AN5290
Application note

Minimal BOM for STM32WB Series microcontrollers

Introduction

STM32WB Series microcontrollers are designed to minimize the number of external components needed to ensure optimized RF performance.

This document details the bill of materials (BOM) for Bluetooth® Low-Energy applications.

The QFN48 package is used as a reference but the considerations valid for it can easily be extended to other packages.

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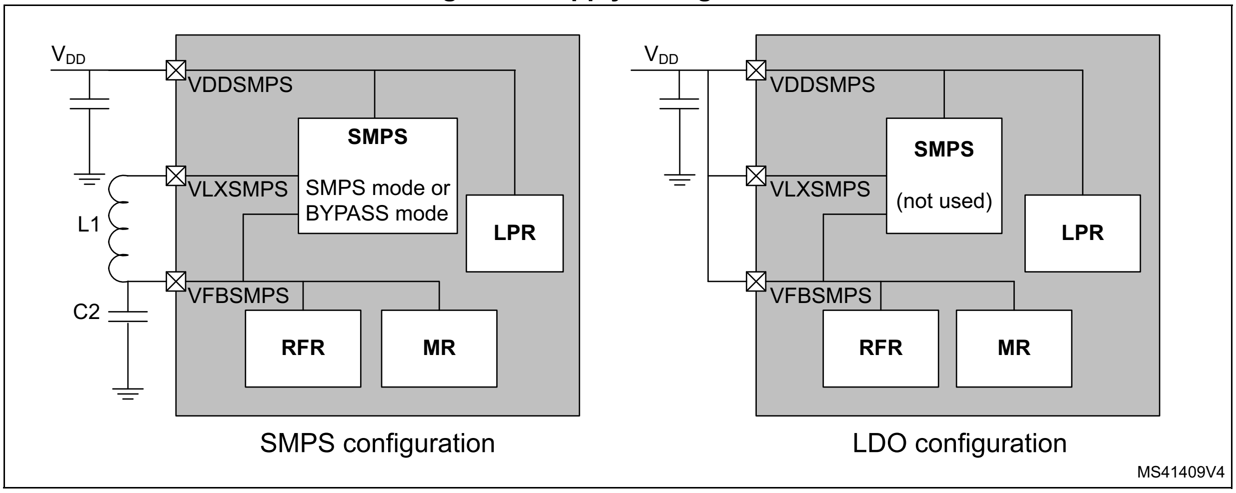
1 Design considerations

1.1 SMPS and LDO configurations

The STM32WB Series microcontrollers are based on Arm®[a] cores.

The power management implemented on some of these devices (see the datasheets available on *www.st.com)* embeds a powerful switched mode power supply (SMPS) to improve power efficiency when the supply voltage is higher than 2 V, otherwise the LDO configuration is used. The two configurations are shown in *Figure 1*. See AN5246 “*Usage of SMPS on STM32WB Series microcontrollers*”, available on *www.st.com*, for more details.

Figure 1. Supply configurations



To operate properly, the SMPS needs two inductors and two capacitors. In the LDO configuration no external components are needed. The detailed electrical schemes are shown in *Section 2*.

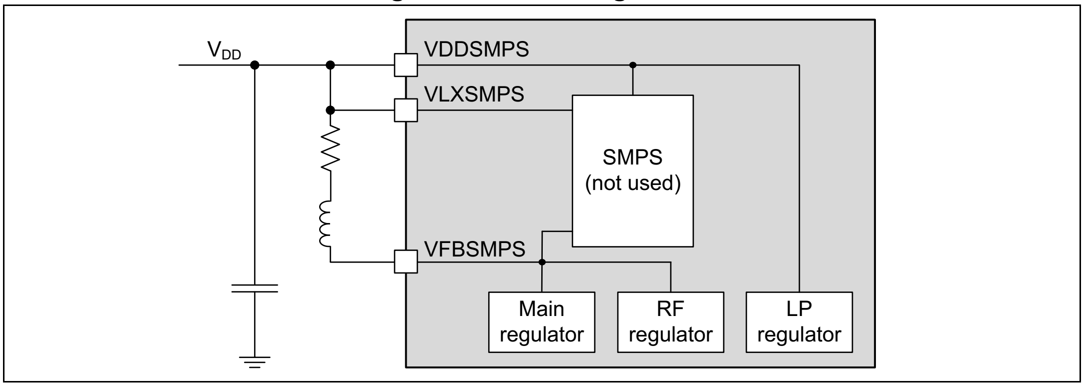
a. Arm is a registered trademark of Arm Limited (or its subsidiaries) in the US and/or elsewhere.

1.2 LDO configuration for V_{DD} > 3 V

This configuration applies only to STM32WB55Vx devices with REV_ID = 0x2001 in register DBGMCU_IDCODE (see RM0434, available on *www.st.com)*.

An inductance and a resistor must be added in series between VLXSMPS and VFBSMPS pins, as shown in *Figure 2*.

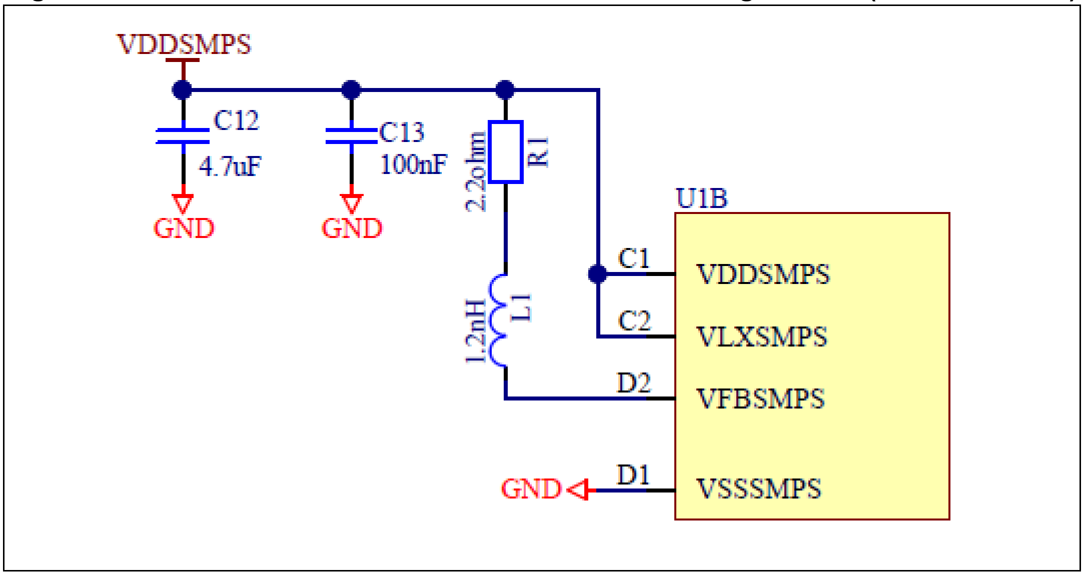
Figure 2. LDO configuration



The recommended values (see *Figure 3*) are:

- Inductance: 1.8 ± 0.1 nH, 6 GHz ± 15% self-resonance frequency, 1000 mA rated current (e.g. Murata LQG15HS1N8B02)
- Resistor: 2.2 Ω, able to support 1 W for 5 ns (e.g. Vishay D10/CRCW0402e3)

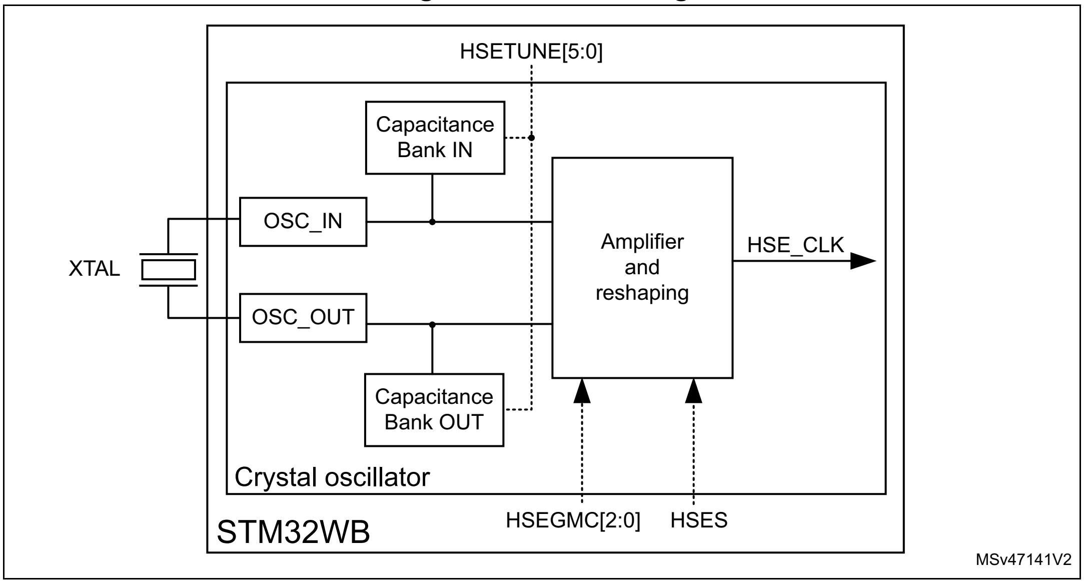
Figure 3. Recommended schematic for the no SMPS configurations (STM32WB55Vx)



1.3 HSE trimming

STM32WB MCUs use the HSE oscillator for the RF clock generation, this component must be fine-tuned. Internal load capacitors are used, removing the need for external parts, as shown in *Figure 4*. See AN5042 "*HSE trimming for RF applications using the STM32WB Series*", available on *www.st.com*, for more details.

Figure 4. HSE trimming

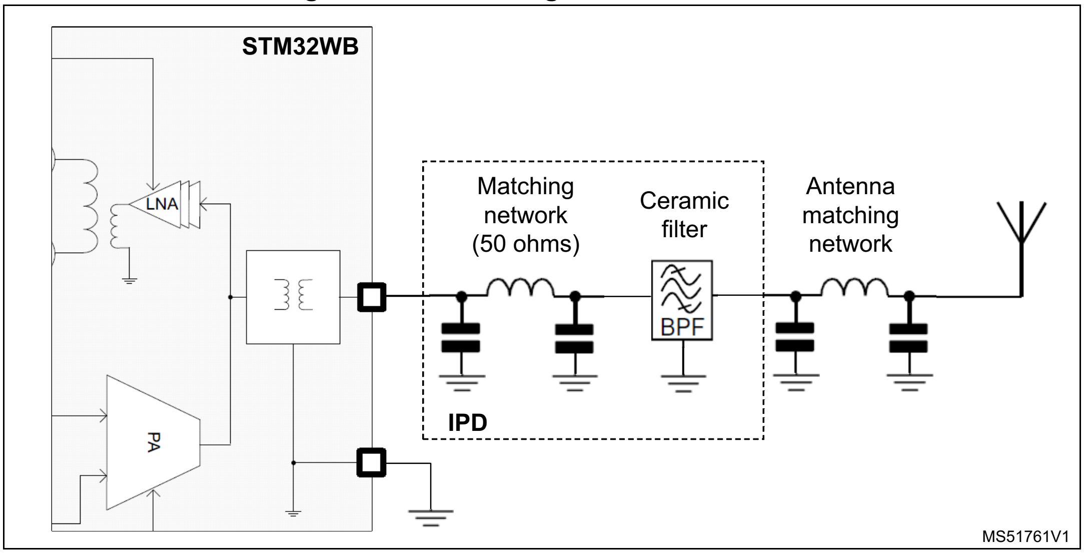


1.4 RF matching

There is a unique pin RX/TX for the RF and this interface is single ended, thus eliminating the need for external baluns. Furthermore, internal band pre-filtering helps to reduce external components.

An external PI filter made-up by discrete components followed by a ceramic filter is needed for, respectively, impedance matching and harmonics rejection. Another matching network is required for the antenna. To optimize the BOM and the performance stability, these filters can be replaced by an internal passive device (IPD), as shown in *Figure 5*.

Figure 5. RF matching and external filters



The RF performance strongly depends upon the PCB layout. AN5165 "*Development of RF hardware using STM32WB microcontrollers*", available on *www.st.com,* describes the precautions to be taken for the layout of an RF board with the STM32WB.

2 Schematics

Figure 6. Optimized solution with discrete components (STM32WBx5xx products)

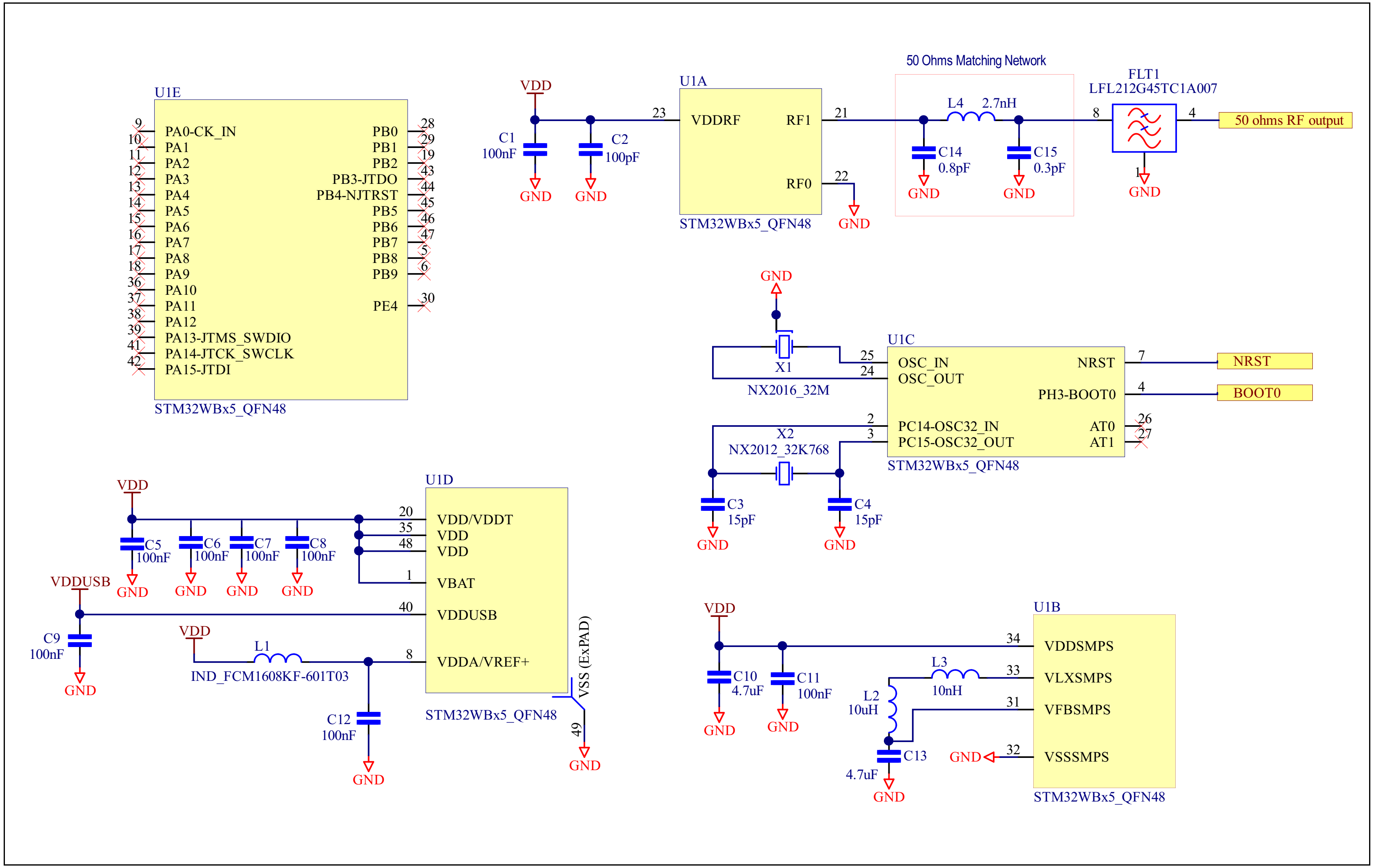


Figure 7. Optimized solution with discrete components (STM32WBx0xx products)

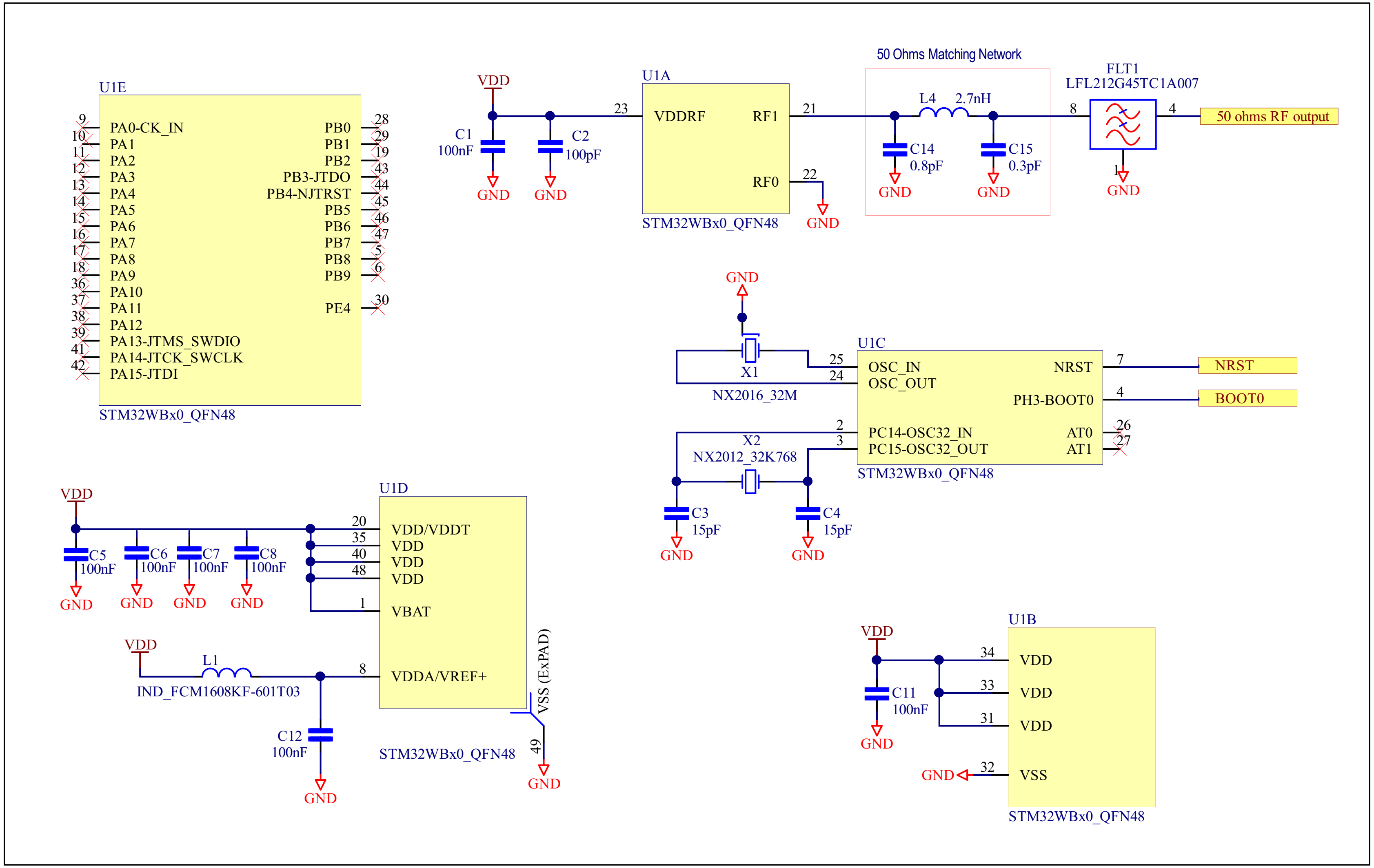


Figure 8. Optimized solution with IPD (STM32WBx5xx products)

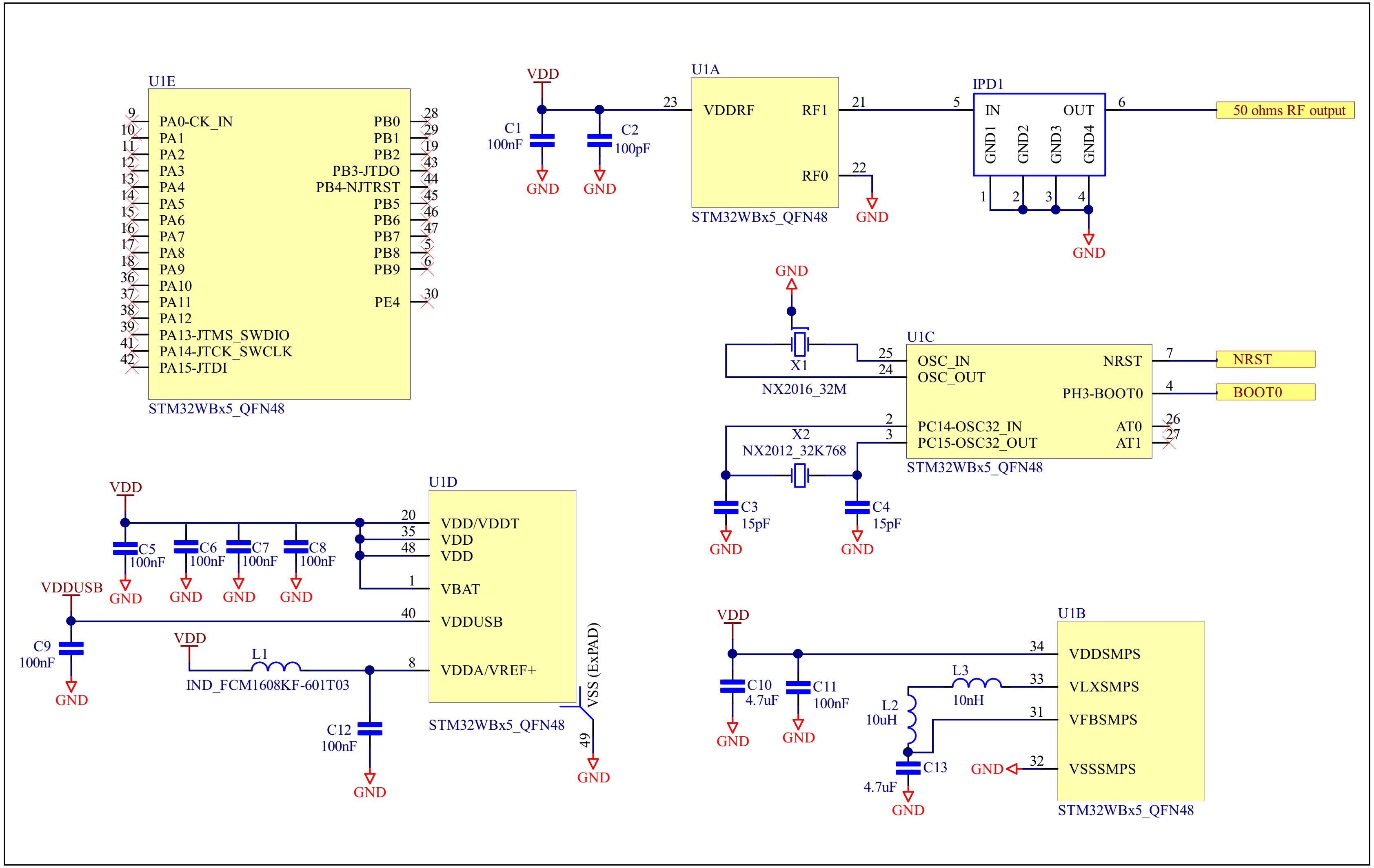


Figure 9. Optimized solution with IPD (STM32WBx0xx products)

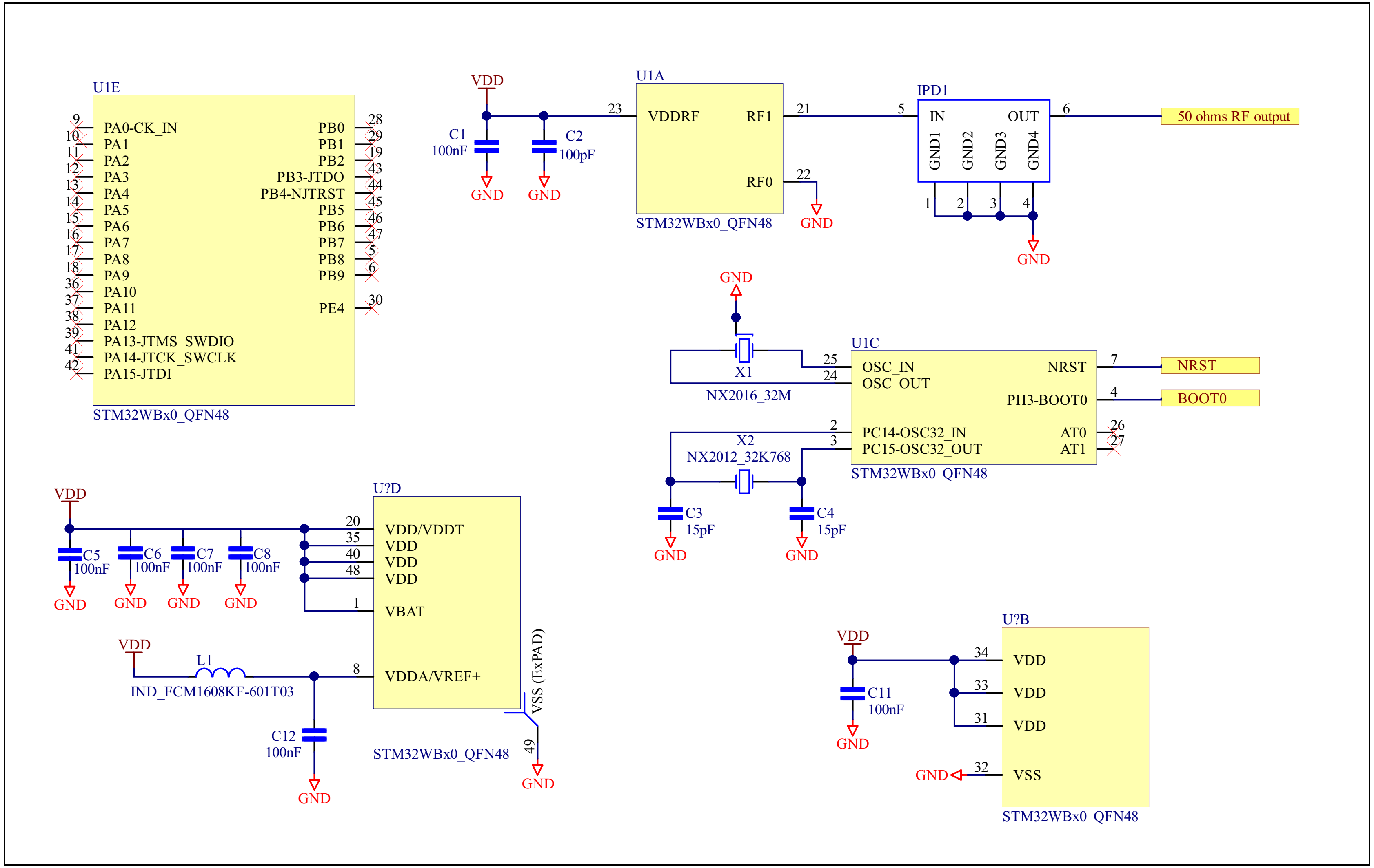
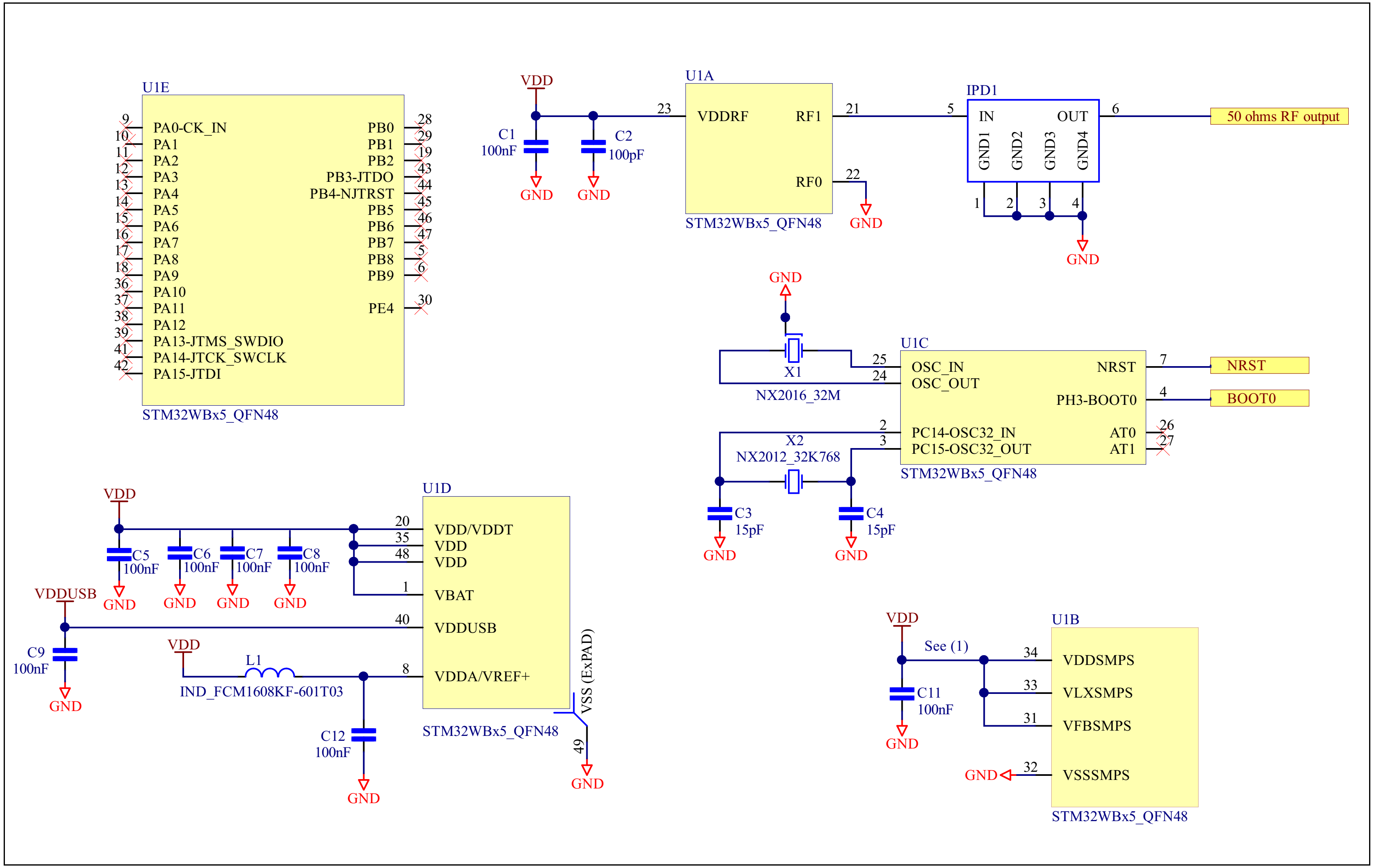


Figure 10. Solution without SMPS (STM32WBx5xx products)



1. For STM32WB55Vx add L and R, as indicated in *Section 1.2: LDO configuration for VDD > 3 V*

3 Bill of materials

Table 1. Bill of materials - Optimized solution with discrete components

Designator	Description	Comment	Footprint	Manufacturer	Part number
C1, C5, C6, C7, C8, C9, C11, C12	Capacitor, not polarized (X5R)	100 nF decoupling capacitors	0402	Murata	GRM155R61H104KE19D
C2	Capacitor, not polarized	100 pF decoupling capacitors		Yageo	CC0402KRX7R9BB101
C3, C4		15 pF LSE crystal capacitor		Murata	GRM1555C1H4R3CA01D
C10, C13		4.7 µF decoupling capacitor			GRM155R61A475MEAAD
C14		0.8 pF matching network			GRM1555C1HR80BA01D
C15		0.3 pF matching network			GRM1555C1HR30WA01D
L1	Coil	Filtering coil	0603	TAI-TECH	FCM1608KF-601T03
L2	Inductor	10 µH SMPS inductor	0805	Murata	LQM21FN100M70L
L3		10 nH SMPS inductor	0402		LQG15WZ10NJ02D
L4		2.7 nH matching network			LQG15HS2N7S02D
X1	Crystal	32 MHz - HSE	NX2016	NDK	NX2016SA_32MHz
X2		32.768 kHz - LSE	NX2012		NX2012SA_32-768kHz
FLT1	Low-pass filter	Harmonics rejection	-	Murata	LFL212G45TC1A007

Table 2. Bill of materials- Optimized solution with IPD

Designator	Description	Comment	Footprint	Manufacturer	Part number
C1, C5, C6, C7, C8, C9, C11, C12	Capacitor, not polarized (X5R)	100 nF decoupling capacitors	0402	Murata	GRM155R61H104KE19D
C2	Capacitor, not polarized	100 pF decoupling capacitors	0402	Yageo	CC0402KRX7R9BB101
C3, C4	Capacitor, not polarized	15 pF LSE crystal capacitor	0402	Murata	GRM1555C1H4R3CA01D
C10, C13	Capacitor, not polarized	4.7 µF decoupling capacitor	0402	Murata	GRM155R61A475MEAAD
L1	Coil	Filtering coil	0603	TAI-TECH	FCM1608KF-601T03
L2	Inductor	10 µH SMPS inductor	0805	Murata	LQM21FN100M70L
L3	Inductor	10 nH SMPS inductor	0402	Murata	LQG15WZ10NJ02D
X1	Crystal	32 MHz - HSE	NX2016	NDK	NX2016SA_32MHz
X2	Crystal	32.768 kHz - LSE	NX2012	NDK	NX2012SA_32-768kHz
IPD1	Integrated passive device	Matching network and low-pass filter	Bumpless CSP	STMicroelectronics	MLPF-WB55-01E3

Table 3. Bill of materials - Solution without SMPS

Designator	Description	Comment	Footprint	Manufacturer	Part number
C1, C5, C6, C7, C8, C9, C11, C12	Capacitor, not polarized (X5R)	100 nF decoupling capacitors	0402	Murata	GRM155R61H104KE19D
C2	Capacitor, not polarized	100 pF decoupling capacitors	0402	Yageo	CC0402KRX7R9BB101
C3, C4	Capacitor, not polarized	15 pF LSE crystal capacitor	0402	Murata	GRM1555C1H4R3CA01D
L1	Coil	Filtering coil	0603	TAI-TECH	FCM1608KF-601T03
X1	Crystal	32 MHz - HSE	NX2016	NDK	NX2016SA_32MHz
X2	Crystal	32.768 kHz - LSE	NX2012	NDK	NX2012SA_32-768kHz
IPD1	Integrated passive device	Matching network and low-pass filter	Bumpless CSP	STMicroelectronics	MLPF-WB55-01E3

4 Conclusion

The devices of the STM32WB Series show excellent RF performance (detailed in the product datasheets available on www.st.com), with a minimal set of external components associated with a PCB layout that complies with RF guidelines.

5 Revision history

Table 4. Document revision history

Date	Revision	Changes
14-Feb-2019	1	Initial release.
20-Feb-2019	2	Updated *Section 1.1: SMPS and LDO configurations*. Updated *Table 2: Bill of materials- Optimized solution with IPD*.
25-Sep-2019	3	Updated *Section 1.1: SMPS and LDO configurations* and *Section 4: Conclusion*. Updated *Figure 4: HSE trimming*, *Figure 6: Optimized solution with discrete components (STM32WBx5xx products)*, *Figure 8: Optimized solution with IPD (STM32WBx5xx products)* and *Figure 10: Solution without SMPS (STM32WBx5xx products)*. Added *Figure 7: Optimized solution with discrete components (STM32WBx0xx products)* and *Figure 9: Optimized solution with IPD (STM32WBx0xx products)*.
22-Jan-2020	4	Updated *Table 1: Bill of materials - Optimized solution with discrete components*, *Table 2: Bill of materials- Optimized solution with IPD* and *Table 3: Bill of materials - Solution without SMPS*. Updated *Figure 6: Optimized solution with discrete components (STM32WBx5xx products)*, *Figure 7: Optimized solution with discrete components (STM32WBx0xx products)*, *Figure 8: Optimized solution with IPD (STM32WBx5xx products)*, *Figure 9: Optimized solution with IPD (STM32WBx0xx products)* and *Figure 10: Solution without SMPS (STM32WBx5xx products)*.
12-May-2020	5	Updated *Figure 1: Supply configurations*. Added *Section 1.2: LDO configuration for VDD > 3 V*.
22-Jul-2020	6	Updated *Section 1.2: LDO configuration for VDD > 3 V*. Updated *Figure 3: Recommended schematic for the no SMPS configurations (STM32WB55Vx)*. Added footnote to *Figure 10: Solution without SMPS (STM32WBx5xx products)*.