User guide

N32G032 Series MCU Hardware Design Guide

Introduction

This document details the hardware design checklist for N32G032 series MCUs to provide users with hardware design guidance.

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CONTENS

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1. N32G032 Series MCU Hardware Design Checklist

1.1 Introduction to power supply

The operating voltage (VDD) of N32G032 series chips is 1.8V~5.5V. Mainly: VDD, VDDA pins. For details, please refer to the relevant datasheet

1.2 VDD power supply scheme

VDD is the main power supply of MCU and must be powered by a stable external power supply. The voltage range is 1.8V~5.5V. All VDD pins need to place a 0.1uF decoupling capacitor nearby, and one VDD pin needs to add a 4.7uF decoupling capacitors. For the specific design of the decoupling capacitor, please refer to the reference design schematic diagram of the minimum system of each package in Chapter 3.

VDDA is the analog power supply, providing power to most of the analog peripherals. It is recommended to place a 0.1uF and a 1uF capacitor at the VDDA input pin.

1.3 External pin reset circuit

A system reset occurs when a low level (external reset) occurs on the NRST pin. The external NRST pin reset reference circuit is as follows

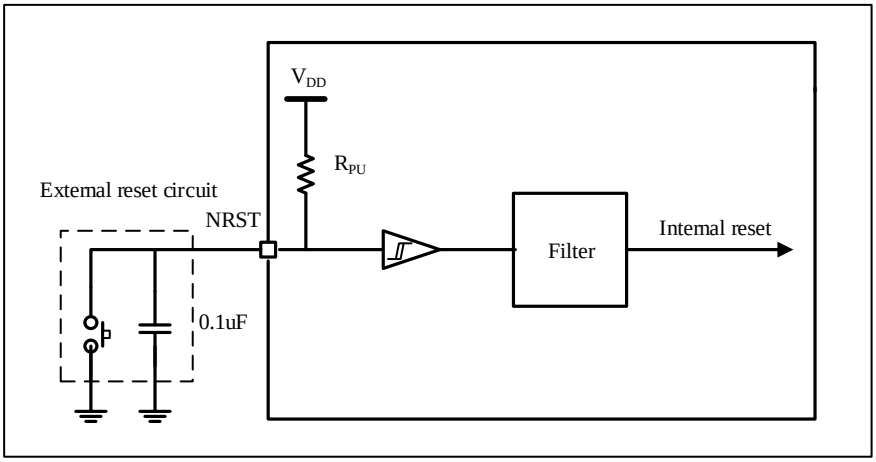

Figure 1-1 System reset diagram

Note: The reset pin NRST cannot be left floating in the design, and the external capacitor 0.1uF is given as a typical reference value. If the reset time needs to be accelerated, the NRST pin can be pulled up externally, and the typical value of the pull-up resistor is 10K. In addition, the user can decide whether to add a reset button according to the actual needs of the product.

1.4 External clock circuit

N32G032 series MCU contains 2 external clocks: external high-speed clock HSE (4MHz~20MHz) and external low-speed clock LSE (usually 32.768KHz).

HSE and LSE configure the corresponding load capacitance according to the characteristics of the crystal

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oscillator. For details, please refer to the description of the external clock characteristics in the relevant datasheet.

When using LSE, the adjacent IO pins (take N32G032C8L7 as an example, the adjacent pins are PC13 and PF0) cannot have GPIO flip level signals. Refer to Figure 1-2 for adjacent pins. The inverted level signal will cause unstable LSE operation.

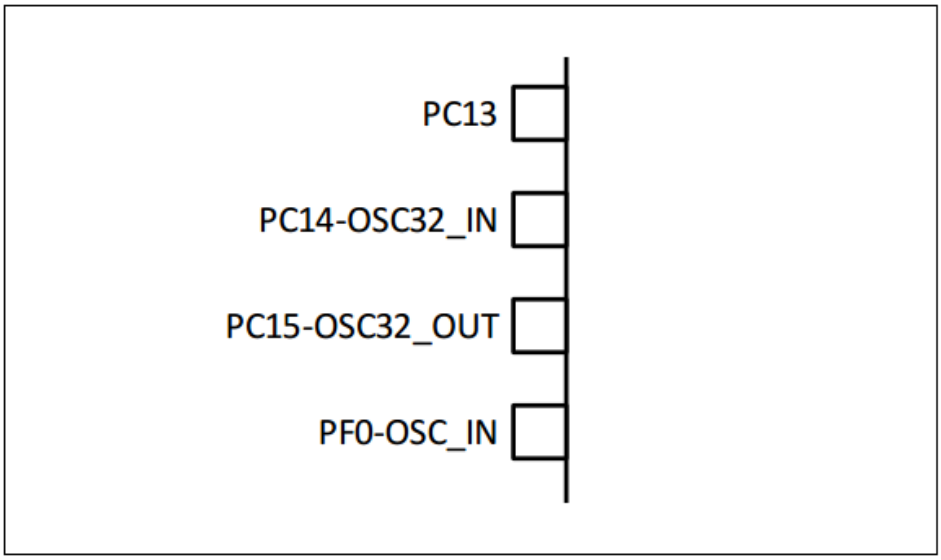

Figure 1-2 PC13/PF0 pin cannot have flip signal

1.5 Boot Pin Connection

The figure below shows the external connections required for the N32G032 series chip to select the boot memory. Please refer to the relevant section of the datasheet for the startup mode.

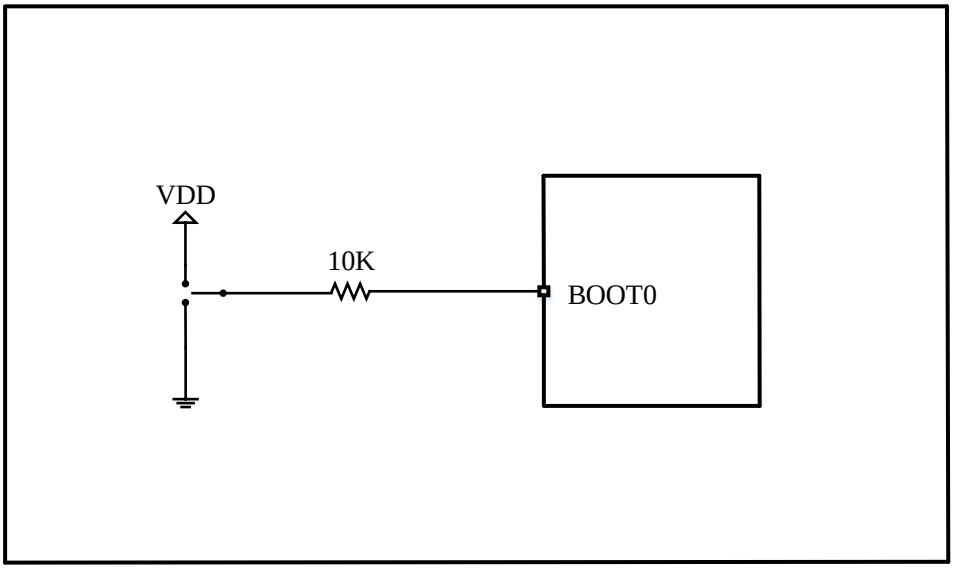

Figure 1-3 Startup mode implementation example

Note: The resistance values in the figure are given as typical reference values only.

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1.6 Independent ADC Converter

To improve the conversion accuracy, the ADC has a pair of independent power supplies, an independent VDDA pin powers the ADC, and the VSSA pin is used as the ground terminal of the analog power supply. It can be separately filtered and shielded from noise on the PCB to power the ADC.

Regarding the ADC circuit design, please pay attention to the following points:

1） When using ADC sampling, it is recommended to shorten the external wiring distance;

2） It is recommended to keep away from some high frequency inversion signals around the input signal of ADC;

3） During ADC conversion, the chip does not support modifying the ADC configuration. If you need to modify the configuration, you need to wait for the current conversion to end or turn off the ADC before configuring;

4） When a certain ADC channel is used, negative voltage (such as -0.2V) cannot be applied to other unused ADC sampling channels. If this negative voltage is applied, the voltage of the normally sampled ADC channel will be pulled down, resulting in sampling. data is inaccurate;

5） When a certain ADC channel is used, high voltage (greater than VDD voltage) cannot be applied to other unused ADC sampling channels. If this high voltage is applied, the voltage of the normally sampled ADC channel will be pulled up, resulting in the read Data is inaccurate.

6） When using ADC, the maximum value of RAIN cannot be too large, and it needs to comply with the following formula:

$$R_{AIN} < \frac{T_S}{f_{ADC} \times C_{ADC} \times \ln(2^{N+2})} - R_{ADC}$$

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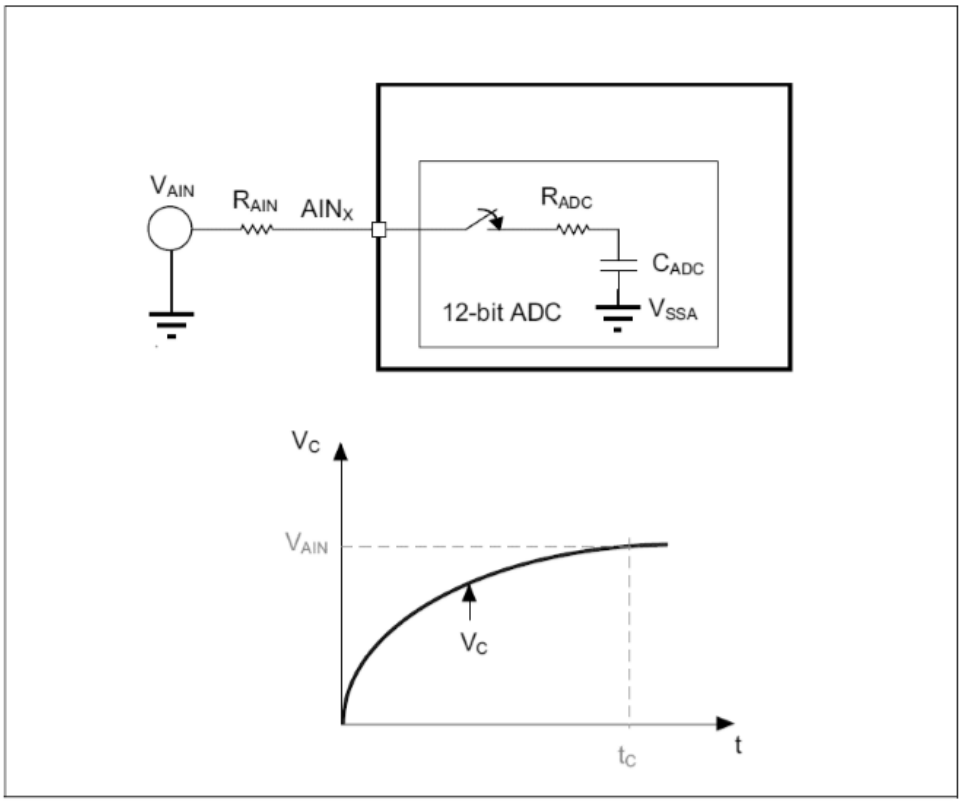

Figure 1-4 Influence of series resistance of ADC input port

The following figure shows the relationship between external input impedance and sampling time: (Maximum allowable error = 1/4LSB, 12-bit resolution, ADC clock frequency = 18MHZ)

Sampling cycle	Sampling time(ns)	External input impedance $R_{AIN}(\Omega)$
6	333.3	521.1
8	444.4	961.5
14	777.8	2282.7
20	1111.1	3603.8
29	1611.1	5585.6
42	2333.3	8448.0
56	3111.1	11530.7
72	4000.0	15053.8
88	4888.9	18576.9
120	6666.7	25623.0
182	10111.1	39274.9
240	13333.3	52046.0
300	16666.7	65257.5
400	22222.2	87276.6
480	26666.7	104891.9
600	33333.3	131314.9

Figure 1-5 The relationship between ADC external input impedance and sampling time

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1.7 IO power-on pulse processing

During the power-on process, because the IO is in a high-impedance state and the internal circuit coupling characteristics, a high-level pulse will appear on the IO at the moment of power-on (the actual high-pulse voltage value should be measured by the user). If the pulse will affect its application, it is recommended to add an appropriate capacitor (1nF~100nF) or an appropriate pull-down resistor (10K~100K) on the corresponding IO.

The following picture shows the waveform of IO (PA9) during the power-on process of the development board N32G032C8L7-STB 1.0:

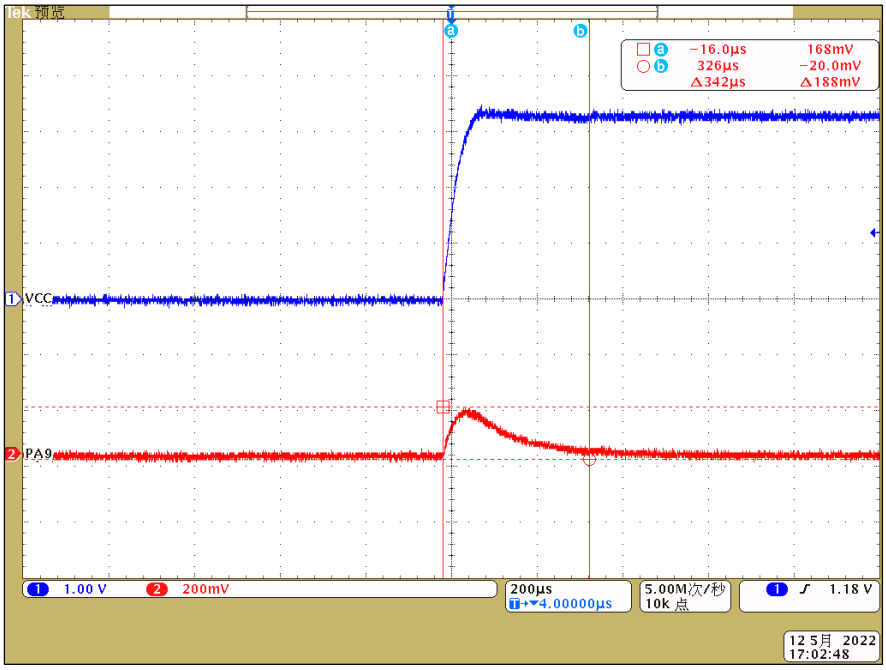

Figure 1-6 IO (PA9) waveform during power-on

The following picture shows the waveform of the IO (PA9) plus a 10K pull-down resistor during the power-on process of the development board N32G032C8L7-STB 1.0:

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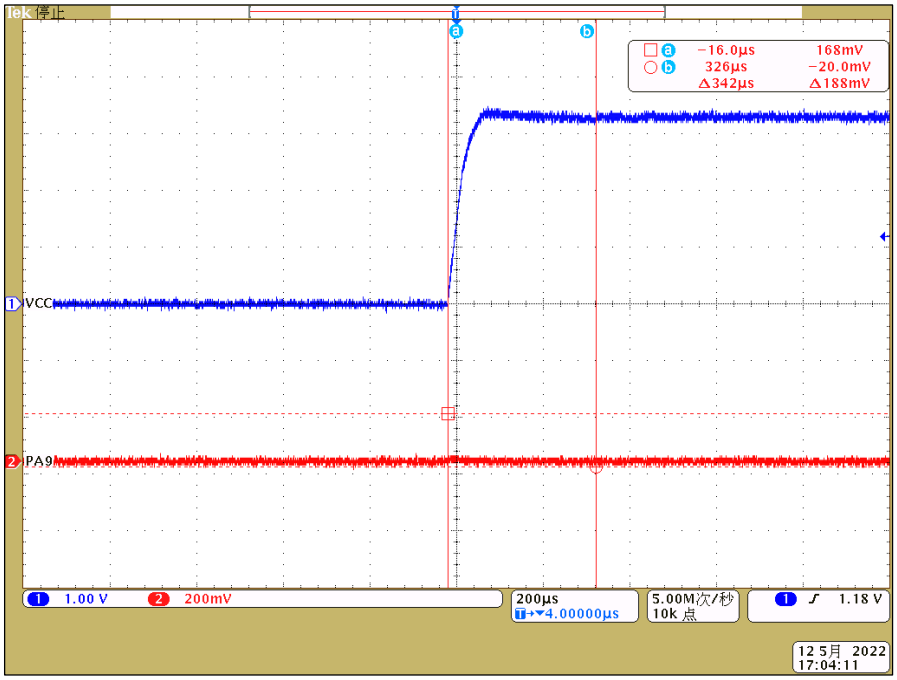

Figure 1-7 Waveform after IO (PA9) plus pull-down resistor during power-on process

1.8 IO withstand voltage

When using the chip, please pay attention to the withstand voltage value of each IO. In the I/O column defined by pin multiplexing in the datasheet, TC: Standard 5V IO is marked

封装						Pin name (function after reset)	Type(1)	I/O structure	Alternate functions	Additional functions
LQFP48/ TQFP48	LQFP32	QFN32(5mx5m)	QFN32(4mx4m)	UFQFPN20	TSSOP20					
1	1	1	1	-	-	VDD	S	-	Complementary power supply	
2	-	-	-	-	-	PC13	I/O	TC	RTC_TAMP1, RTC_TS, RTC_OUT,	WKUP1
3	-	-	2	1	-	PC14-OSC32_IN (PC14)	I/O	TC	-	OSC32_IN
4	-	-	3	2	-	PC15-OSC32_OUT (PC15)	I/O	TC	-	OSC32_OUT

Figure 1-8 I/O structure defined by datasheet pin multiplexing

Note: TC: Standard 5V IO; when using the chip, pay attention to the impact of signals higher than 5V on IO.

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1.9 Anti-static design

1.9.1 PCB Design

For the PCB design of ordinary two-layer boards, it is recommended to do wrapping around the signal lines, and try to cover the edges of the PCB as much as possible. If the cost allows, it can be designed with a four-layer board or a multi-layer board. In a multi-layer PCB, the ground plane acts as an important charge source, which can offset the charge on the electrostatic discharge source, which is conducive to reducing the electrostatic field band. The ground plane of the PCB can also be used as a shield for the signal line (of course, the larger the opening of the ground plane, the lower the shielding effectiveness). In addition, if a discharge occurs, since the ground plane of the PCB board is large, the charge is easily injected into the ground plane, rather than into the signal line. This will help protect the component, because the charge can be drained before causing component damage.

1.9.2 ESD Protection Devices

In the actual product design, the chip itself has a certain anti-static ability. The static level of N32G032 series MCU ESD (HBM) mode is +/-4KV, but if there is a higher ESD protection level requirement, and the pins of the chip need Direct external connection is used as the output or input port of the product. At this time, the pins of the chip are directly exposed to the outermost part of the product, and cannot be isolated by laying the ground or other means. Under this condition, it is generally necessary to consider an external ESD protection device. TVS diode is a typical ESD protection device. The following is an example of a typical connection method.

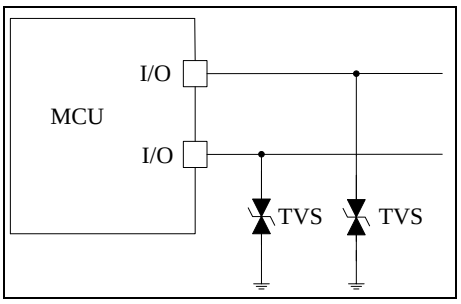

Figure 1-9 TVS connection on I/O pins

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1.10 Debug Interface

N32G032 series chips support serial (SWD) debug interface, please refer to the relevant user manual for detailed application.

Debug Signal	GPIO Pins
SWDIO	PA13
SWCLK	PA14

Table 1-1 Debug Interface

1.11 BOOT serial interface

N32G032 series chips support BOOT serial communication. The serial interface is as follows:

BOOT Serial Port	GPIO Pins
USART1_TX	PA9
USART1_RX	PA10

Table 1-2 Serial port interface

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2. Overall Design Suggestions

1） Printed circuit board

It is recommended to use a multi-layer printed circuit board with a dedicated independent ground plane (VSS) and a dedicated independent power supply plane (VDD), which can provide good coupling performance and shielding effect. In practical applications, if a multi-layer printed circuit board cannot be used considering the economical reason, a good grounding and power supply structure must be ensured when designing the circuit.

2） Device location

In PCB design, different circuits need to be laid out separately according to the different effects of each device on EMI. For example, high-current circuits, low-voltage circuits, and high-frequency devices. Thereby reducing cross-coupling on the PCB.

3） Ground and power supply (VSS, VDD)

Each module (analog circuit, digital circuit, low-sensitivity circuit) should be grounded separately, the digital ground and the analog ground should be separated, and all the grounds should be connected together at one point eventually. According to the size of the printed circuit board current, try to increase the width of the power line to reduce the loop resistance. At the same time, the direction of the power wire and the ground wire should be as consistent as possible with the direction of the current, and the power source should be as close to the ground wire as possible to reduce the area of the loop. This helps to enhance noise immunity. The area without devices on the PCB needs to be filled with ground to provide good shielding effect

4） Decoupling

All power pins need to be properly connected to power. These connections, including pads, wires, and vias, should have as low impedance as possible. The method of increasing the wiring width is usually adopted, and decoupling capacitors must be placed close to the chip for each pair of VDD and VSS pins. The figure below shows a typical layout of the power/ground pins.

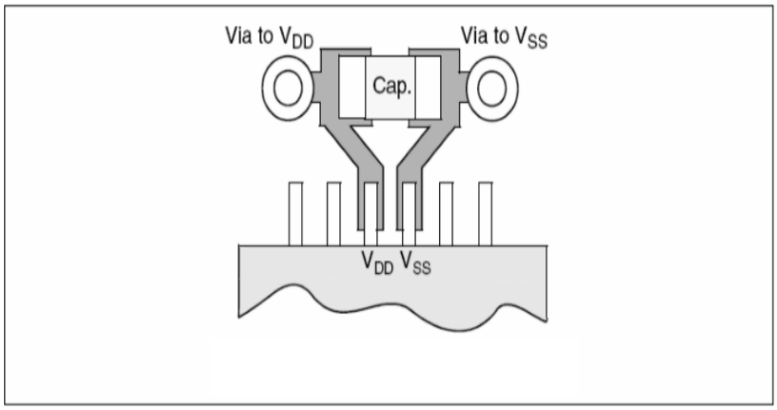

Figure 2-1 Typical layout of VDD/VSS pins

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3. Minimum System Reference Design Schematic

3.1 LQFP64

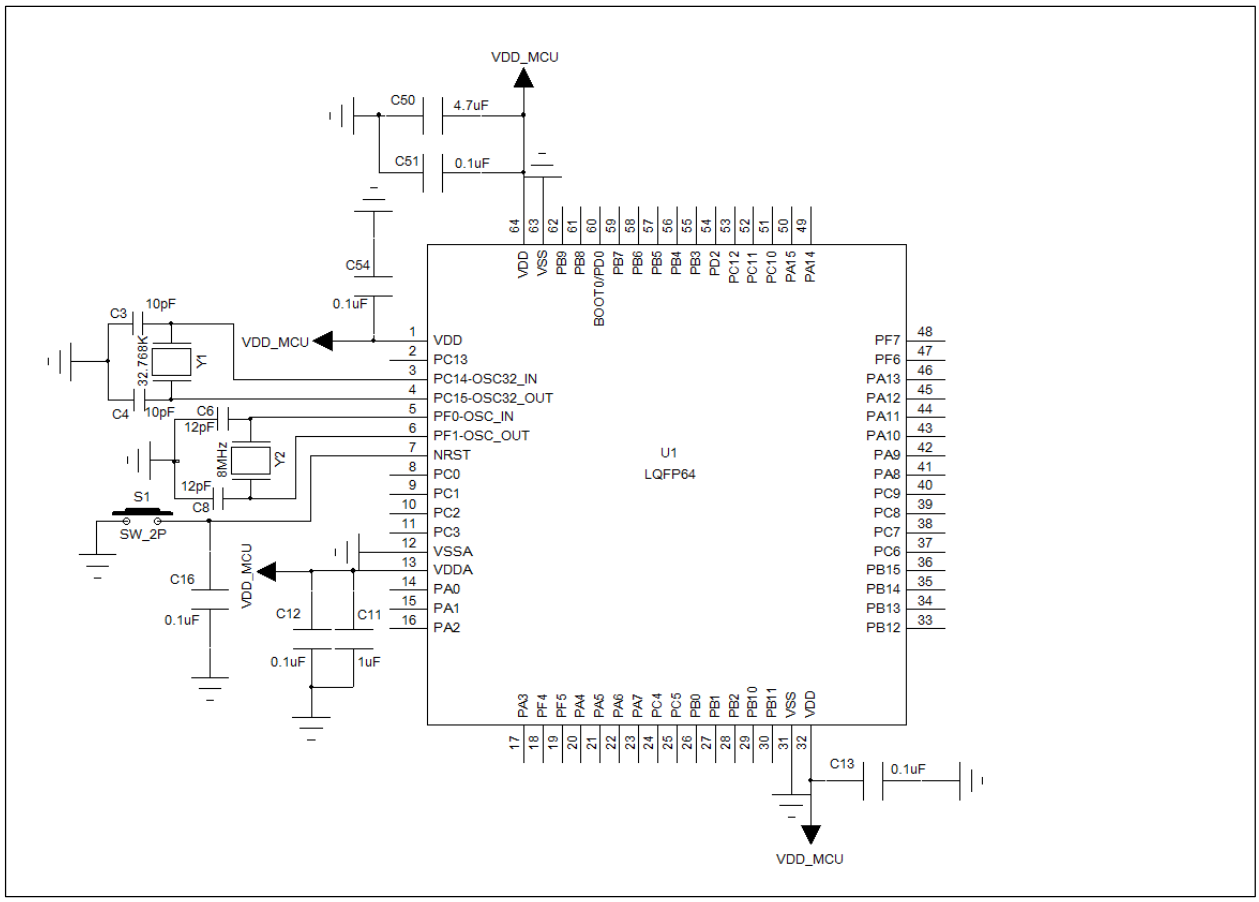

Figure 3-1 N32G032 Series LQFP64 Package Minimum System Reference Design Schematic

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3.2 LQFP48

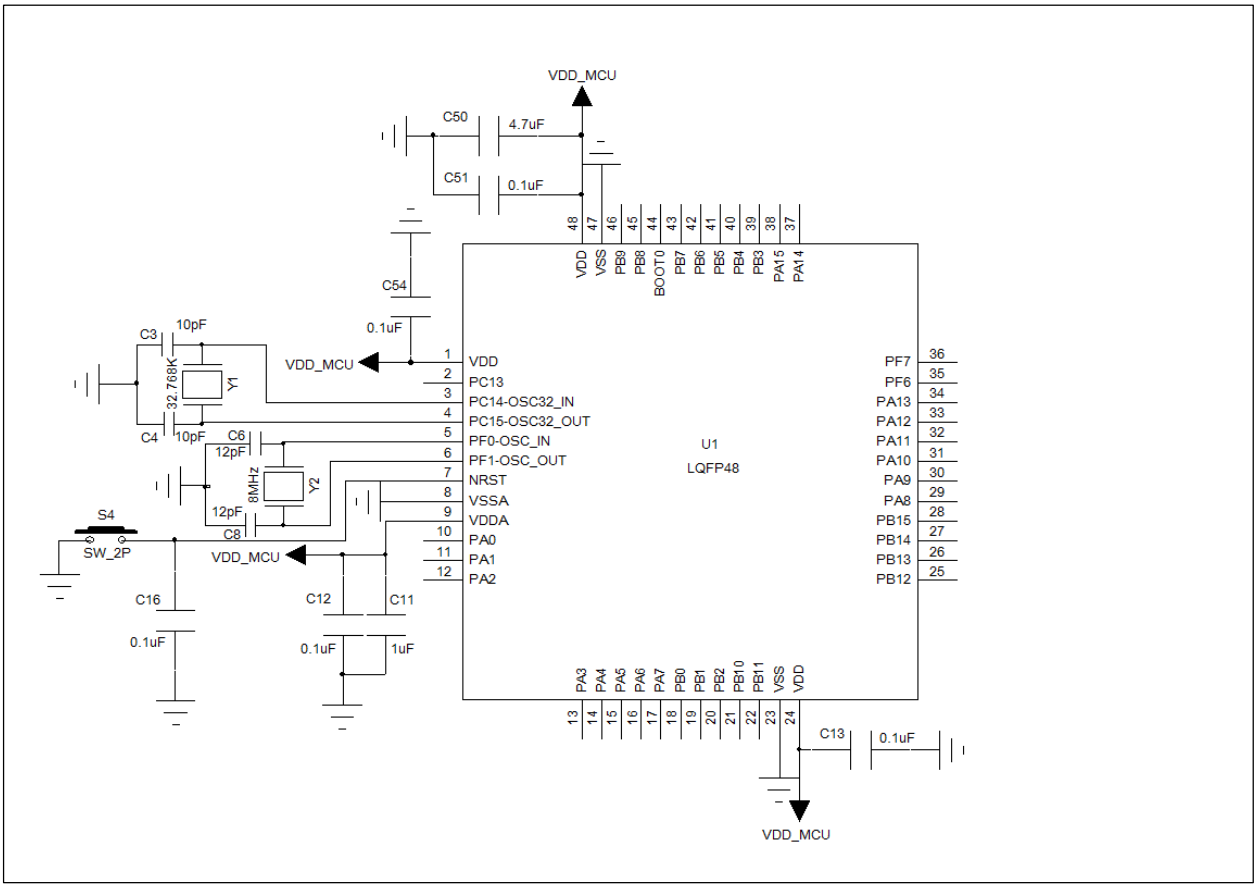

Figure 3-2 N32G032 Series LQFP48 Package Minimum System Reference Design Schematic

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3.3 LQFP32

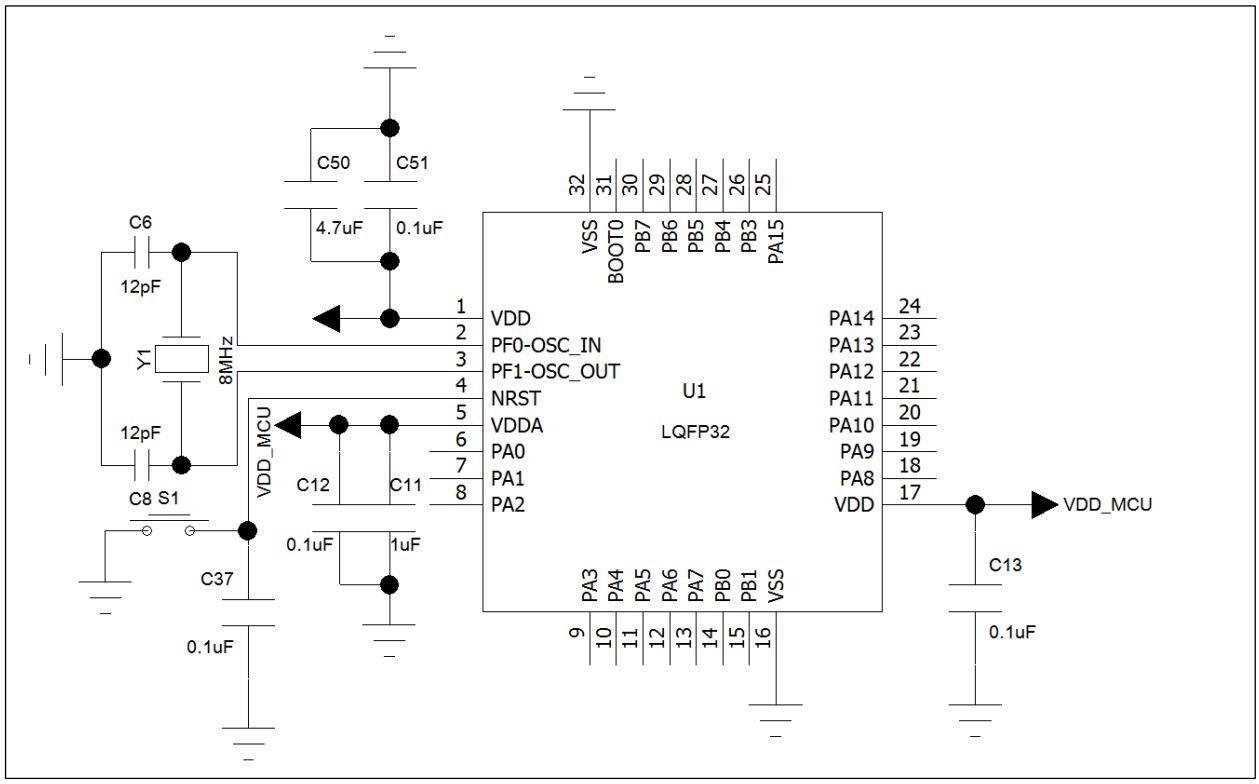

Figure 3-3 N32G032 Series LQFP32 Package Minimum System Reference Design Schematic

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3.4 QFN32

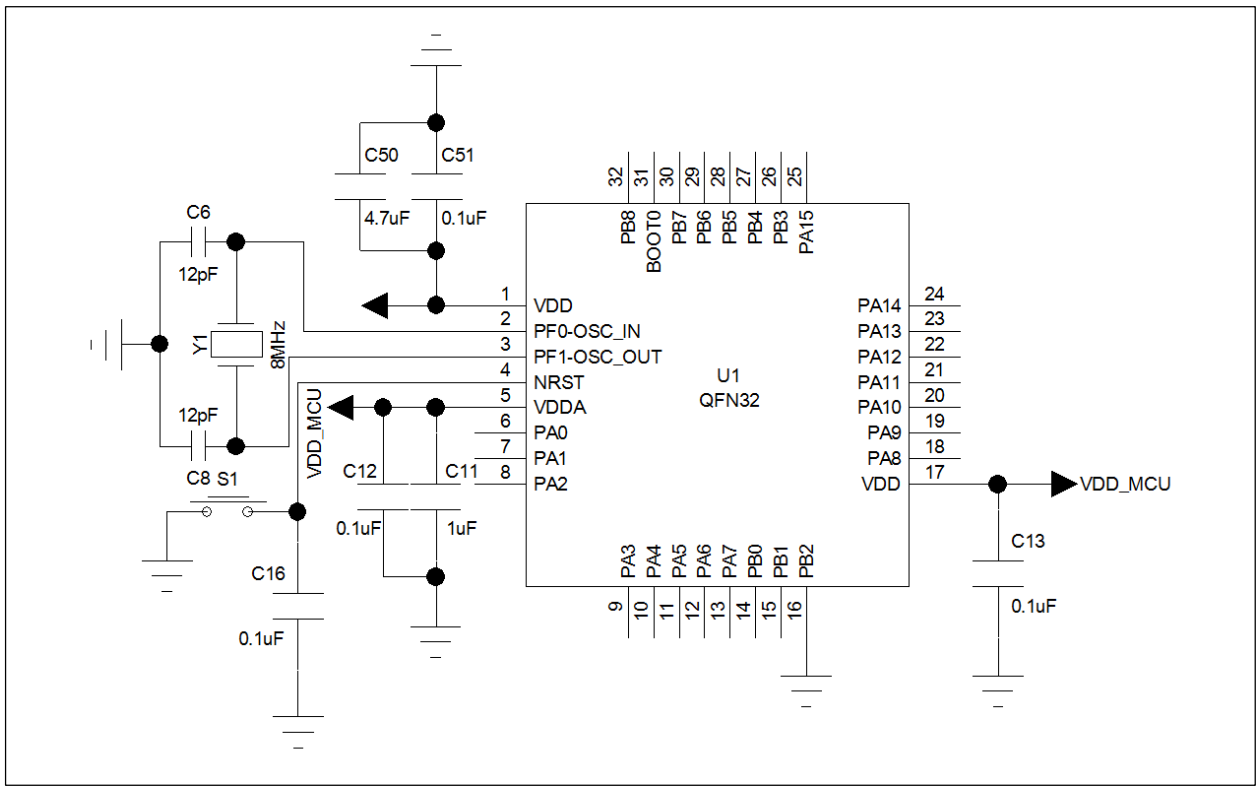

Figure 3-4 N32G032 Series QFN32 Package Minimum System Reference Design Schematic

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3.5 WLCSP25

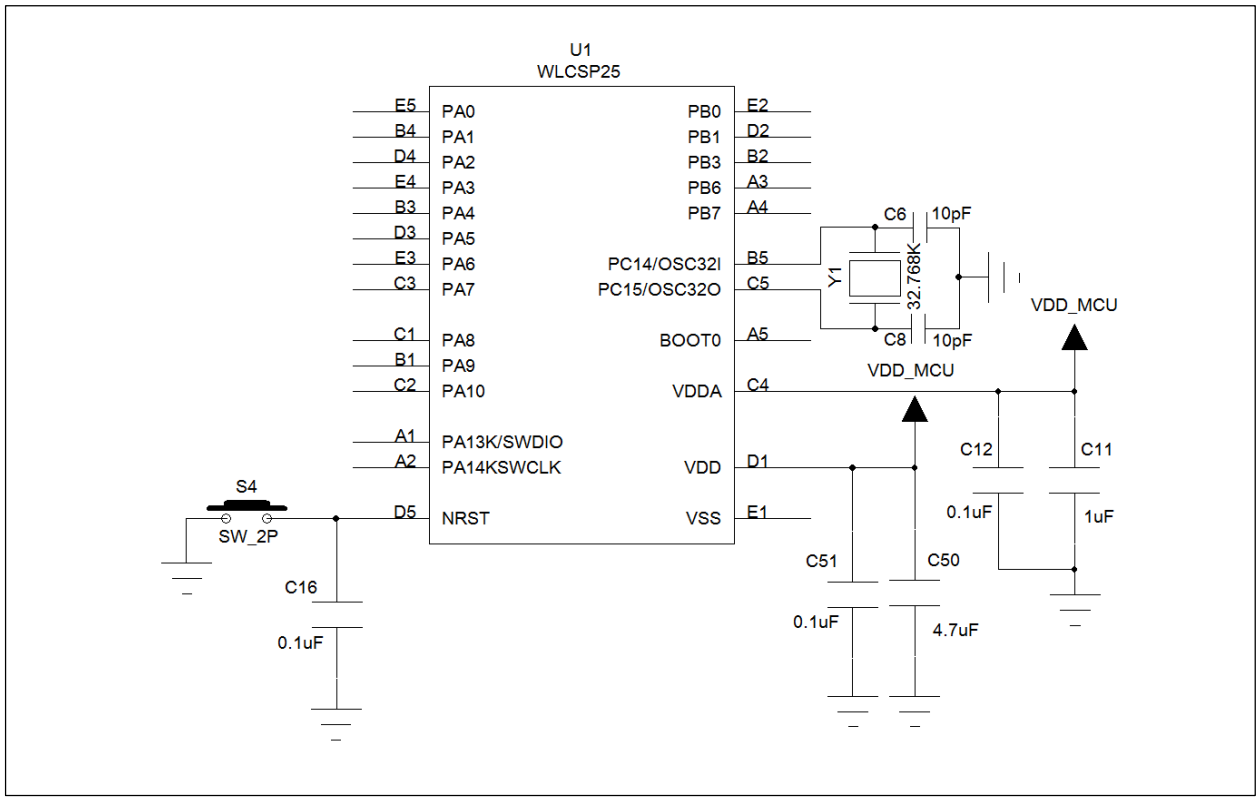

Figure 3-5 N32G032 Series WLCSP25 Package Minimum System Reference Design Schematic

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3.6 UFQFPN20

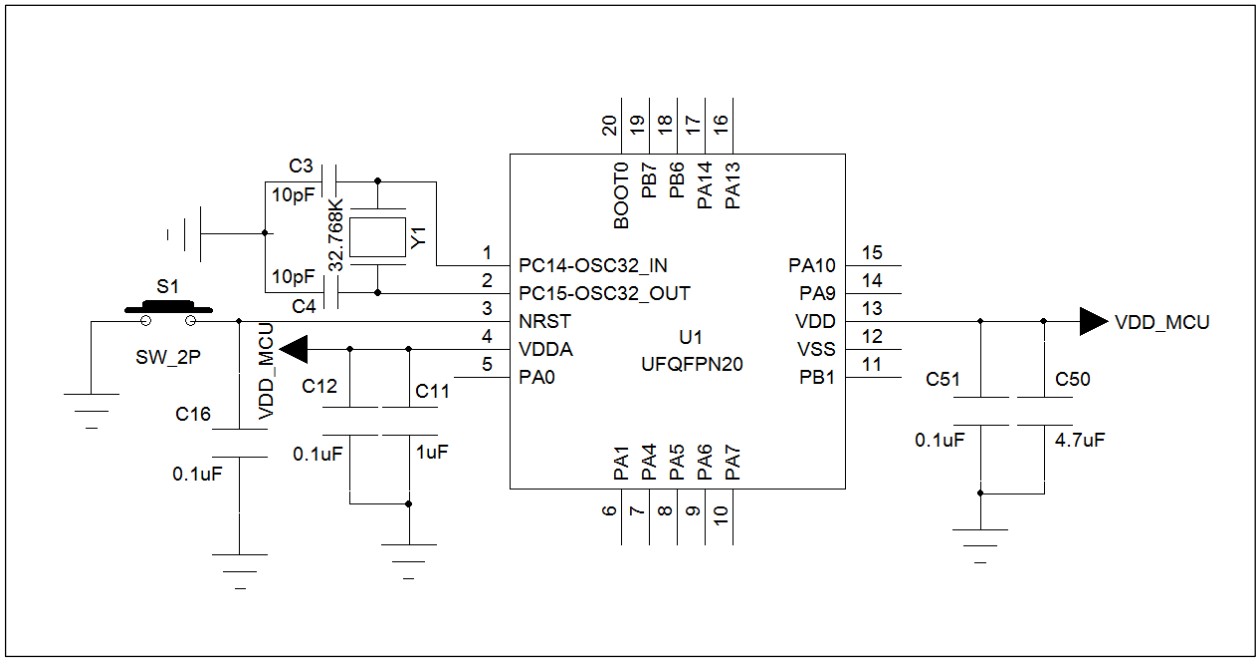

Figure 3-6 N32G032 Series UFQFPN20 Package Minimum System Reference Design Schematic

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3.7 TSSOP20

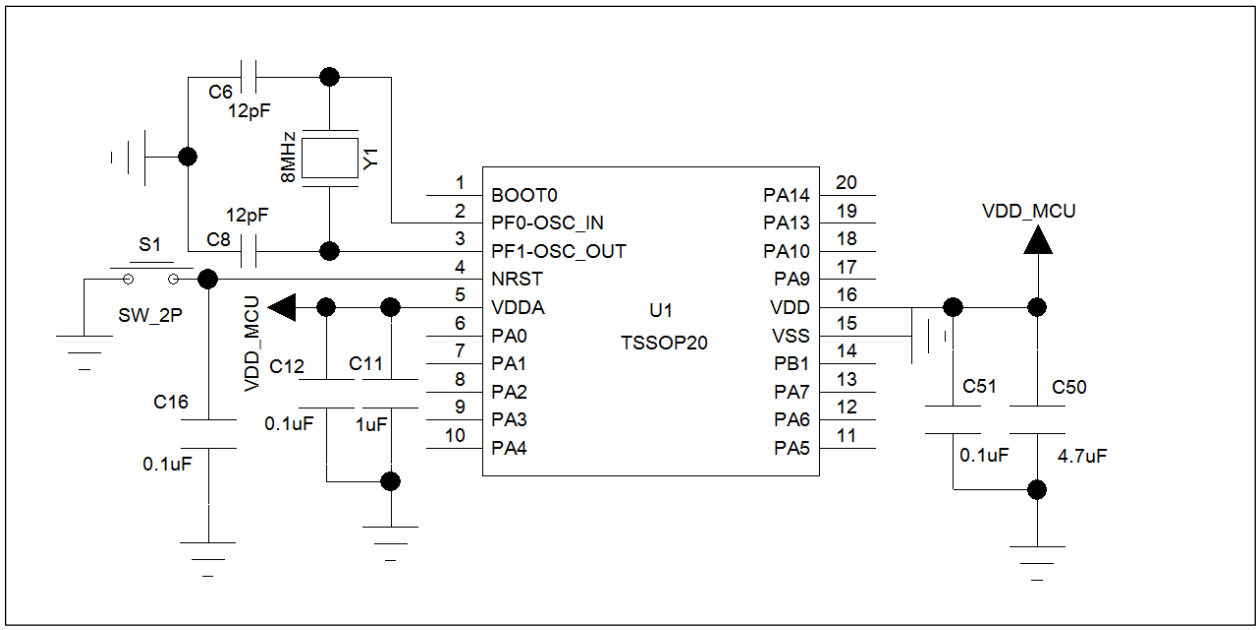

Figure 3-7 N32G032 Series TSSOP20 Package Minimum System Reference Design Schematic

Figure 3-1 ~ Figure 3-7 is the reference design schematic diagram of the minimum system of each package of N32G032 series, which mainly reflects the design of power supply decoupling capacitor, clock, reset circuit, etc. The clock circuit depends on the user's design, and the chip supports internal high-speed and low-speed clocks for users to choose.

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4. PCB LAYOUT Reference

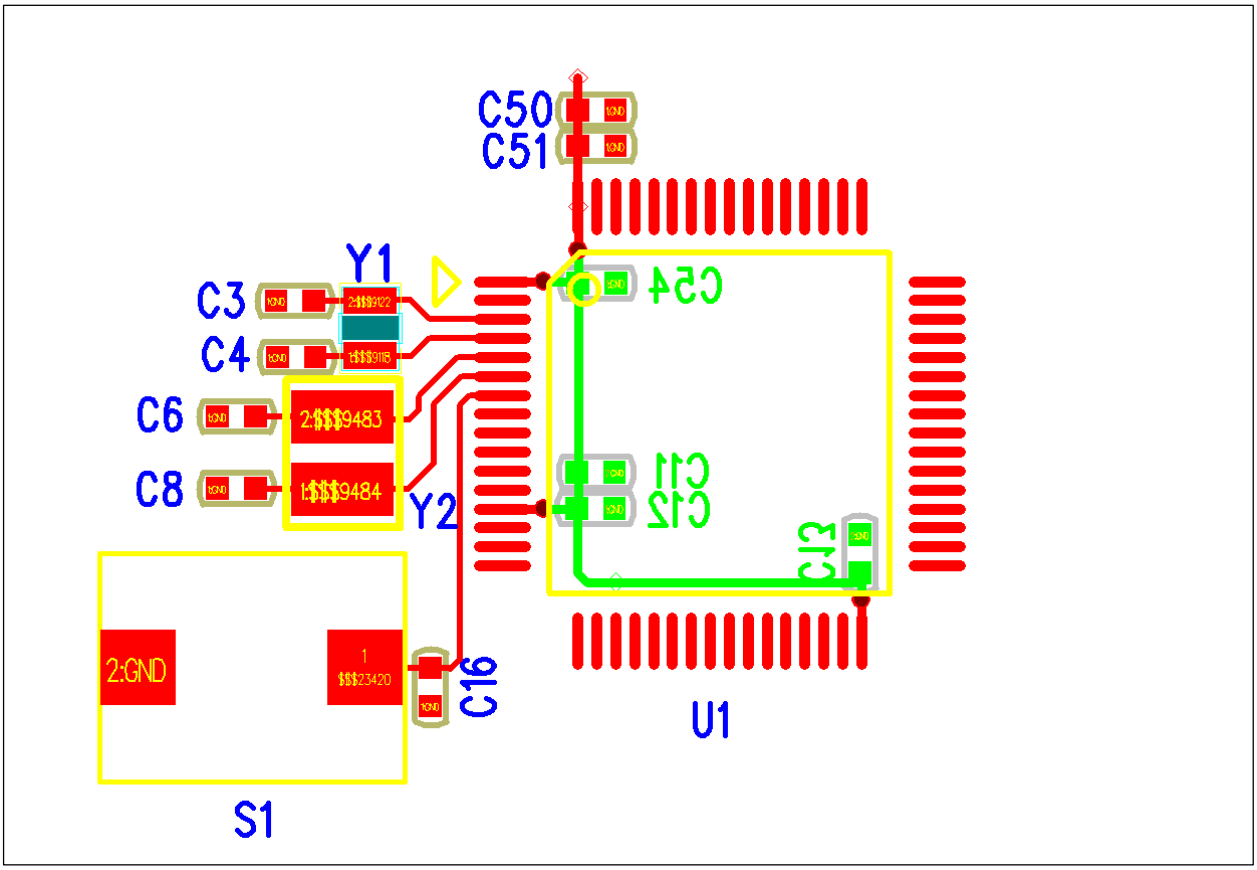

Figure 4-1 N32G032 series LQFP48 package PCB LAYOUT reference diagram

During PCB LAYOUT design, decoupling capacitors need to be placed near each power pin. The external crystals and traces of the HSE and LSE should be grounded as much as possible. The area below the crystals close to the crystals also needs to be grounded, and no signal lines can pass through them to prevent the signal lines from interfering with the crystal signals.

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5. Typical failure analysis

The common problems and analysis methods encountered by customers in the process of using the chip are described as follows

5.1.1 Short circuit between power pins and ground

Problem Description:

The VDD pin of the chip is short-circuited with the GND test, and the chip is abnormally hot after power-on.

Problem check:

1) Whether the VDD decoupling capacitor has insufficient withstand voltage to cause the capacitor to break down and short circuit.
2) When the product starts up, whether the VDD voltage exceeds the specified maximum value.
3) Whether there is an overshoot voltage exceeding the maximum value of VDD during the operation of the product.
4) In the process of production and use, whether there is static electricity that causes chip damage.

5.1.2 GPIO damage

Problem Description:

The chip GPIO cannot output a high level or a low level normally, the GPIO is used as an input to detect the level error, the VIH or VIL test value is abnormal, and the pin impedance is abnormal.

Problem check:

1) Whether the external input voltage to the chip GPIO exceeds the maximum value, such as the 5V-tolerant I/O input voltage exceeding 5V.
2) Whether there is a high voltage input to the GPIO port during product production and testing.
3) In product design, whether there is a high-voltage signal near the GPIO trace coupled to the GPIO input port.
4) In the process of production and use, whether there is static electricity that causes chip damage.

5.1.3 ADC sampling inaccurate

Problem Description:

When sampling the voltage at the ADC input port of the chip, the sampling voltage is inaccurate.

Problem check:

Refer to Section 1.6 to confirm whether the hardware and software settings meet the requirements of ADC considerations.

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6. Historical Versions

Version	Date	Remark
V1.1.0	2023-9-13	1. Create documentation

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