonics (Power Index = 76 → TX Power ≈ +16 dBm)

		Measured maximums of the radiated power in EIRP [dBm]						Measured maximums in EIRP [dBm]	Margin [dB]	FCC 15.247 limit in EIRP [dBm]
Cut:		XY		XZ		YZ				
Polarization		H	V	H	V	H	V			
2402 MHz	2nd harm.	-47.5	-47.2	-47.2	-45.2	-48.8	-52.2	-45.2	4	-41.2
	3rd harm.	-41.2	-46.2	-41.2	-43.4	-46.2	-45.7	-41.2	—	—
2440 MHz	2nd harm.	-50.2	-51.5	-47.5	-46	-51.3	-52.7	-46.0	4.8	-41.2
	3rd harm.	-43.9	-48	-43.3	-42.1	-44.2	-42.5	-42.1	0.9	-41.2
2480 MHz	2nd harm.	-49.5	-52.2	-45.2	-49.8	-53.7	-51.6	-45.2	4.0	-41.2
	3rd harm.	-45.9	-49.4	-43.6	-42.4	-45.2	-41.5	-41.5	0.3	-41.2

Table 4.3. BLE Low-Power +8 dBm RF Chain Radiated TX Harmonics (Power Index = 53 → TX Power ≈ +6 dBm)

		Measured maximums of the radiated power in EIRP [dBm]						Measured maximums in EIRP [dBm]	Margin [dB]	FCC 15.247 limit in EIRP [dBm]
Cut:		XY		XZ		YZ				
Polarization		H	V	H	V	H	V			
2402 MHz	2nd harm.	-53.0	-51.3	-48.4	-50.0	-48.7	-49.4	-48.4	7.2	-41.2
	3rd harm.	-50.4	-52.2	-47.8	-44.5	-43.5	-50.8	-43.5	-	-
2440 MHz	2nd harm.	-54.4	-54.7	-53.2	-54.1	-53.5	-53.6	-53.2	12.0	-41.2
	3rd harm.	-53.0	-52.0	-46.2	-43.0	-43.0	-49.5	-43.0	1.8	-41.2

		Measured maximums of the radiated power in EIRP [dBm]						Measured maximums in EIRP [dBm]	Margin [dB]	FCC 15.247 limit in EIRP [dBm]
Cut:		XY		XZ		YZ				
Polarization		H	V	H	V	H	V			
2480 MHz	2nd harm.	-52.2	-53.6	-53.5	-49.7	-49.3	-53.7	-49.3	8.0	-41.2
	3rd harm.	-52.3	-52.5	-47.8	-45.2	-43.1	-47.4	-43.1	1.9	-41.2

Table 4.4. BLE Low-Power 0 dBm RF Chain Radiated TX Harmonics (Power Index = 31 → TX Power ≈ -3.5 dBm)

		Measured maximums of the radiated power in EIRP [dBm]						Measured maximums in EIRP [dBm]	Margin [dB]	FCC 15.247 limit in EIRP [dBm]
Cut:		XY		XZ		YZ				
Polarization		H	V	H	V	H	V			
2402 MHz	2nd harm.	-48.0	-48.0	-46.7	-47.5	-54.4	-56.3	-46.7	5.5	-41.2
	3rd harm.	-47.1	-48.4	-43.8	-44.2	-49.9	-51.7	-43.8	-	-
2440 MHz	2nd harm.	-50.0	-51.2	-48.4	-55.1	-55.7	-58.1	-48.4	7.2	-41.2
	3rd harm.	-49.2	-48.3	-44.7	-52.0	-49.4	-48.6	-44.7	3.5	-41.2
2480 MHz	2nd harm.	-60.0	-60	-58.9	-57.9	-57.7	-59.2	-57.7	16.5	-41.2
	3rd harm.	-50.0	-50.1	-45.4	-49.9	-46.1	-47.0	-45.4	4.2	-41.2

5. WLAN RX sensitivity

Table 5.1. WLAN RX Sensitivity

WLAN Standard	Data-rate [Mbps]	WLAN RX Sensitivity [dBm]													
		CH1	CH2	CH3	CH4	CH5	CH6	CH7	CH8	CH9	CH10	CH11	CH12	CH13	CH14
802.11b	1	-95.5	-95.5	-95.5	-95.5	-95.5	-95.5	-95	-95.5	-95.5	-95	-95	-95.5	-95.5	-94.5
	11	-86	-86	-86	-86	-86	-86	-86	-86	-86	-86	-86	-86	-86	-85.5
802.11g	6	-90.5	-91	-91	-91	-91	-91	-91	-91	-91	-91	-91	-91	**-89**	—
	54	-74.5	-74.5	-74	-74.5	-74.5	-74.5	-74.5	-74.5	-74.5	-74.5	-74	-74.5	-74	—
802.11n	7.2	-90	-89.5	-89.5	-90	-90	-90	-90	-90	-90	-89.5	-90	-90	-88.5	—
	72.2	-70	-70	-70	-70	-69.5	**-69**	-70	-69.5	-69.5	-69.5	-69.5	-69.5	-69.5	—
802.11ax	8.6	-89.5	-89.5	-89.5	-89.5	-89.5	-89.5	-89.5	-89.5	-89.5	-89.5	-89.5	-89.5	-89	—
	86	-70	-69.5	-69.5	-69.5	-69.5	-69.5	-69.5	-69	-69.5	-69.5	-69	-69	-69	—

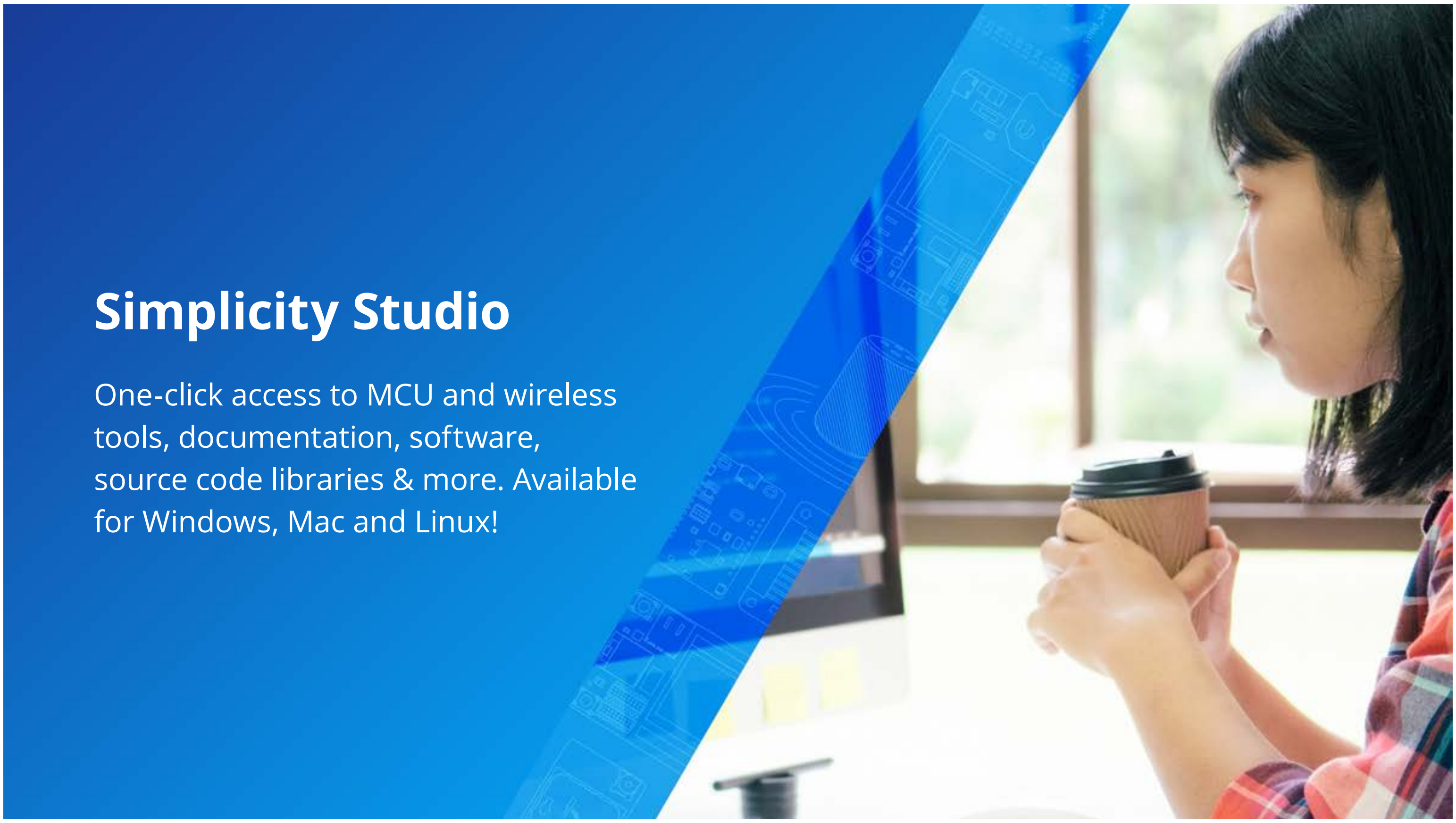
The cells in bold indicate that RX performance is -2 dB worse than datasheet values, which is still within the normal RX performance range.

6. Revision History

Revision 0.1

September, 2025

Initial release.



IoT Portfolio	SW/HW	Quality	Support & Community
www.silabs.com/IoT	www.silabs.com/simplicity	www.silabs.com/quality	www.silabs.com/community

Silicon Laboratories Inc.
400 West Cesar Chavez
Austin, TX 78701
USA

www.silabs.com