AN12893

Using the DC-DC Feature

Rev. 0 — 30 June 2022 Application note

Document information

Information	Content
Keywords	JN5189, QN9090, K32W, DCDC
Abstract	This document outlines critical parameters for DC-DC external component selection and implication of incorrect component selection.

1 Introduction

This application note provides a hardware design guide for the DC-DC converter on the JN5189, QN9090, and K32W devices. It explains how to choose external components for the DC-DC converter properly. The document focuses on the critical parameters of external components and their implication of incorrect selection, including a PCB design example of the external component.

2 Theory and uses of DC-DC converters

DC-to-DC converters are used in portable electronic devices such as cellular phones and laptop computers, which are supplied with power from batteries primarily. Such electronic devices often contain several subcircuits, each with its own voltage level requirement different from the one supplied by the battery or an external supply, sometimes higher or lower than the supply voltage. Additionally, the battery voltage declines as its stored energy is drained. Switched DC-to-DC converters offer a method to increase the voltage from a partially lowered battery voltage instead of using multiple batteries to accomplish the same thing. This method saves space.

Most DC-to-DC converter circuits also regulate the output voltage. Some exceptions include high-efficiency LED power sources, a kind of DC-to-DC converter that regulates the current through the LEDs and simple charge pumps that double or triple the output voltage.

Switching converters, such as buck converters in JN5189, QN9090, and K32W, provide much greater power efficiency as DC-to-DC converters than linear regulators. These linear regulators are simpler circuits that lower voltages by dissipating power as heat but do not step up output current.

Warning:

The DC-DC function is bypassed by removing the inductor and mounting a series resistor to VBAT on the JN5189, QN9090, or K32W OM15069 module, as shown in Figure 1.

However, this mode is not allowed and NXP does not support this mode.

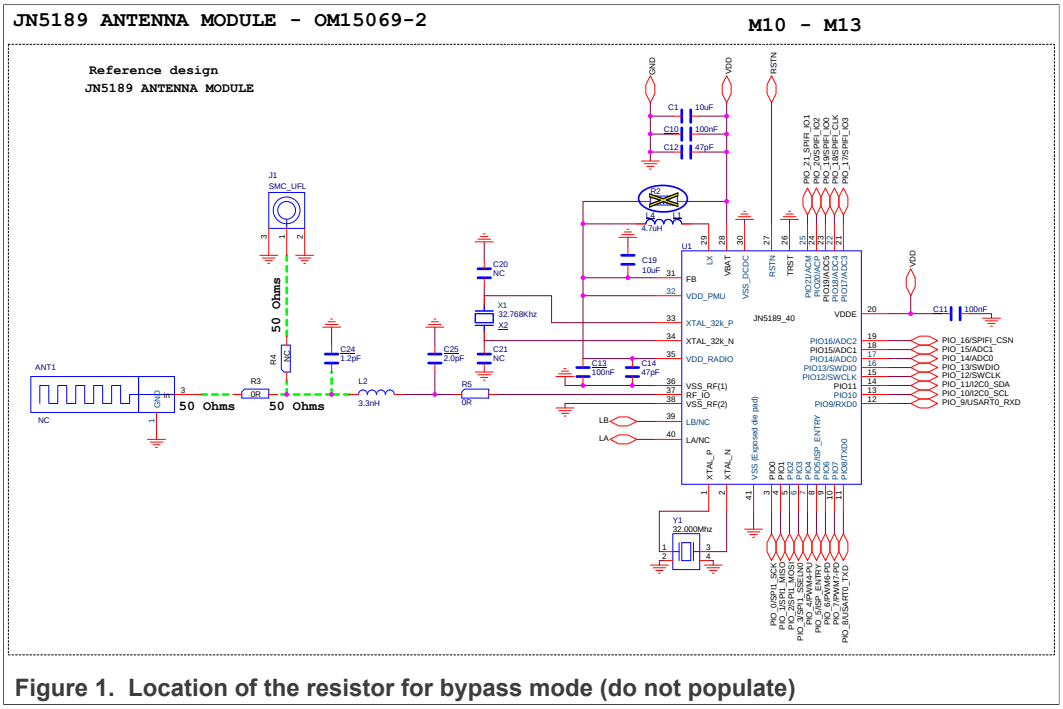

Figure 1. Location of the resistor for bypass mode (do not populate)

3 Hardware design guide

This chapter summarizes the hardware requirements for external components used for a proper functionality of the DC-DC internal converter. It contains the recommendation of appropriate component selection and the PCB drawing.

The JN5189, QN9090, and K32W family consist of internal regulators including the DC-DC converter, which are supplied by the main external supply domain with VBAT of 1.9 V – 3.6 V. Figure 2 shows the connection of all the external components and the MCU required for proper DC-DC functionality.

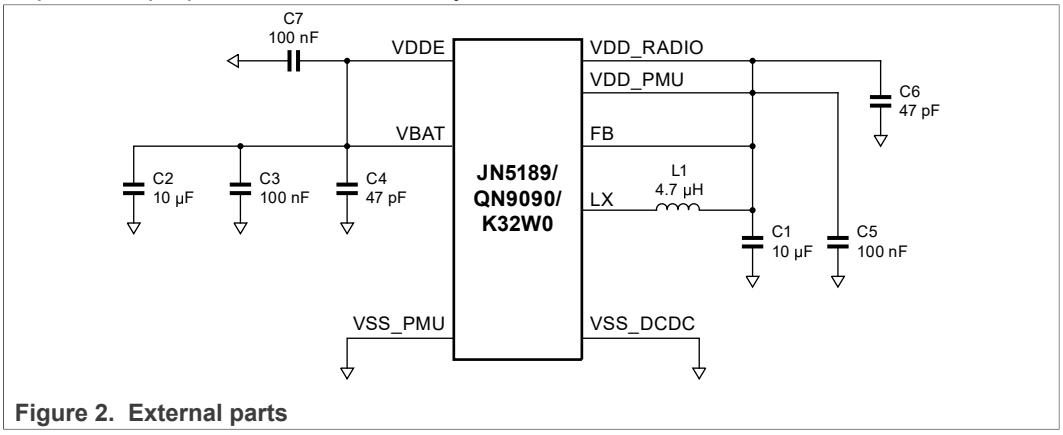

Figure 2. External parts

Table 1 summarizes the pin names and numbers for all packages.

Table 1. List of pin names and numbers for internal DC-DC converter

Pin Name	Pin number (HVQFN40)
VBAT	28
VDD_PMU	32

Table 1. List of pin names and numbers for internal DC-DC converter...*continued*

Pin Name	Pin number (HVQFN40)
VDD_RADIO	35
VDDE	20
VSS_DCDC	30
VSS_PMU	-
LX	29
FB	31

Table 2 summarizes the values and limitations for the external components of the DC-DC internal converter.

Table 2. External parts

Part	Minimum	Type	Maximum	Unit
C1	10	22 (X5R or X7R)	47	µF
C2	10	22 (X5R or X7R)	47	µF
C3	80	100 (X5R or X7R)	120	nF
C4	38.7	47 (COG)	56.2	pF
C5	80	100 (X5R or X7R)	120	nF
C6	38.7	47 (COG)	56.2	pF
C7	80	100 (X5R or X7R)	120	nF
L1	3.87	4.7	10	µH

3.1 Input decoupling capacitors

The 100 nF and 47 pF ceramic capacitors are the input decoupling capacitors for the DC-DC converter. The 10 µF or 20 µF input ceramic capacitor is used to decouple and power the internal DC-DC converter. All the decoupling capacitors must be placed close to the pin. For the capacitors, there is no Equivalent Series Resistance (ESR) value restriction.

3.2 Output filter capacitor

This capacitor sets the voltage ripple value, which is essential for USB power supply requirements. A minimum value of the output capacitor is 10 µF and is necessary for the correct functionality of the DC-DC converter.

If the value of the output capacitor is below 10 µF, the voltage ripple is higher, and it does not meet the requirements of internal LDO. Values higher than the typical 22 µF increase possible noise current.

3.3 Power inductor

The typical inductor value for most applications is from 3.7 µH – 5.6 µH. Those values are chosen based on the desired ripple current.

At the expense of higher output-voltage ripple, small-value inductors result in a higher output current slew rate, improving the load transient response of the converter. The higher the values of inductors, the lower the ripple current, reducing the core magnetic hysteresis losses.

Table 3 summarizes the values and limitations of the power inductor.

Table 3. Power inductor

Parameter	Minimum	Type	Maximum	Unit
Inductance value	3.7	4.7	5.6	µH
Saturation current	350	500	-	mA

3.3.1 Saturation current limitation

The minimum value of the saturation current is 350 mA. The recommended saturation current is 500 mA or higher.

3.4 PCB guide line

To reduce the series resistance from the DC-DC inductor, keep the traces as thick and as short as possible. The ground between the inputs of capacitors C2, C3, C4, the DC-DC ground pads, and the output capacitor C1 must be on the same plane. It is not possible to use a via or a strap connection.

Figure 3 shows a proper DC-DC ground connection.

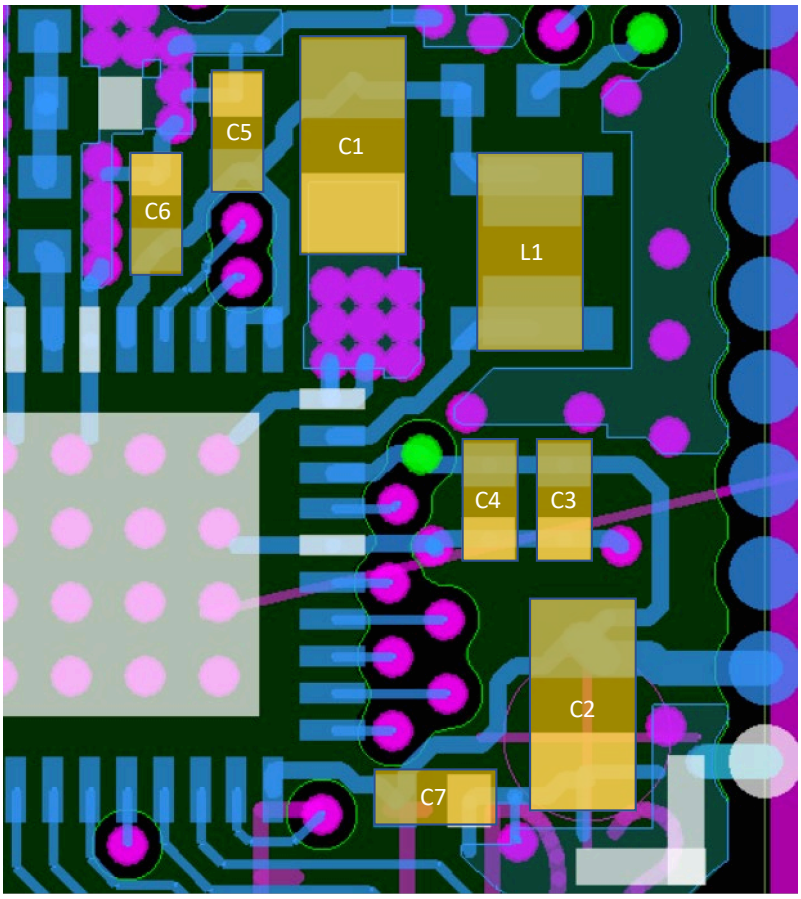

Figure 3. Ground connection

4 Conclusion

This application note summarizes all external components and PCB recommendations of the internal DC-DC converter used in JN5189, QN9090, and K32W. For proper

functionality, follow these recommendations in your designs with JN5189, QN9090, and K32W.

Efficiency is often the main design goal when using a DC-DC converter. Using the DC-DC converters increases the conversion efficiency from battery voltage to a low supply voltage. Even though a linear regulator can be used, it cannot achieve the same efficiency as switching regulators.

5 Revision history

Revision history

Rev.	Date	Description
0	30 June 2022	Initial release

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