AN5290
Application note

Getting started with STM32WB MCU hardware development

Introduction

The microcontrollers of the STM32WB series 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 be easily extended to other packages.

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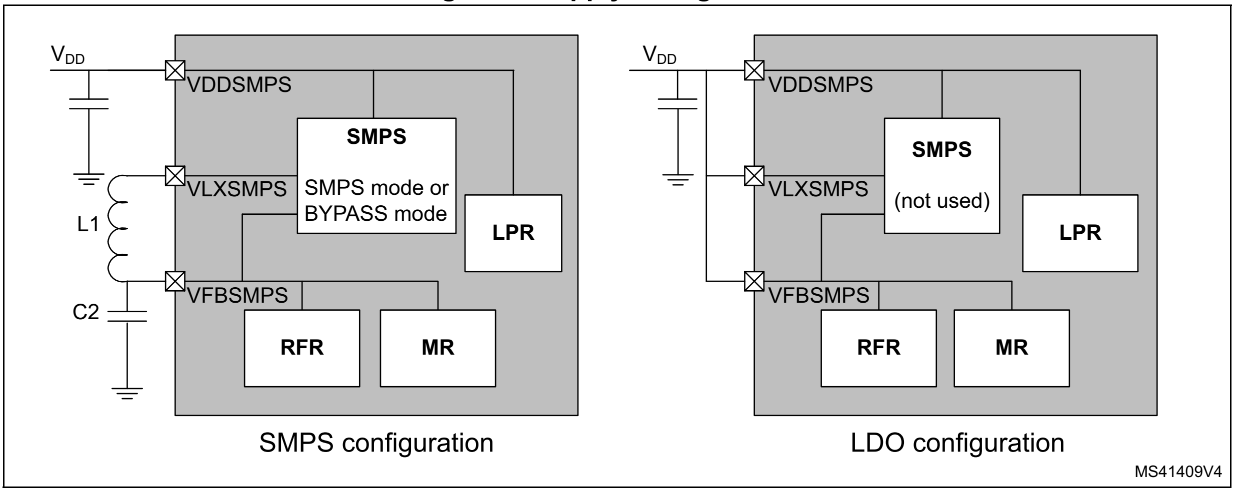
1 Design considerations

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 (refer to the datasheets) 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 "*How to use SMPS to improve power efficiency on STM32WB MCUs*", 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*.

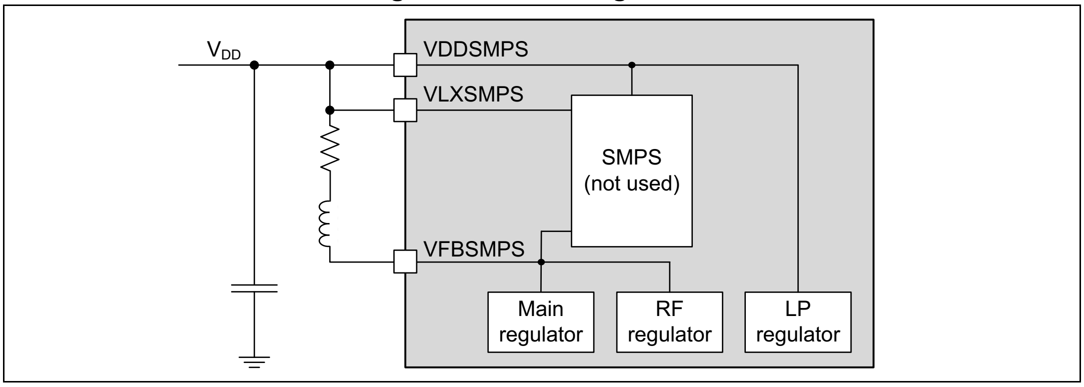
a. Arm is a registered trademark of Arm Limited (or its subsidiaries) in the US and/or elsewhere.

1.2 LDO configuration for V_{DD} > 2.5 V

This configuration applies only to STM32WB5xxx and STM32WB3xxx 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*.

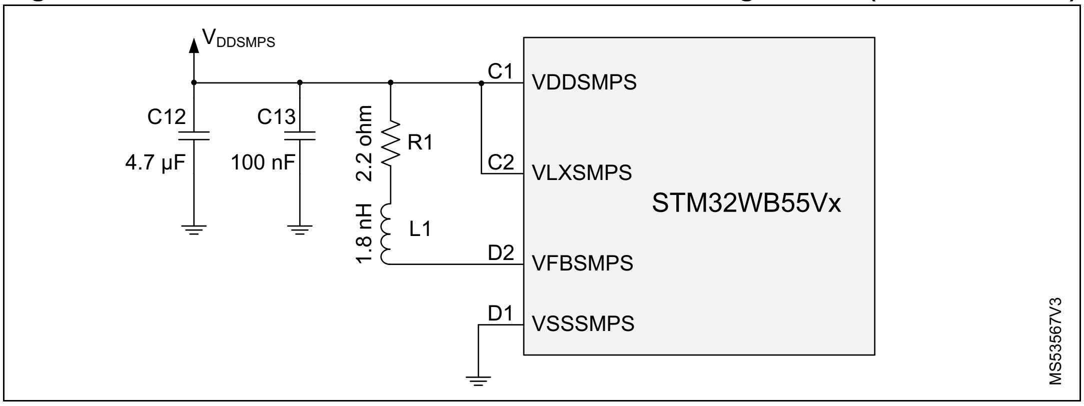
Figure 2. LDO configuration



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

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

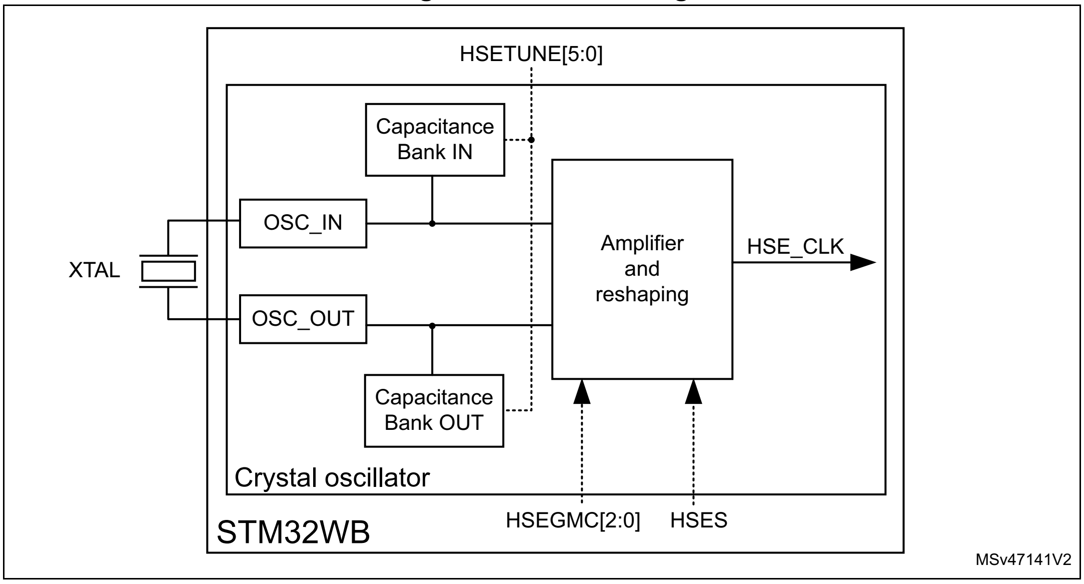
Figure 3. Recommended schematic for the no SMPS configurations (STM32WB55Vx)



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 “*How to calibrate the HSE clock for RF applications on STM32 wireless MCUs*”, available on *www.st.com*, for more details.

Figure 4. HSE trimming

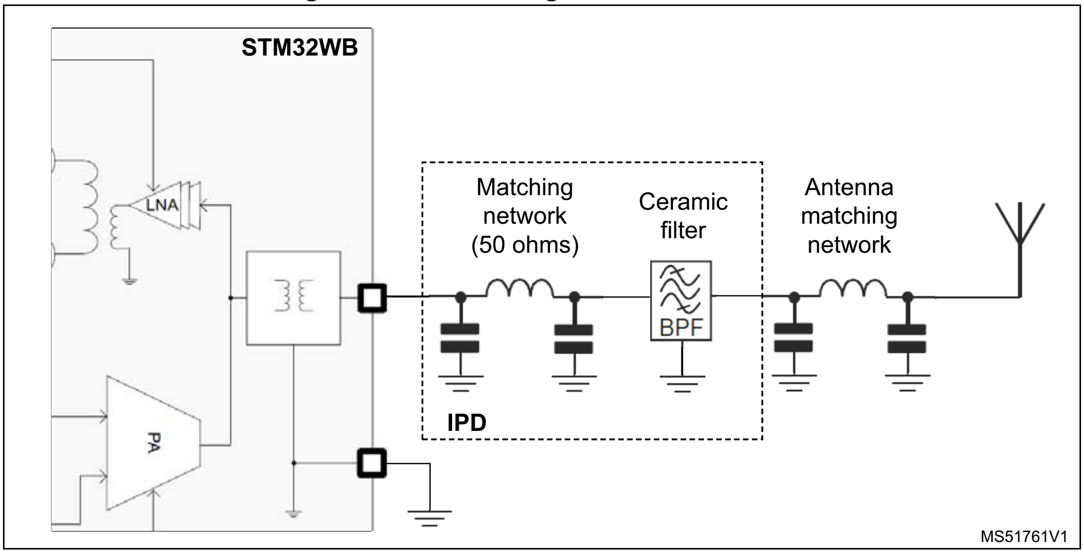


1.4 RF matching

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

An external PI filter made up by discrete components is needed for impedance matching, it is followed by a ceramic filter for rejection of harmonics. 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 “How to *develop RF hardware using STM32WB microcontrollers*”, available on *www.st.com,* describes the precautions needed for the layout of an RF board with the STM32WB.

2 Schematics

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

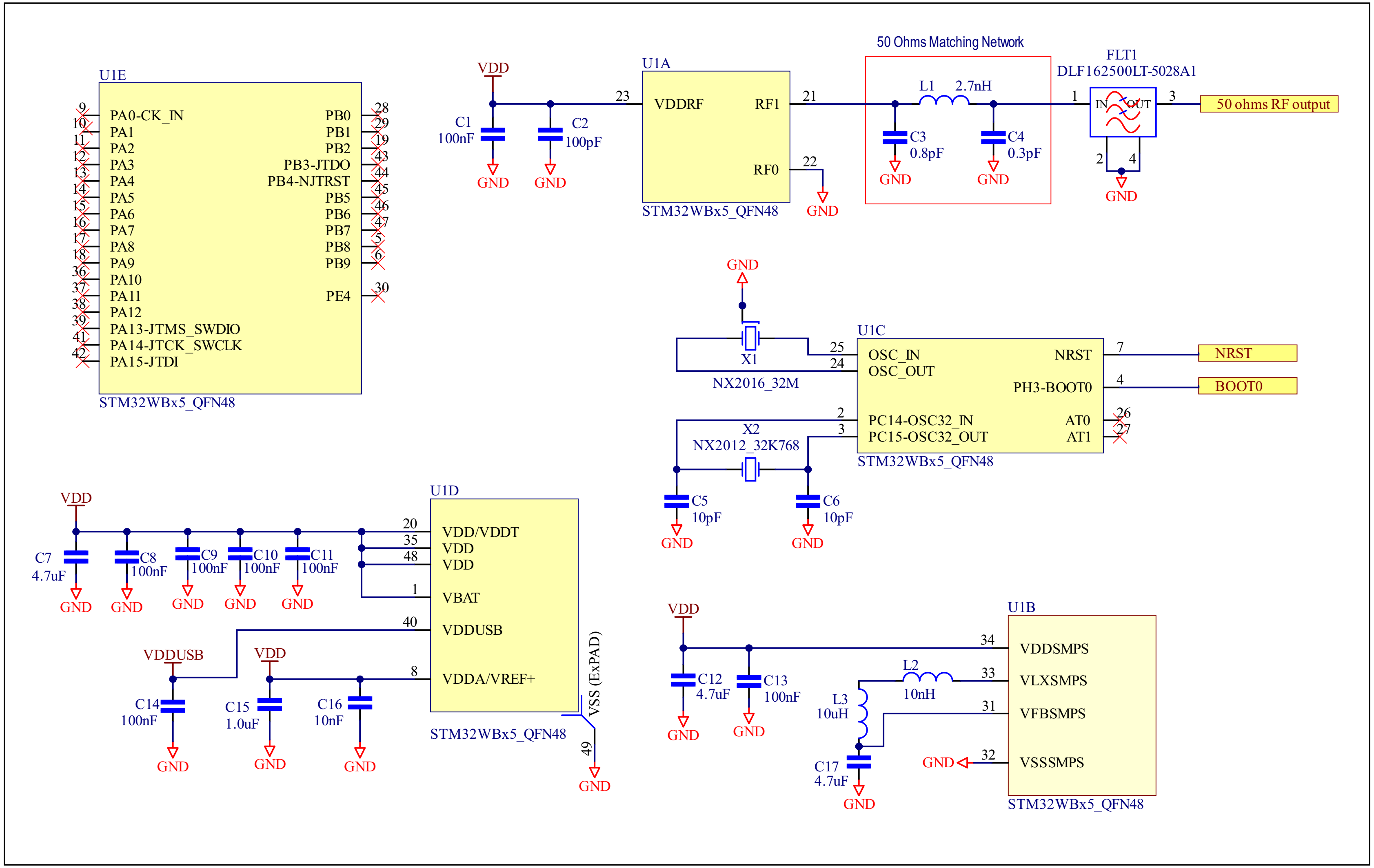


Figure 7. Optimized solution with discrete components (STM32WBx0xx products)

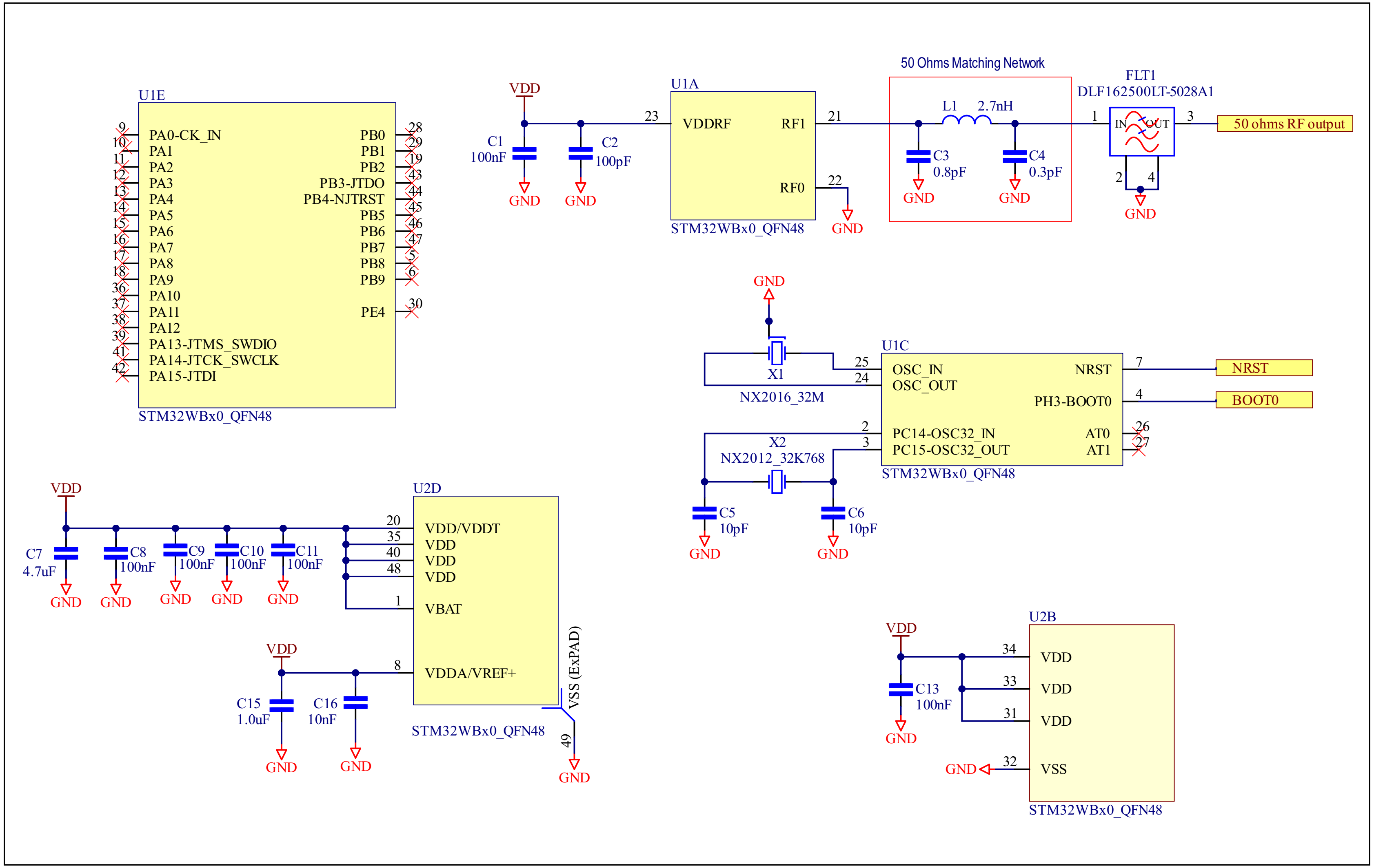


Figure 8. Optimized solution with IPD (STM32WBx5xx products)

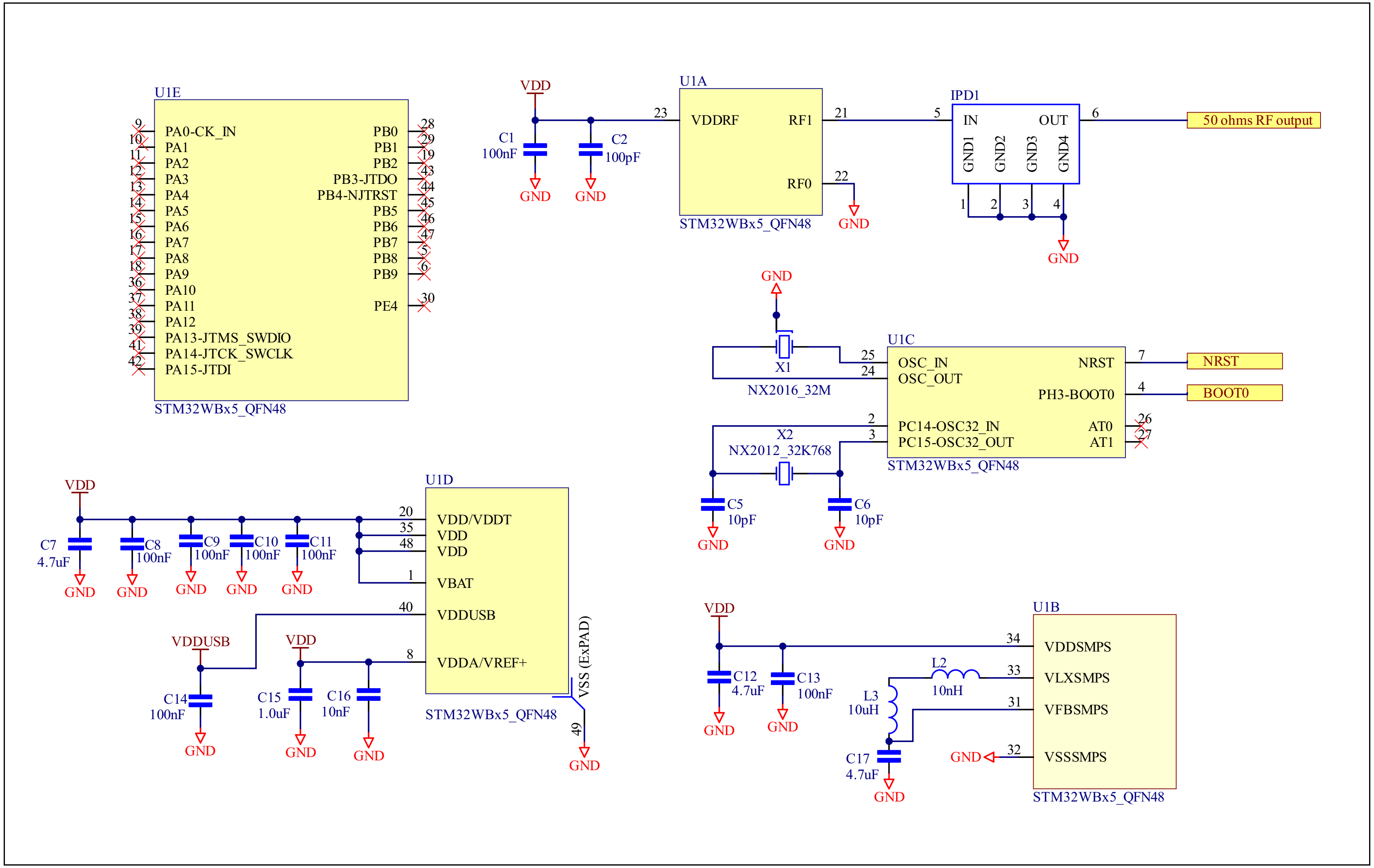


Figure 9. Optimized solution with IPD (STM32WBx0xx products)

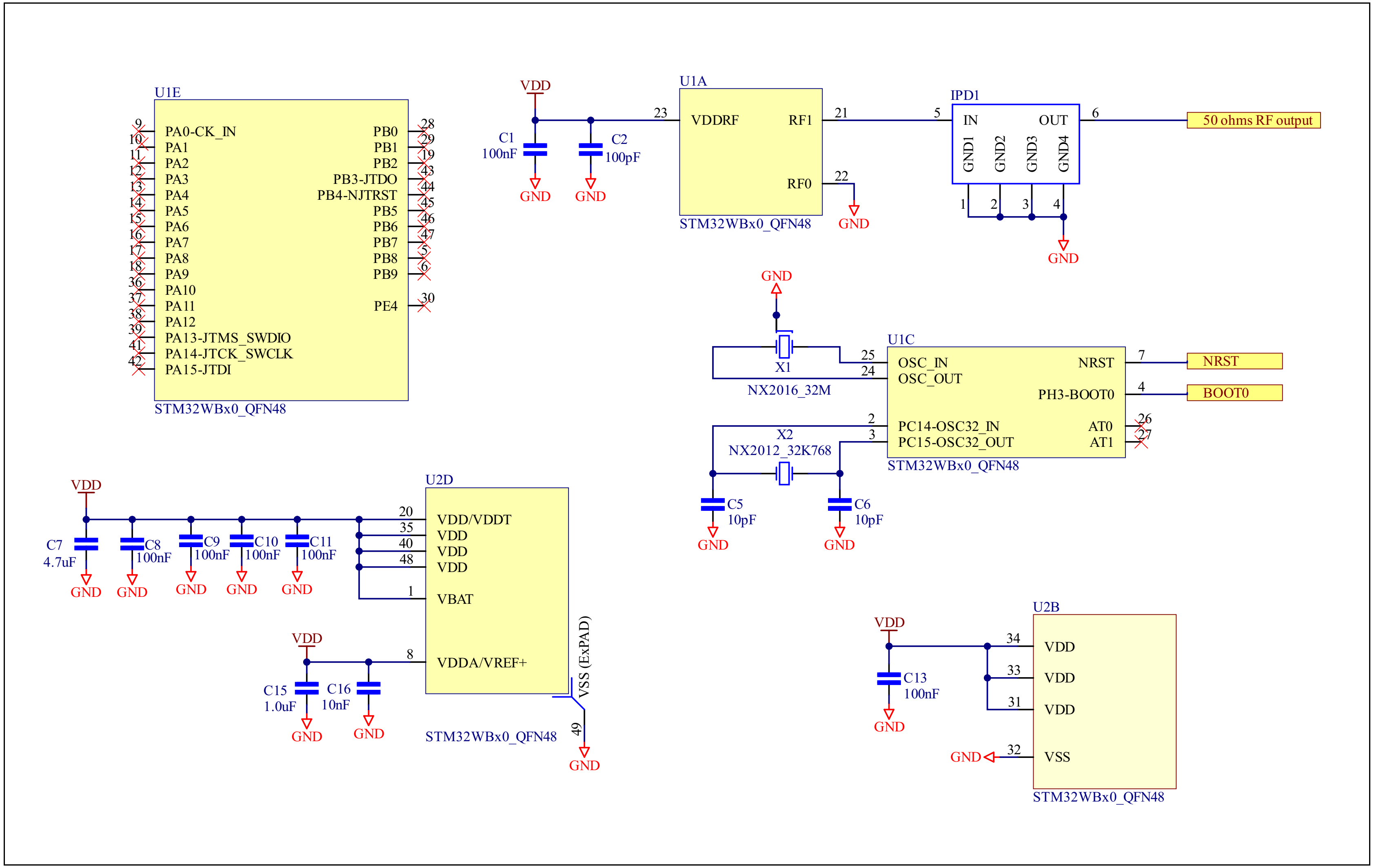
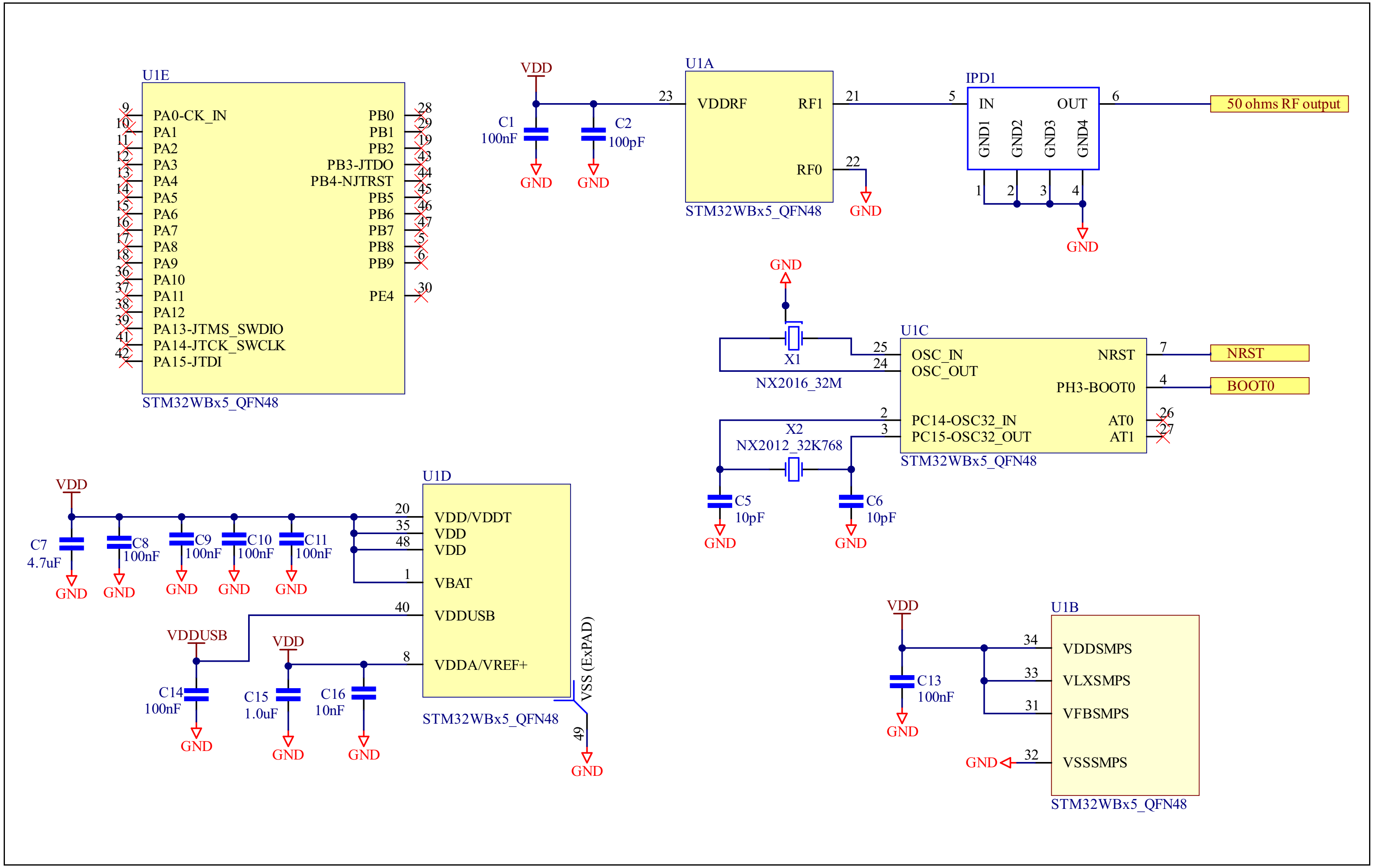


Figure 10. Solution without SMPS (STM32WBx5xx products)



1. For STM32WB55Vx add L and R, as indicated in *Section 1.2: LDO configuration for VDD > 2.5 V*.

3 Bill of materials

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

<table>
<tr><th>Designator</th><th>Description</th><th>Comment</th><th>Footprint</th><th>Manufacturer</th><th>Part number</th></tr>
<tr><td>C16</td><td rowspan="2">Capacitor, not polarized (X5R)</td><td>10 nF
decoupling capacitor</td><td rowspan="8">0402</td><td>Kyocera-AVX</td><td>0402YD103KAT2A</td></tr>
<tr><td>C1, C8, C9, C10, C11, C13, C14</td><td>100 nF
decoupling capacitors</td><td>Murata</td><td>GRM155R61H104KE19D</td></tr>
<tr><td>C2</td><td>Capacitor, not polarized (X7R)</td><td>100 pF
decoupling capacitor</td><td>Yageo</td><td>CC0402KRX7R9BB101</td></tr>
<tr><td>C5, C6</td><td>Capacitor, not polarized (C0G)</td><td>10 pF
LSE crystal capacitor</td><td rowspan="5">Murata</td><td>GRM0335C1E100JA01D</td></tr>
<tr><td>C7, C12</td><td rowspan="2">Capacitor, not polarized (X5R)</td><td>4.7 µF
decoupling capacitors</td><td>GRM155R61A475MEAAD</td></tr>
<tr><td>C15</td><td>1.0 µF
decoupling capacitor</td><td>GRM155R61A105KE15D</td></tr>
<tr><td>C3</td><td rowspan="2">Capacitor, not polarized (C0G)</td><td>0.8 pF
matching network</td><td>GRM1555C1HR80BA01D</td></tr>
<tr><td>C4</td><td>0.3 pF
matching network</td><td>GRM1555C1HR30WA01D</td></tr>
<tr><td>L3</td><td rowspan="3">Inductor</td><td>10 µH
SMPS inductor</td><td>0805</td><td rowspan="3">Murata</td><td>LQM21FN100M70L</td></tr>
<tr><td>L2</td><td>10 nH
SMPS inductor</td><td>0402</td><td>LQG15WZ10NJ02D</td></tr>
<tr><td>L1</td><td>2.7 nH
matching network</td><td>0402</td><td>LQG15HS2N7S02D</td></tr>
<tr><td>X1</td><td rowspan="2">Crystal</td><td>32 MHz - HSE</td><td>NX2016</td><td rowspan="2">NDK</td><td>NX2016SA_32MHz</td></tr>
<tr><td>X2</td><td>32.768 kHz - LSE</td><td>NX2012</td><td>NX2012SA_32-768kHz</td></tr>
<tr><td>FLT1</td><td>Low-pass filter</td><td>Harmonics rejection</td><td>-</td><td>Murata</td><td>DLF162500LT-5028A1</td></tr>
</table>

Table 2. Bill of materials- Optimized solution with IPD

Designator	Description	Comment	Footprint	Manufacturer	Part number
C16	Capacitor, not polarized (X5R)	10 nF decoupling capacitor	0402	Kyocera-AVX	0402YD103KAT2A
C1, C8, C9, C10, C11, C13, C14		100 nF decoupling capacitors		Murata	GRM155R61H104KE19D
C2	Capacitor, not polarized	100 pF decoupling capacitors		Yageo	CC0402KRX7R9BB101
C5, C6		10 pF LSE crystal capacitor		Murata	GRM0335C1E100JA01D
C7, C12	Capacitor, not polarized (X5R)	4.7 µF decoupling capacitor		Murata	GRM155R61A475MEAAD
C15		1.0 µF decoupling capacitor			GRM155R61A105KE15D
L2	Inductor	10 nH SMPS inductor	0402	Murata	LQG15WZ10NJ02D
L3		10 µH SMPS inductor	0805		LQM21FN100M70L
X1	Crystal	32 MHz - HSE	NX2016	NDK	NX2016SA_32MHz
X2		32.768 kHz - LSE	NX2012		NX2012SA_32-768kHz
FLT1	Low-pass filter	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
C16	Capacitor, not polarized (X5R)	10 nF decoupling capacitor	0402	Kyocera-AVX	0402YD103KAT2A
C1, C8, C9, C10, C11, C13, C14		100 nF decoupling capacitors		Murata	GRM155R61H104KE19D
C2	Capacitor, not polarized	100 pF decoupling capacitor		Yageo	CC0402KRX7R9BB101
C5, C6		10 pF LSE crystal capacitors		Murata	GRM0335C1E100JA01D
C7	Capacitor, not polarized (X5R)	4.7 µF decoupling capacitor		Murata	GRM155R61A475MEAAD
C15		1.0 µF decoupling capacitor			GRM155R61A105KE15D
X1	Crystal	32 MHz - HSE	NX2016	NDK	NX2016SA_32MHz
X2		32.768 kHz - LSE	NX2012		NX2012SA_32-768kHz
FLT1	Low-pass filter	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 > 2.5 V*.
22-Jul-2020	6	Updated *Section 1.2: LDO configuration for VDD > 2.5 V*. Updated *Figure 3: Recommended schematic for the no SMPS configurations (STM32WB55Vx)*. Added footnote to *Figure 10: Solution without SMPS (STM32WBx5xx products)*.
30-Mar-2023	7	Updated *Section 1.2: LDO configuration for VDD > 2.5 V*. Updated schematics (figures *6* to *10*). 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*. Minor text edits across the whole document.
08-Jan-2024	8	Updated *Figure 3: Recommended schematic for the no SMPS configurations (STM32WB55Vx)*.