

Capacitive Touch Screen PCB Design Guide

1. Applied for

All MCU with touch function.

2. Design instructions

The PCB Layout of capacitive touch products has a great influence on the touch sensitivity, so some suggestions on the PCB Layout of touch MCU can be referred to.

3. Basic principles of PCB design for touch panel

3.1. Follow the basic principles of analog - digital hybrid circuit design

The analog circuit of precision capacitance measurement is integrated in the capacitive touch sensing chip, so it should be treated as an independent simulation circuit in PCB design. Follow the basic principles of analog - digital hybrid circuit design.

3.2. Adopt star connection to ground

The ground wire of the touch IC shall not be shared with other circuits, and shall be separately connected to the grounding point of the power input of the board. It is recommended to use “star connection” to ground. Refer to Figure 1 for the connection mode.

3.3. Influence of noise generated on power supply on touch MCU

The same procedure should be followed for the power circuit. The touch IC is best to use a separate cable from the board power supply point, do not share the power loop with other circuits. If the circuit cannot be completely independent, it should be guaranteed to supply power to the touch MCU first and then lead to other circuit, which can reduce the influence of noise generated by other circuits on the power supply to the touch MCU. Refer to Figure 1 for connection mode.

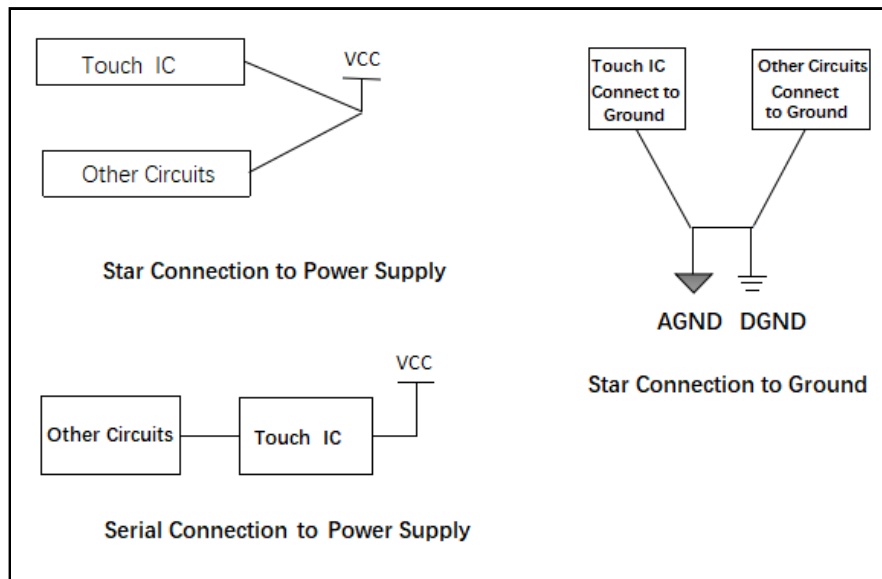


Fig. 1: Schematic diagram of connection method of VCC and GND

4. Touch Pad Design

4.1. Touch pad material

The touch pad includes PCB copper foil, metal sheet, flat-topped cylindrical springs, conductive cotton, conductive ink, conductive rubber, ITO layer of conductive glass, etc. No matter what material is used, the key sensing pad should be as close as possible to the panel, and there should be no air gap in the middle. When flat-top cylindrical springs are used, the diameter of the hollow floor at the connection between the touch line and the spring should be slightly larger than the diameter of the spring column to ensure that the spring will not touch the floor even if compressed onto the PCB board.

4.2. Touch pad shape

In principle, it can be made into any shape, and holes or hollows can be left in the middle. The general application of round and square is more common.

4.3. Area size of touch pad

Area of key sensing pad: minimum 4mm X 4mm, maximum 30mm X 30mm. The actual area size depends on the requirements of the sensitivity, and is proportional to the sensitivity. In general, the diameter of the button sensor pad should be greater than 4 times the thickness of the panel, and the SNR can be improved by increasing the size of the electrode. The shape and area of each sense element should be the same to ensure the same sensitivity. In general, 12mmX12mm is typical for most applications.

4.4. Distance between touch pads

The distance between each touch pad should be as large as possible (more than 3mm), so as to reduce the mutual interference between the electric fields formed by them. When using PCB copper foil as touch pad, if the distance between touch pads is 5MM to 10MM, the touch pad must be separated by copper connected to the ground. If each touch pad is far away from each other, copper connected to the ground should be used to isolate it as far as possible. Appropriately widening the distance between touch pads is helpful to improve touch sensitivity.

4.5. Connection mode between touch pad and various touch structures

- a. When using copper foil of PCB for touch pad make sure touch pad is snug to PCB.
- b. Use a spring-attached patch touch pad and place the touch pad on top of the panel.
- c. Use conductive rubber or cotton. The bottom of conductive cotton or rubber is glued to the copper foil of PCB, and the top is glued to the panel as an induction.
- d. A flexible PCB made of conductive ink or ITO is inserted into interface of the touch port.

5. Design recommendations for passing EMC tests

Touch products are required to pass rigorous FCC testing. It is suggested to refer to the following suggestions to reduce the external radiation of the touch MCU

5.1. Use decoupling capacitor

Please add a decoupling capacitor for the power supply of the touch MCU, which can reduce the interference of the touch MCU to the power supply. Generally, a 104 ceramic capacitor is connected in parallel at the VCC and GND terminals of the chip, which can play the role of decoupling and bypassing. Decoupling capacitors should be placed as close to the chip as possible.

5.2. Use lower operating voltage

3.3V is used to power the touch MCU, which can effectively reduce the amplitude of the AC pulse of the touch MCU.

5.3. Reasonable copper wires layout

Whether using a single-sided PCB or a double-sided PCB, the blank area of the PCB should be covered with copper connected to the ground, and the wiring between the key sensing pad and the input pins of the IC should be wrapped with the copper. This can absorb electromagnetic radiation and improve the EMC index. It is recommended to use double layer PCB.

5.4. MCU turn on the EMI function

6. Component layout

6.1. The location of the chip

There is a function of line length correction in touch sensing IC, so the difference of the line length between each key sensing pad and IC pin will not lead to significant difference in key sensitivity. However, if the PCB board space allows, the touch chip should be placed in the middle of the touch pad as far as possible, so that the distance difference between the pins of each induction channel of IC and the sense element is minimal.

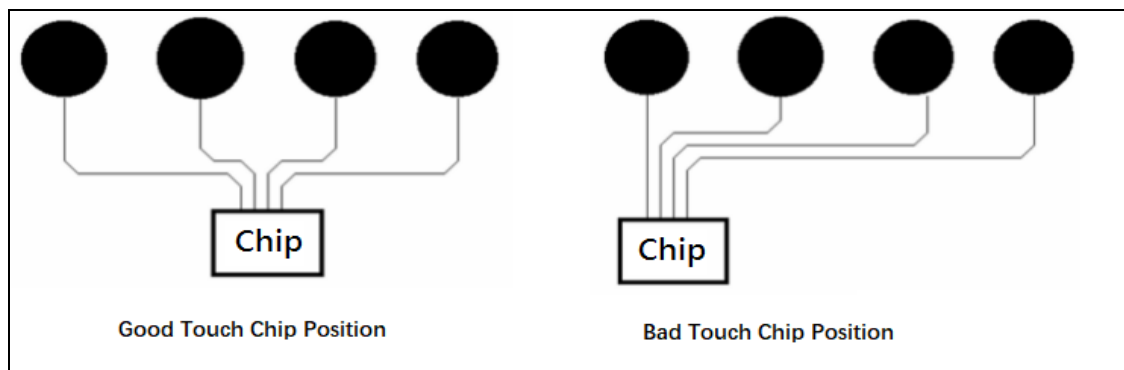


Fig. 2: Touch the lead wire

6.2. Size and clearance of key sensing pad (capacitive sensor)

In order to meet the aesthetic design requirements of the panel, the best touch sensing effect must be obtained by reasonably arranging the size and spacing of the sensing disk.

6.3. Location of the voltage regulator circuit

The voltage stabilizing circuit and the filter circuit are placed on the touch panel as far as possible.

6.4. Sensitivity adjustment CS capacitor (Applied for products with CS pin)

6.4.1 Selection of CS Capacitor

CS capacitors are recommended to use NPO/C0G capacitors. The material with temperature compensation capacitor (NPO/C0G) has a better effect on the stability of touch sensitivity. The experimental results show that the material with NPO/C0G has a better effect on the stability of anti-power noise interference than the material with X7R. The CS capacitance value will depend on the final PCBA and touch sensitivity adjustment. There is no absolute value. It is recommended to adjust from 10nF to find the best CS capacitance value.

6.4.2 The position of the CS capacitor

CS capacitors in applications are recommended to be placed close to the chip CS pin. VDD is recommended for CS capacitor of MCU, which will have better effect against ripple interference of power supply. If PCB layout space is sufficient, it is recommended that CS capacitor be reserved for VDD and GND.

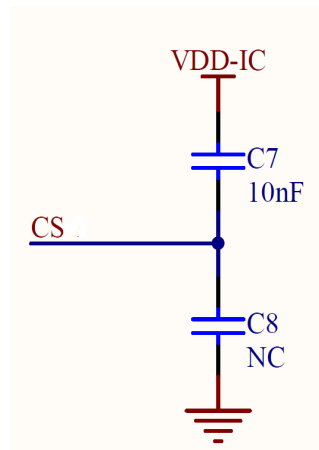


Fig. 3: Schematic diagram of touch sensitivity capacitance CS

6.5. Touch channel series resistance

6.5.1 Position of touch channel series resistance

Touch channel series resistance (the series resistance between the touch button and the touch chip), it is better to place the key pin close to the touch chip.

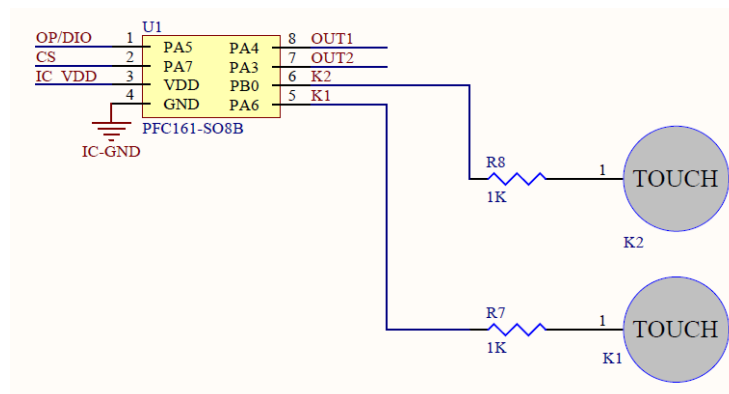


Fig. 4: Schematic diagram of touch channel series resistance

6.5.2 Selection of touch channel series resistance

The touch channel series resistance is the resistance between the touch chip pin and the touch pad, which is used to improve the anti-interference degree of the circuit and adjust the sensitivity of individual touch channels. Resistors can be used with ordinary patch

resistors or ordinary carbon film resistors, its value is generally recommended 0R/1K/4.7K and so on. It is recommended to select a slightly larger resistor, which can reduce the steepness of the edge of the AC pulse and reduce the higher harmonics. The specific selection should be adjusted according to the actual test conditions.

6.6. Configure the appropriate sensitivity

- a. Sensitivity is proportional to the selection value of the touch library. When the value increases, the sensitivity increases; when the value decreases, the sensitivity decreases.
- b. Sensitivity is inversely proportional to the thickness of the panel. In the same configuration, the thicker the panel thickness, the lower the sensitivity, and the thinner the panel thickness, the higher the sensitivity.
- c. Sensitivity is proportional to the size of the touch pad. The larger the touch pad, the higher the sensitivity, and the smaller the touch pad, the lower the sensitivity.

In the actual application, according to the actual needs of customers to find the ideal compromise. Within a certain range, the larger CS capacitance is, the higher the sensitivity is, and the lower the sensitivity is, the lower the sensitivity is. It is recommended to adjust from 10nF.

7. PCB board wiring

7.1. Double layer PCB board wiring

If the copper foil on the PCB board is directly used as the touch sensing pad, it is recommended to use a double layer PCB board, and the touch chip and the connection from the sensing disk to the chip pin should be placed on the bottom. Induction panel should be placed on the top layer, installed close to the touch panel.

7.2. Single layer PCB board wiring

If a single-sided PCB board is used and a spring or other conductive object is used as the sense element, it is recommended to avoid or reduce the tripping line between the induction board and the IC pin.

7.3. Line width

If the PCB process permit, the connection between the sense element and the chip should be as thin as possible, the line width of the double layer PCB should be 5-10mil, and the line width of the single layer PCB board should be 10-15mil.

7.4. Touch key line wiring rules to avoid noise

Do not let the touch wire be parallel to other signal cables at close range (in double layer PCB board, it is not recommended that the two layers of the panel be closely parallel). If they must be parallel, separate the touch wire from other signal wires, especially those with strong interference and high frequency. Sense element to touch chip online around 0.5mm do not

connect other signal cables. Please choose the connection mode as shown in Figure 5 for the connection between the wire and the sense element through the hole and between IC and the sense element.

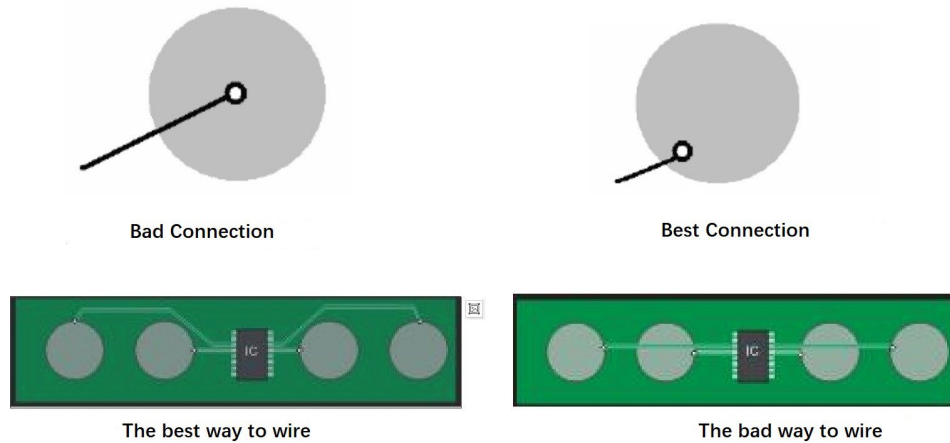


Fig. 5: Good and Bad Wiring

8. Place copper wires connected to ground

The touch chip and its related peripheral circuits are placed with copper wires connected to ground, which can effectively improve the anti-interference ability of the product. Note the following points when placing copper wires to ground:

- a. It is recommended that the touch pad be 1.5MM to 2.0MM away from the copper wires connected to ground. In this distance range, the interference immunity and touch sensitivity of the system can be balanced effectively. If the distance is reduced, the immunity of the system can be improved, but the touch sensitivity will be reduced. On the contrary, when the distance increases, the sensitivity of touch can be improved, but the immunity is slightly decreased, so users can adjust it appropriately according to their own needs. In general, it is not recommended to adjust the sensitivity by changing the copper spread distance, and the sensitivity settings are mainly achieved by adjusting the sensitivity parameter settings in the touch library and the size of the touch pad.
- b. 15mil is recommended for touch line off the floor.

8.1. Double layer PCB board place copper wires connected to ground

8.1.1. The top floor place copper wires connected to ground in the form of a grid

Place copper wires in the form of a grid in the blank part of the top layer, and the area of copper in the grid shall not exceed 40% of the total area of the grid. The grid line width is 5-8mil, and the grid size is 1mm*1mm, as shown in Figure 8-1. The copper laying must be

at least 0.5mm away from the sense element.



Fig. 6: Laying grid copper outside the top key sense element

8.1.2. The bottom floor place solid copper wires

The copper layer on the bottom side of the sense element can be made of grid copper. However, the copper laying must be at least 0.5mm away from the connection between the sense element and the touch chip. It is not allowed to lay copper and other high-frequency signal wires on the back of the key sense element as shown in Figure 8-2.

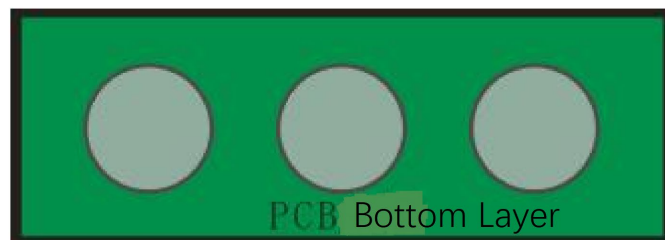


Fig. 7: No copper shall be laid right below the bottom key sense element

8.2. Single layer PCB board place copper wires connected to ground

When a single layer PCB board is used, all the blank areas shall be paved with copper, and the copper wires connected to ground should be more than 0.5mm away from the sense element line. The connecting line of the sense element shall be wrapped by the copper wires connected to ground for obtain a higher EMC index.

9. Power supply

9.1. DC stabilizer

The touch chip reflects the touch output by measuring the small change value of capacitance. The ripple and noise of the power supply should be small, and the strong interference from the power supply should be avoided to isolate external interference and avoid voltage surge. Since the power supply is required to have high stability, it is recommended to use standard voltage regulator, such as the voltage regulator circuit composed of 7805 as shown in Figure 9-1. If the voltage regulator tube cannot be used to provide a set of stable power supply, it is suggested to add a set of RC filters to the power input end of the chip, as shown in Figure 9-2.

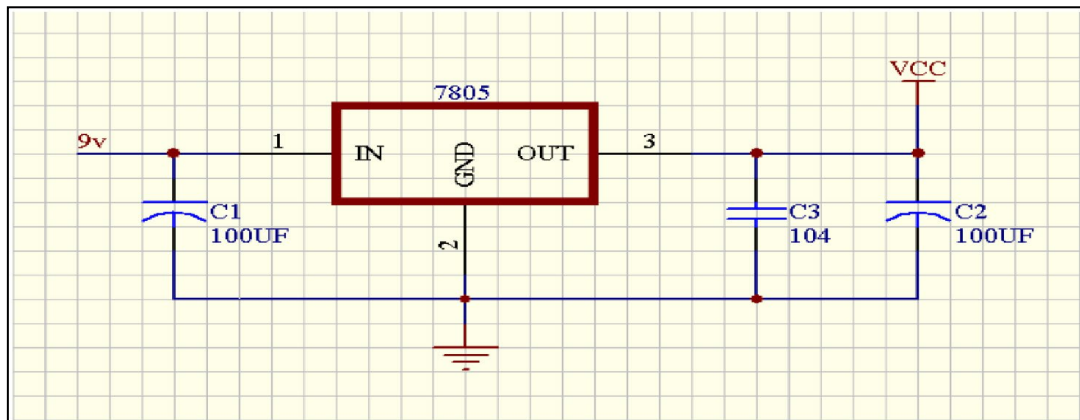


Fig. 8: 7805 regulator circuit

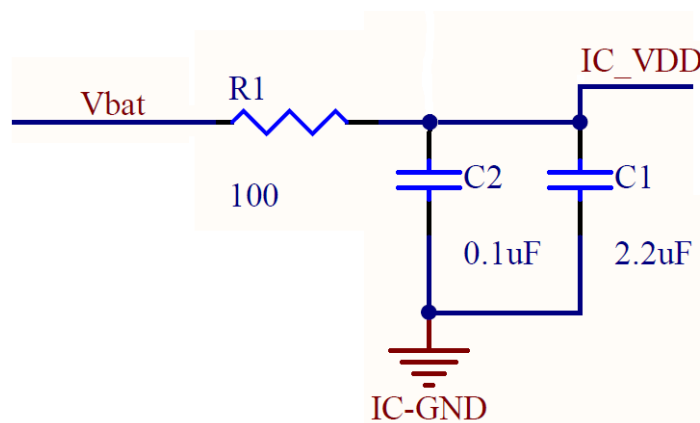


Fig. 9: RC filter schematic diagram of input power

9.2. Placement of Voltage Regulator Device

During PCB layout, the voltage regulator should be as close as possible to the VDD and GND pins of the chip. 7805 voltage regulator device and touch chip should be placed on the same circuit board as far as possible, and placed centrally to avoid noise caused by too long power connection.

9.3. Use an external power supply

If the touch pad is directly powered by an external power supply, it is recommended to add a capacitive filter device, as shown in Figure 9-3. The capacitor in the filter circuit should be located close to the chip.

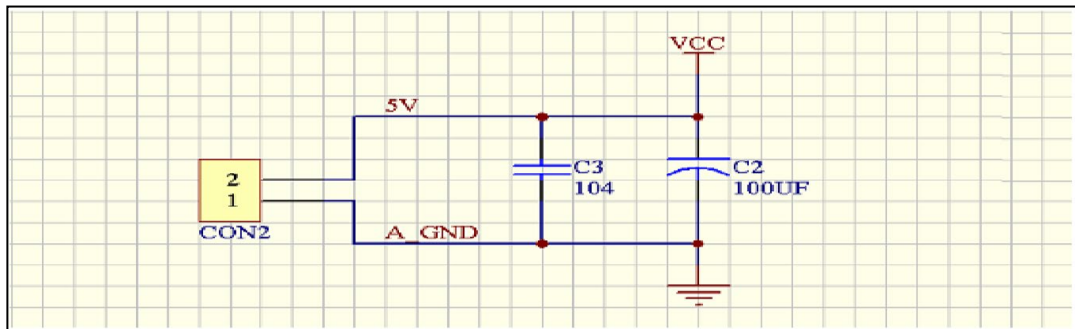


Fig. 10: Power Supply Capacitor Filter Circuit

10. Resistance welding oil (green oil)

Sense element copper foil should be coated with green oil, reduce exposure to copper, to avoid oxidation caused by touch sensitivity affected.

11. Touch sensing keyboard PCB example

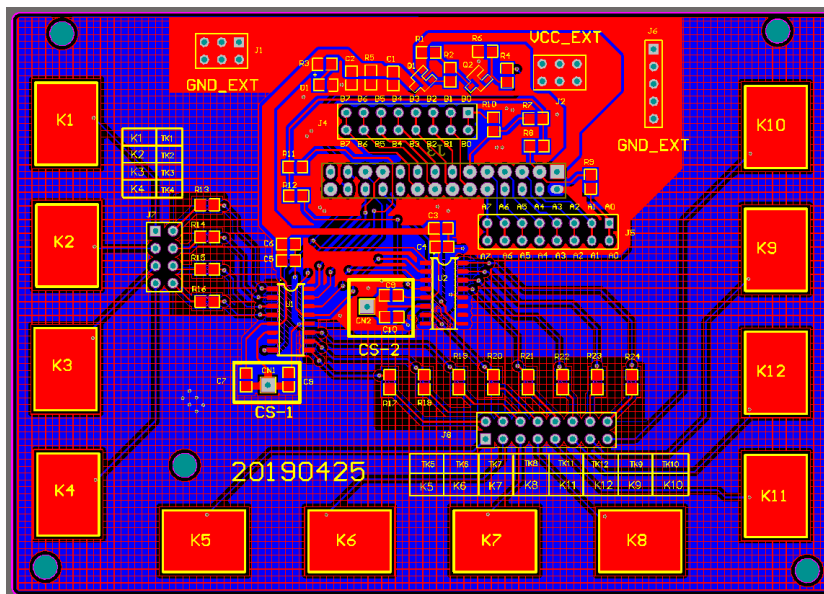


Fig. 11:ICE_Touchkit_2.0C-PCB Overall View

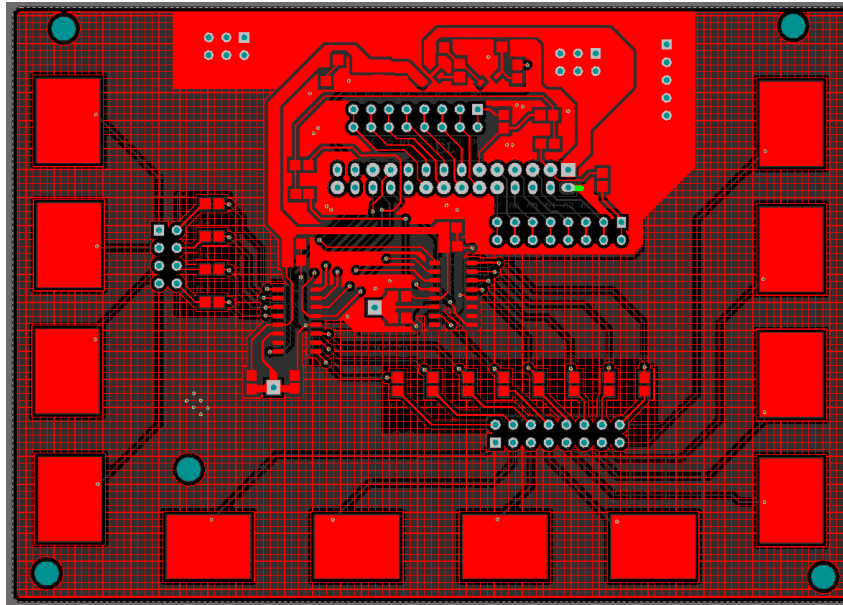


Fig. 12: ICE_Touchkit_2.0C-PCB Top View

(Place copper wires connected to ground in the form of a grid in the blank)

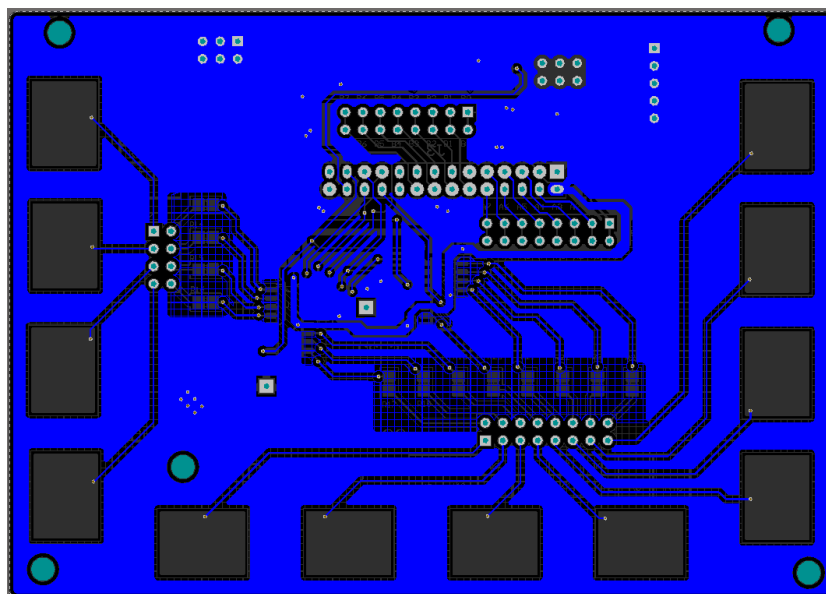


Fig. 13: ICE_Touchkit_2.0C-PCB Bottom View

(Place copper wires connected to ground in the blank)

Appendix: Schematic diagram of ICE_Touchkit

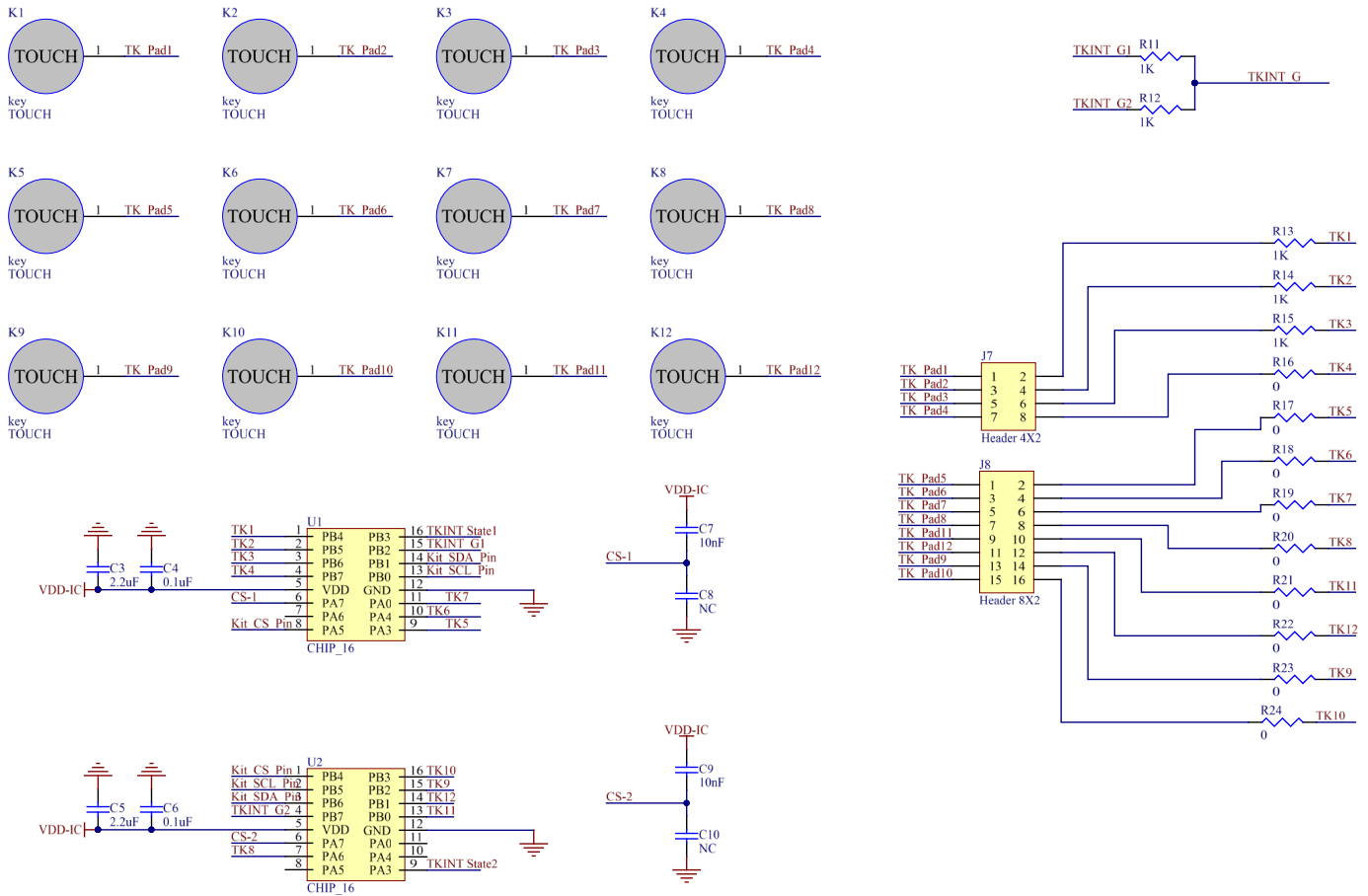


Fig. 14: Schematic diagram of ICE_Touchkit 1/2

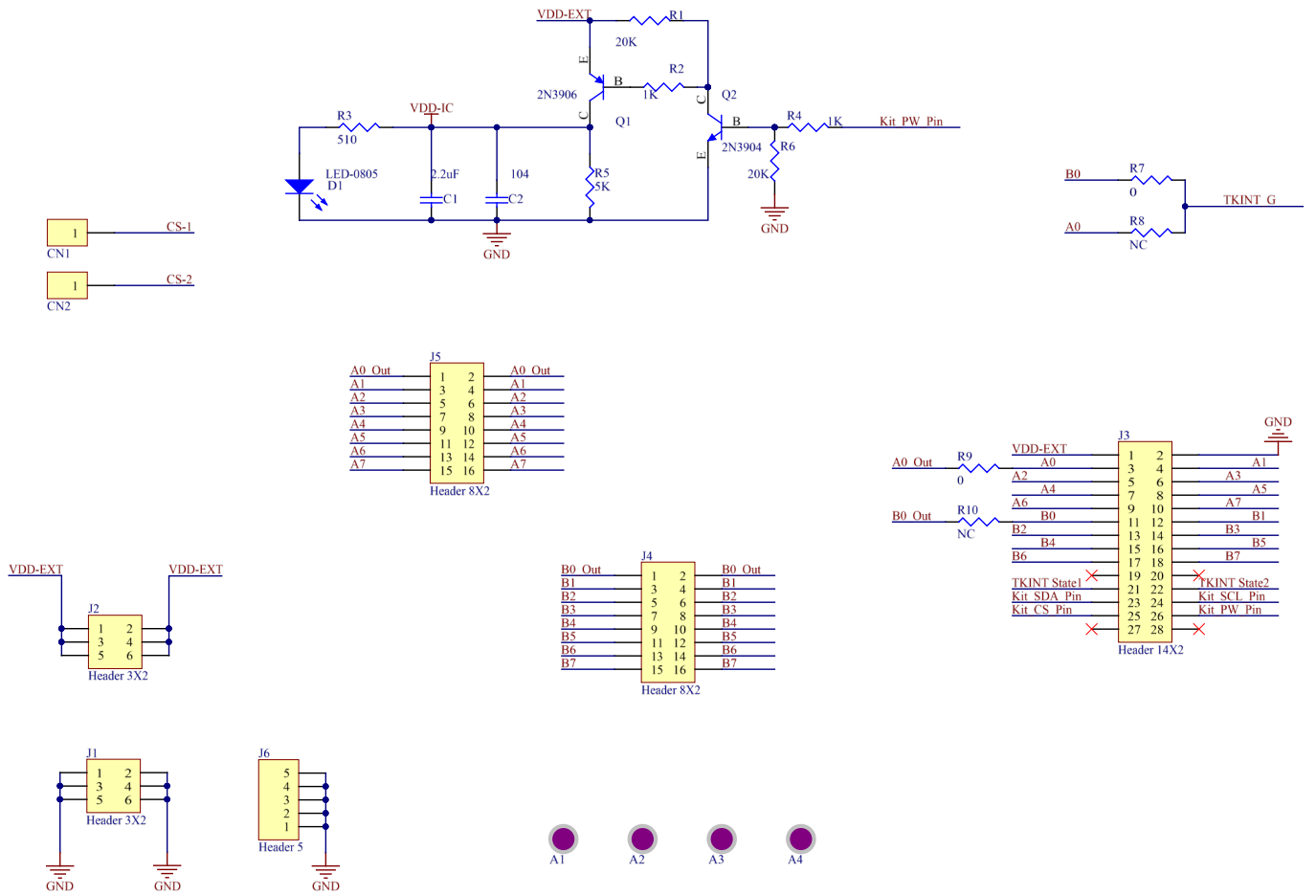


Fig. 15: Schematic diagram of ICE_Touchkit 2/2