XMC1000

Microcontroller Series
for Industrial Applications

Device Guide

✓ PCB Layout Guideline for XMC1x00 microcontroller

Device Guide

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Microcontrollers

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Revision History	
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PCB Layout Guideline

1 Overview

This application note discusses product specific recommendations and guidelines for the XMC1000 family of products from Infineon, specifically in reference to optimizing ADC performance.

The XMC1000 products are built on a low pin count 32-bit microcontroller. The minimum number of available supply pins with this microcontroller means that special care needs to be taken with the layout of these products. The correct board layout will help to achieve the best ADC performance and EMC behavior.

The XMC1000 microcontroller has two internal oscillators (DCO1 and DCO2).

- DCO1 has a clock output of 64MHz, and is used to generate the main clock, MCLK and fast peripheral clock, PCLK.
- DCO2 is used to generate the standby clock running at 32.768kHz, and does not require an external oscillator.

The document should be read in conjunction with the Infineon PCB Design Guidelines for Microcontrollers (AP24026), which gives general design rule information for PCB design.

1.1 Optimized ADC performance

The TSSOP-16 and TSSOP-28 package of the XMC1000 microcontroller has just two supply pins (VDDP / VDD and VSSP / VSS) to which all internal modules are connected. These are the embedded voltage regulator, the port pins, the ADC module and the oscillators in the XMC1000 microcontroller.

The performance of the ADC and the robustness of the oscillator will be reduced, if power supply noise or pin activity noise are not properly de-coupled. For the TSSOP-38 package, there are four supply pins. The VDDP / VDD and VSSP / VSS pins are dedicated to power the ADC module while VDDP and VSSP pins are used to power the rest of the internal modules.

Proper de-coupling can be achieved by separating the ground traces in analog and digital groups. A star point connection should be considered at the pad of the VSSP / VSS pin of the TSSOP-16 and TSSOP-28 package. The ADC reference voltage is connected to the VDDP / VDD pin. Hence, supply noise directly influences the ADC performance.

ADC analog ground can be disturbed by noise injection from neighboring active pins driving high frequency signals from I2C, PWM or the LED and Touch Sense unit. Good PCB layout will reduce the capacitance between those traces to a minimum.

This application note includes layout recommendations for optimized ADC performance.

2 Power Supply De-coupling and Improved ADC Performance

There are two reasons why microcontrollers can cause noise at the power supply. Firstly the synchronous clocked logic functions lead to peak current at the MCU clock frequency. Secondly, pulse pattern and clock output at any port pin will draw current at the pulse pattern's frequency. De-coupling capacitors are intended to buffer the charge needed to feed the required current pulses.

Noise at the power supply lines might also disturb the microcontroller. This noise can be filtered by the same de-coupling capacitor.

The figures in this section show the recommended PCB layout for different applications using TSSOP-38, TSSOP-28 and TSSOP-16 packages of the XMC1000 microcontroller.

2.1 PCB layouts for TSSOP-38 package

Note that for each of the following layout examples, C1 should be at least 100nF and C2 also at least 100nF. Capacitors with low ESR (type X7R for example) are recommended.

2.1.1 ADC and a general GPIO application

If the intended application is primarily for ADC measurement and some simple general purpose input/output toggling, then the following PCB layout is recommended.

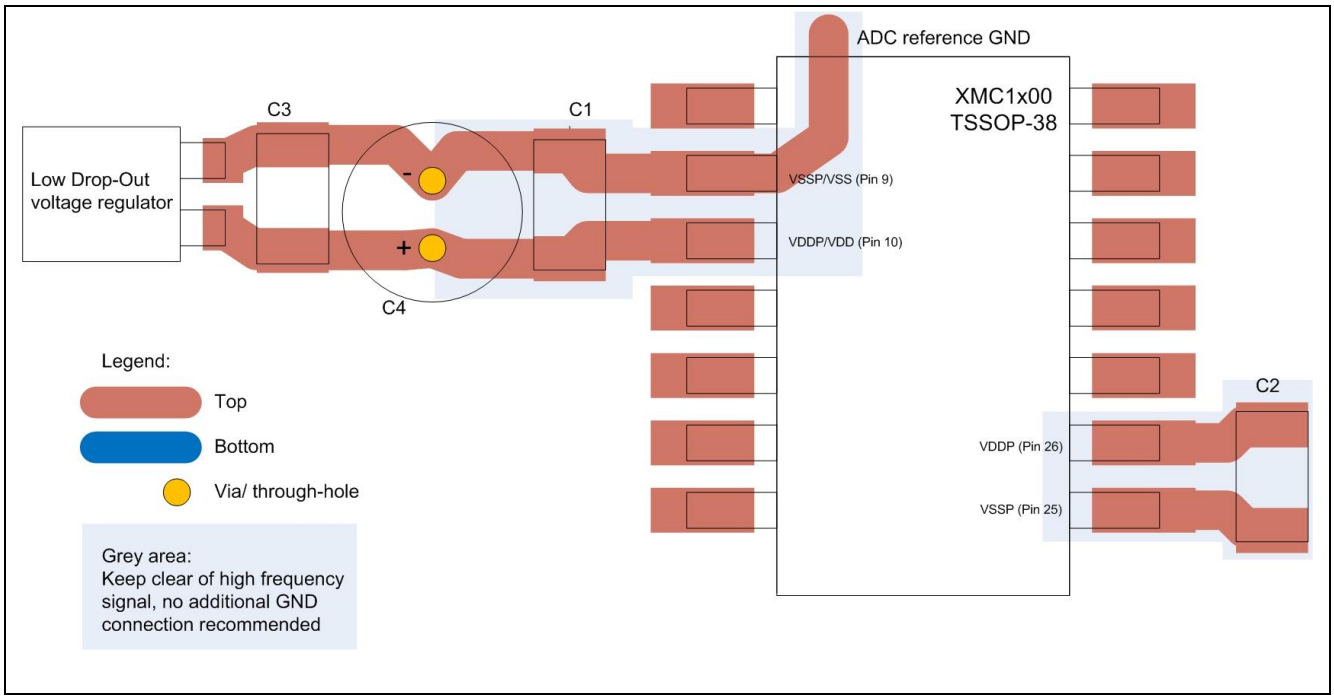

Figure 1 PCB layout for ADC and general GPIO application using TSSOP-38 package

Normally, there is a low drop-out voltage regulator to step down the input voltage to the operating voltage of the XMC1000 microcontroller. The electrolytic capacitor C4 at the output of the voltage regulator acts as a low pass filter and reduces the ripple voltage of VDDP. C3 is the decoupling capacitor for filtering of high frequency noise.

C1 acts as decoupling capacitor for ADC circuitry. C2 acts as the decoupling capacitor for the digital circuitry of the XMC1000 microcontroller. Any additional connection will bypass the decoupling capacitor C1 and C2 and will therefore reduce their effectiveness.

The grey areas shown in the figures should be kept clear of any GND connections and GND planes. Ensure that the decoupling capacitors C1 and C2 are placed as close to the pins as possible.

For TSSOP-38 package, pin 10 (VDDP / VDD) and pin 26 (VDDP) are connected internally. Similarly, pin 9 (VSSP / VSS) is connected internally to pin 25 (VSSP). Hence, those pins do not need to connect externally.

The ADC reference GND connection is intended to be utilized in common mode with the ADC's input pins. Any additional connection to pin 9 (VSSP / VSS) in this figure will cause supply noise to be injected to the ADC's reference GND.

2.1.2 ADC and LED Touch Sense application

If the board is also to be used for driving an LED, then an additional VDDP copper trace should be routed from pin10 (VDDP / VDD) to pin26 (VDDP) of the TSSOP-38 package. As additional current needs to be supplied from the port pin to drive the LEDs, so an additional VDDP copper trace will increase the current carrying capability of the internal VDDP bonding wire.

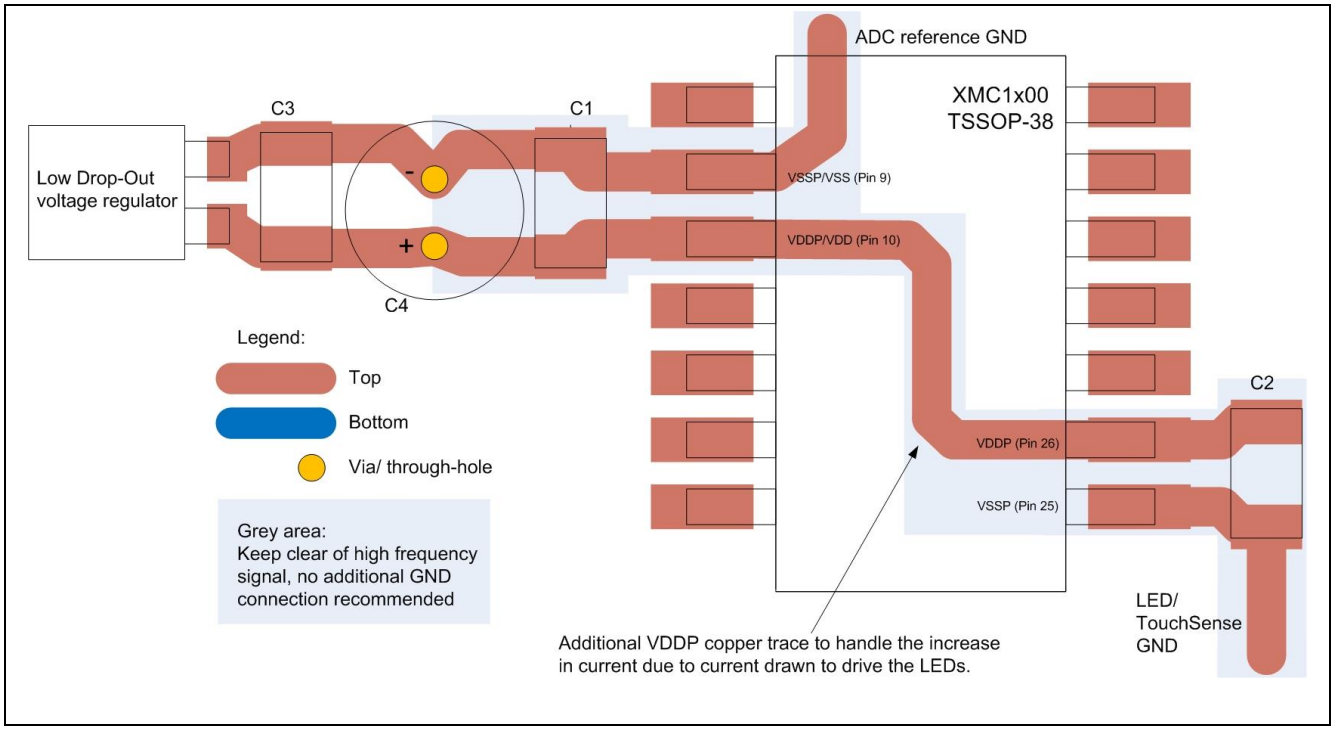

Figure 2 PCB layout for ADC and LED Touch Sense application using TSSOP-38 package

2.1.3 ADC and Motor or Power Conversion Application

If the board is to be used for ADC and Motor or Power Conversion applications, where high switching waveforms will be output from the CCU4 / CCU8 port, then the following PCB layout is recommended:

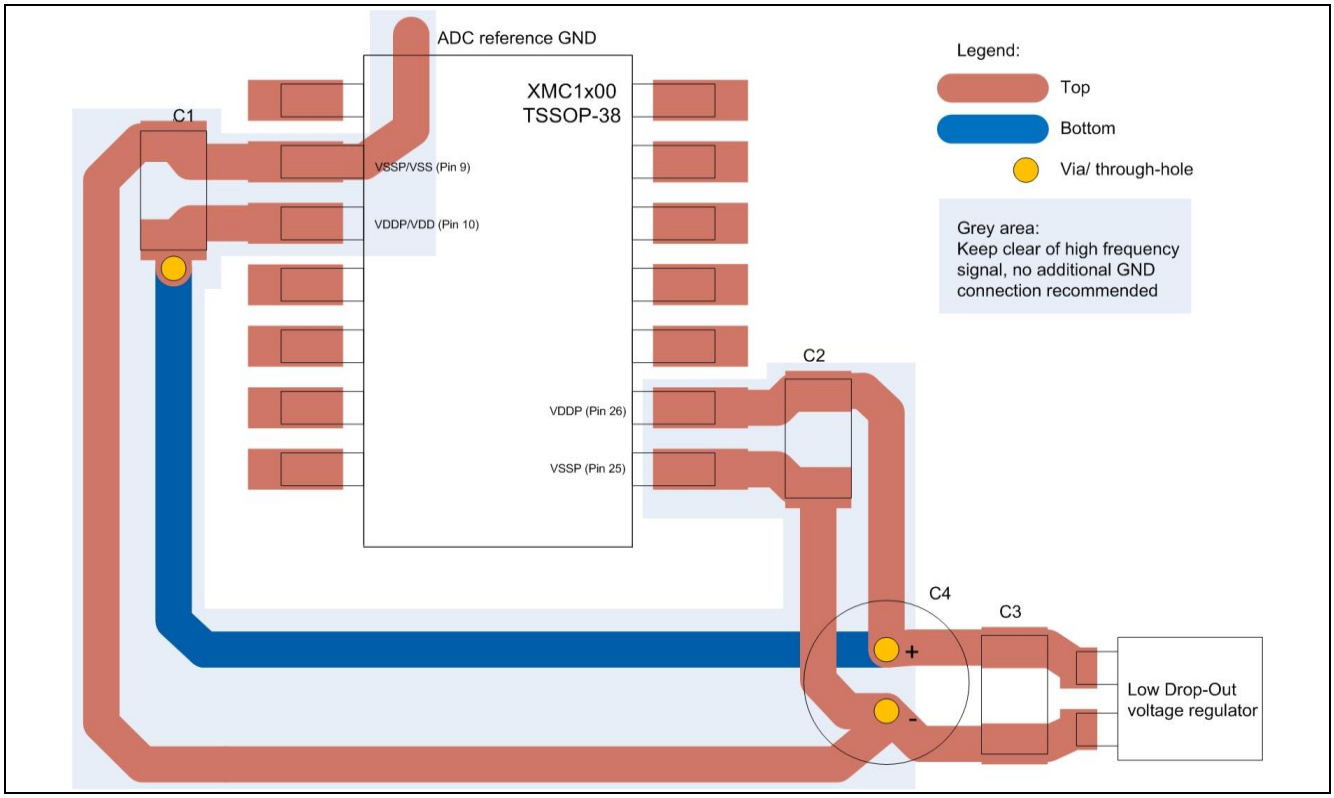

Figure 3 PCB layout for ADC and Motor or Power Conversion application using TSSOP-38 package

At the negative terminal of the electrolytic capacitor C4, a star-point ground should be used. A digital ground trace will run from this star-point ground to VSSP (Pin 25) of the XMC1000 microcontroller. Another analog ground trace will also run from the negative terminal of C4 to VSSP / VSS (Pin 9) of the XMC1000 microcontroller. By using this star-point ground configuration, the interference of digital noise at VSSP (Pin 25) to the analog ground at VSSP / VSS (Pin 9) is minimized.

2.2 PCB layouts for TSSOP-28 and TSSOP-16 packages

In the following layouts, C2 should be set 100nF and capacitors with low ESR (type X7R for example) are recommended.

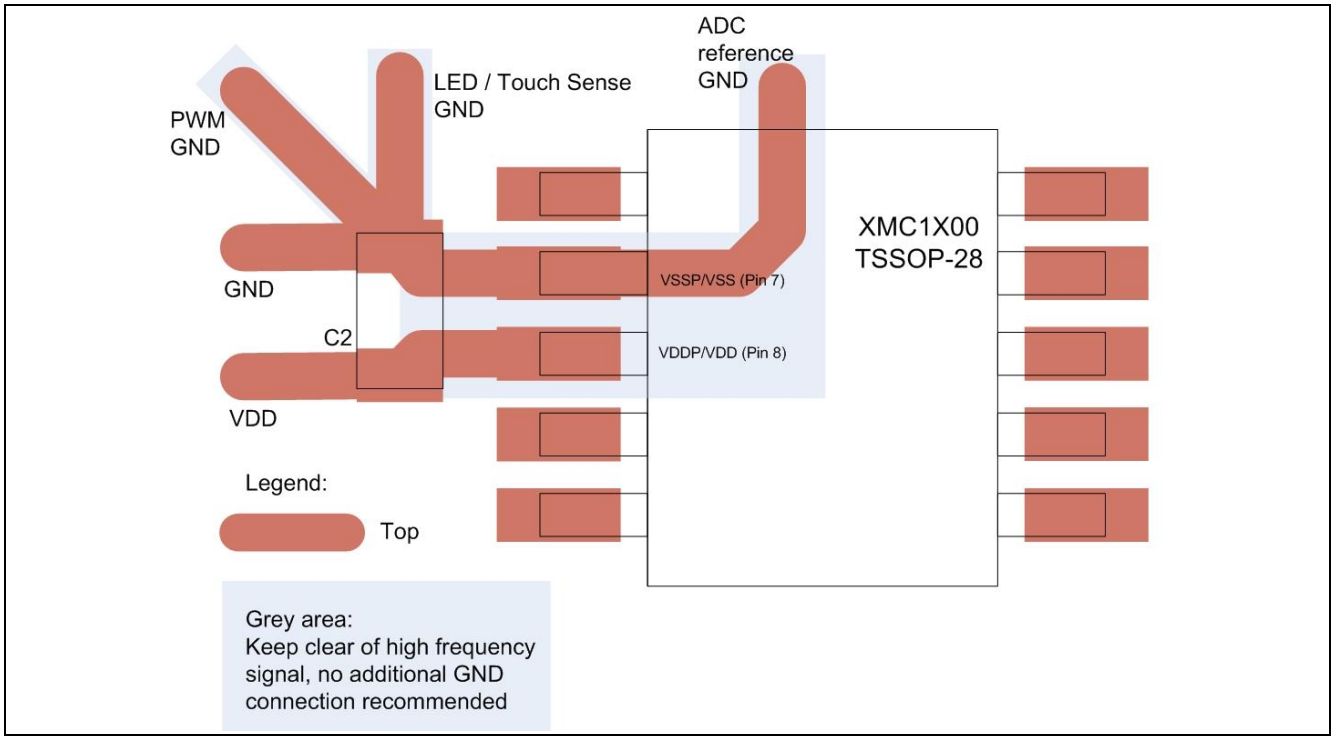

Figure 4 PCB layout for TSSOP-28 package

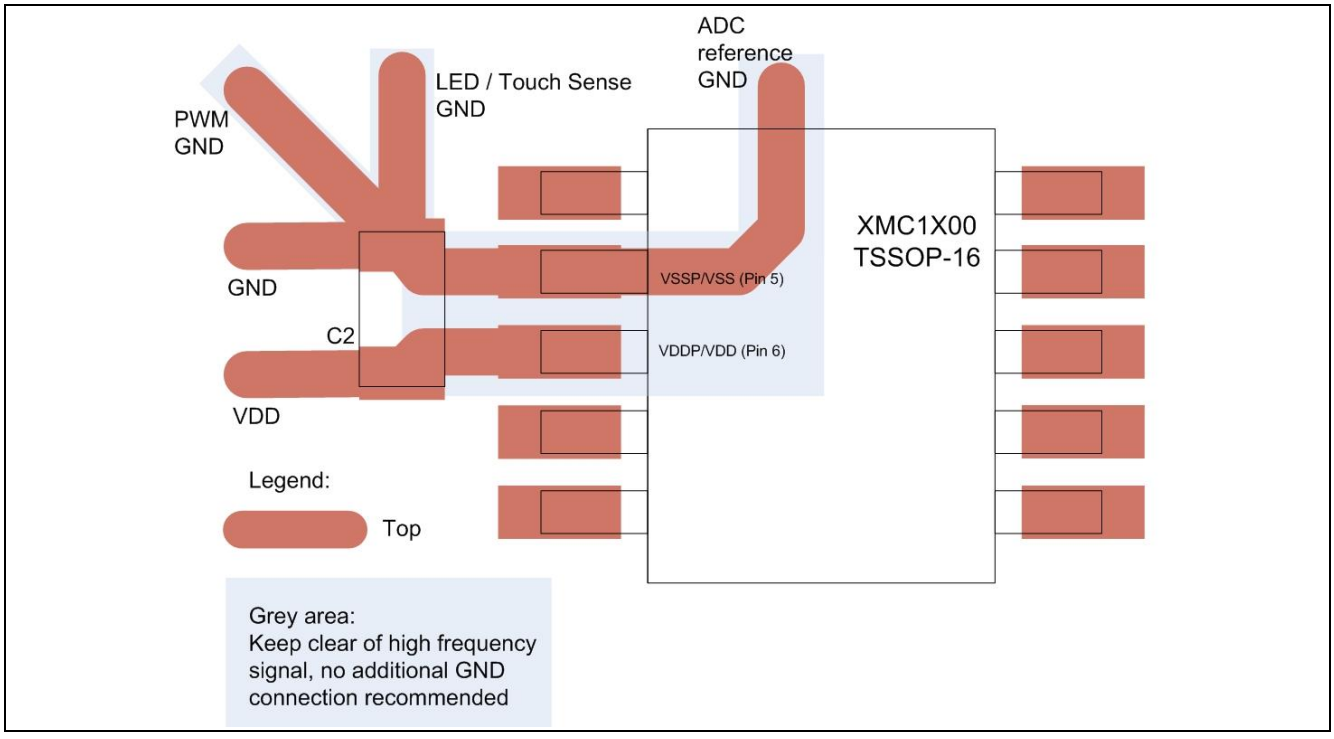

Figure 5 PCB layout for TSSOP-16 package

For TSSOP-28 and TSSOP-16 packages, there is only 1 pair of VDDP / VDD and VSSP / VSS pins, so a star-point ground is recommended at de-coupling capacitor C2.

A star configuration at the VSSP / VSS pin (for the TSSOP-16 and TSSOP-28 packages) is the least noisy connection for the ADC reference ground. This connection is best coupled to the ADC's reference voltage ground potential and is important for minimizing ADC errors.

From the star point ground, digital grounds (e.g. PWM ground, LED/Touch sense ground) and analog ground (ADC reference ground) are branched out individually to their circuitry.

The noise of the power supply (VDDP / VDD and VSSP / VSS) is filtered by the capacitor C2 in the TSSOP-28 and TSSOP-16 packages.

It must be ensured that the de-coupling capacitors C2 are placed as close to the pins as possible. It is also important to connect the power supply GND and VDD only at those traces shown in the figures. Any additional connection will bypass the de-coupling capacitor C2 and will therefore reduce it's effectiveness. The grey areas shown in the figures should be kept clear of any GND connections and GND planes.

The ADC reference GND connection is intended to be used in common mode with the ADC's input pins. Any additional connection to the power supply GND will cause supply noise to be injected to the ADC's reference GND. So, if LED/Touch sense ground is required on the application board, please use the star point ground configuration as shown.

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