FAQs – Sensor Design Guidelines

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1. INTRODUCTION

Microchip's mTouch™ Projected Capacitive (Pcap) Touch Sensing technology provides a readily accessible, low cost, low power solution to facilitate implementation of projected capacitive touch user interfaces.

Microchip's *Capacitive Multi-Touch 18x13 Channel Controller* # MTCH6301 is an exciting product offering, which can be purchased at microchipDIRECT www.microchipdirect.com.

This document is a technical brief on designing a PCB projected capacitive sensor for the # MTCH6301 *Capacitive Multi-Touch 18x13 Channel Controller*.

2. SENSOR CONSTRUCTION

The touch sensor is constructed on 4-layer printed circuit board (PCB), which is also used for the application circuit. A 2-layer PCB is possible for some applications.

The PCB consists of a non-conductive fiberglass/epoxy substrate called FR4 and conductors of 1.0 oz/ft^2 (~0.48 mΩ/sq, ~35 um thick) copper. The total board thickness is ~1.6mm.

2.1 Sensor Layers

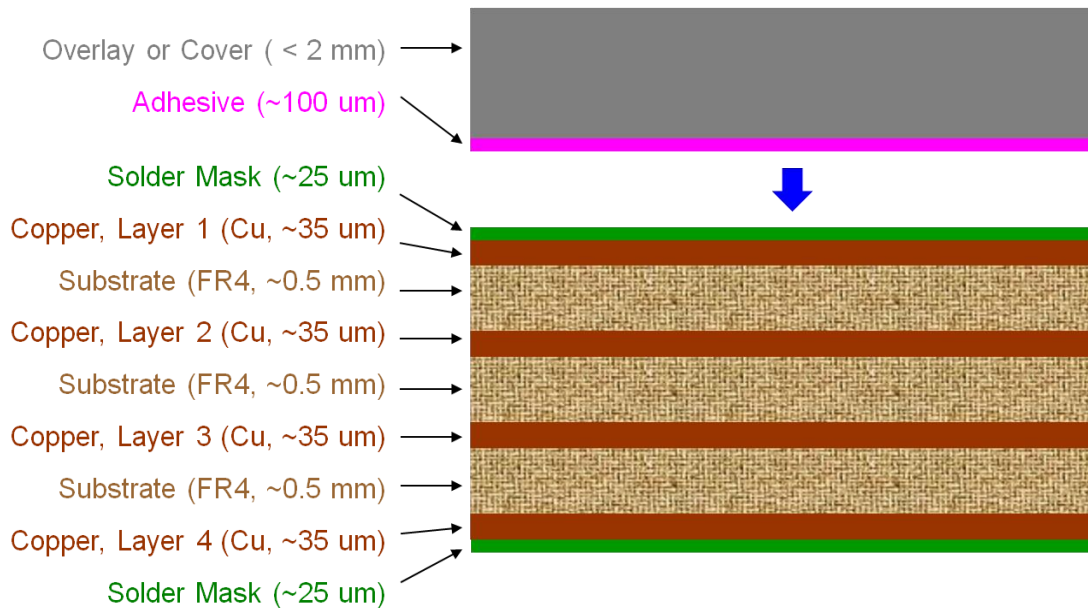A non-scale cross sectional view of the sensor layers is shown below.

Figure 1 : Sensor Layers – Cross Section

2.2 Sensor Overlay

The sensor overlay is a non-conductive molded plastic or glass cover placed on top of the sensor.

2.2.1 Material Type

The overlay material must be non-conductive. For good touch performance, it is preferred to have a material dielectric constant greater than 3. Some commonly used materials are plastics like ABS, Acrylic, and Polycarbonate.

2.2.2 Material Thickness

Touch sensitivity is reduced as the overlay thickness is increased. The material thickness should be in the range of 0.1 mm to 3.0 mm.

An approximate relationship of touch sensitivity verses acrylic overlay thickness is shown below.
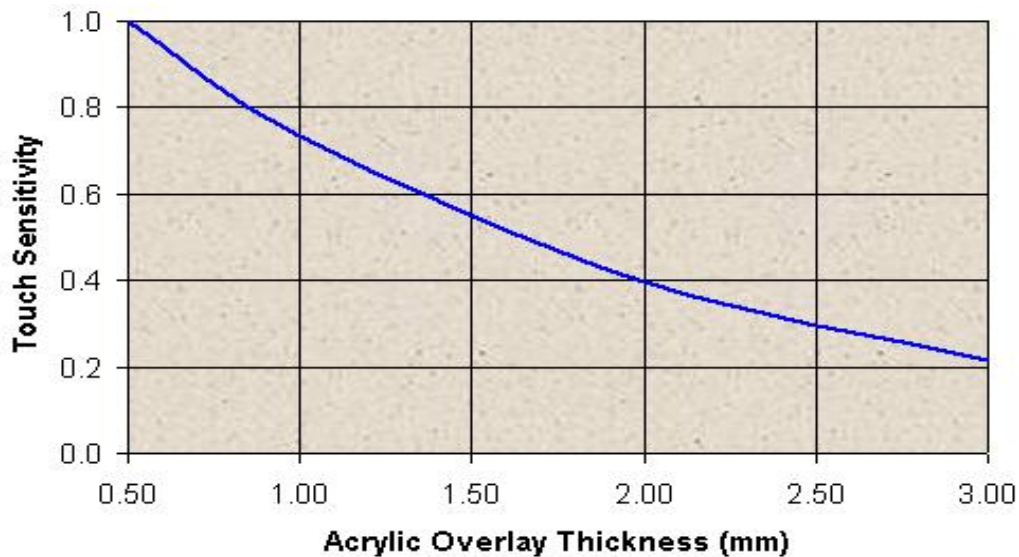
Figure 2 : Touch Sensitivity verses Acrylic Overlay Thickness

2.2.3 Overlay Adhesive

A double sided adhesive is used to mechanically join the overlay to the PCB touch sensor.

A floated overlay-to-sensor interface with no adhesive is not recommended. This can cause poor touch performance due to mechanical instability and a poor dielectric.

The adhesive thickness is typically from approximately 50 um to 200 um thick. An example adhesive is the 3M part 467MP.

2.3 Pattern

The sensor is a matrix of conductive electrodes on the PCB, electrically isolated from each other, arranged as rows and columns or X and Y. An electrode consists of multiple diamond shaped elements, each connected to the next with a conductive neck.

Diamond Element   Neck

Figure 3 : Sensor Electrode

An example 12 electrode X-axis and 9 electrode Y-axis pattern are shown below.

12 X-axis Electrodes (X1-X12)   9 Y-axis Electrodes (Y1-Y9)

X1 X2 X3 X4 X5 X6 X7 X8 X9 X10 X11 X12

Figure 4 : X & Y Axis Electrode Examples

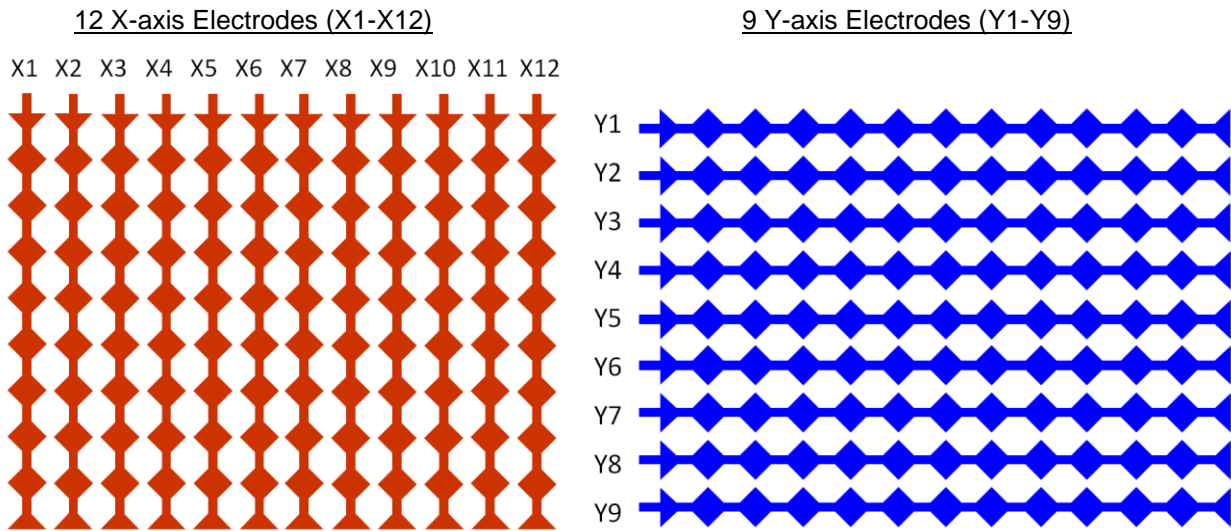The 12 electrode X-axis and a 9 electrode Y-axis are combined on the same PCB layer to create a 12x9 electrode sensor.   A different PCB layer and vias are used for electrode neck cross over locations.
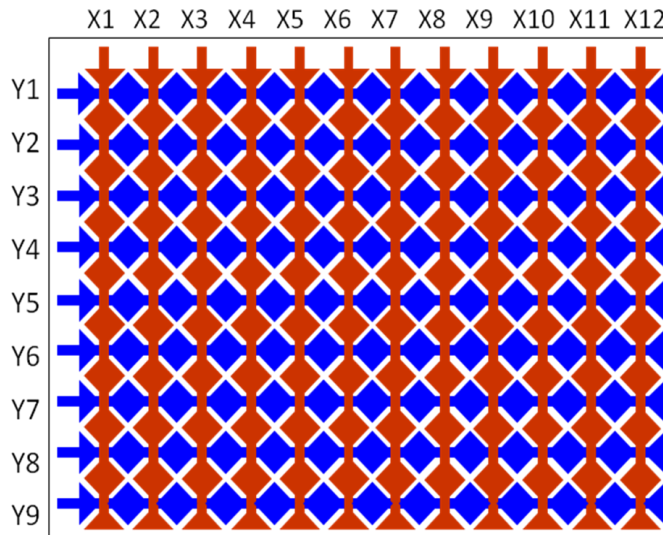
X1 X2 X3 X4 X5 X6 X7 X8 X9 X10 X11 X12

Figure 5 : 12 X-axis and 9 Y-axis Combined Sensor Example

2.4 Electrode Geometry

Diamond elements are used to maximize the exposure of sensor electrodes to a touch.

All electrodes are on the same PCB layer. Electrical isolation is achieved at X & Y axis electrode neck cross over locations by using another PCB layer. Electrode vias to another PCB layer should have approximate diameters of 0.79 mm outer, 0.64 mm inner, and 0.38 mm drill.
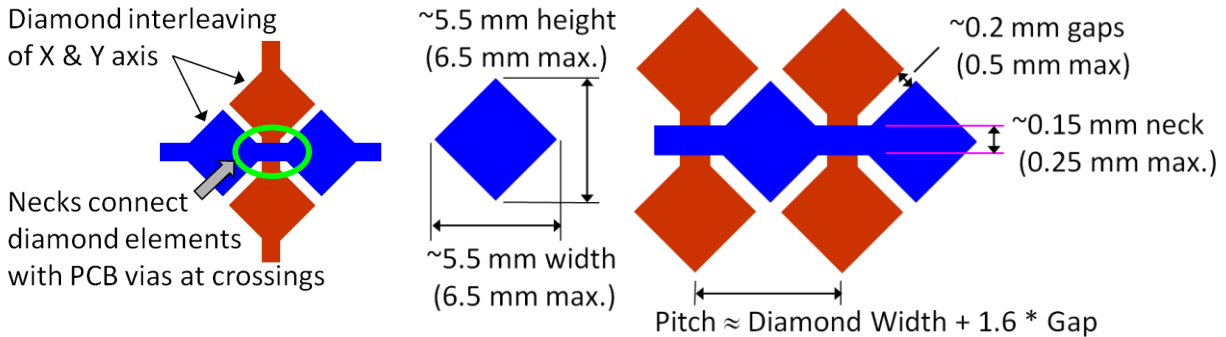

Figure 6 : Electrode Geometry

2.5 Electrode Assignment

Electrodes of one sensor axis route to the controller's Receiver (Rx) measuring pins and the other sensor axis to the controller's Transmitter (Tx) I/O pins.

If there are enough measurement pins on the controller, then a touch performance advantage may be realized by assigning the axis with the higher electrode count to be the Rx electrodes.

2.6 Shielding

Circuit ground shielding is implemented with both, planes and frames of copper on the PCB layers.

• Reduce affects of Electro Magnetic Interference (EMI) to the active sensor area and to controller routing to the sensor electrodes.
• Prevent touches near controller routing to the sensor electrodes from generating false touch events.
• Improve touch sensitivity with an enhanced "free space" circuit ground return path.

2.7 Electrode Routing to Controller

Routing from the controller to electrodes is with 0.15 mm min. traces and 0.3 mm min. spaces. Avoid long parallel routes of Tx's next to Rx's and separate them with 0.5 mm min. space.
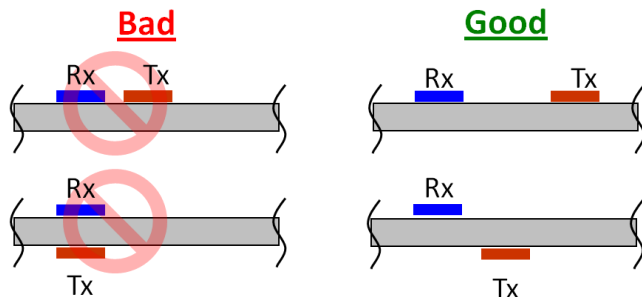

Figure 7 : Rx & Tx Electrode Proximity Routing Cross Section

3. PCB SENSOR AND APPLICATION EXAMPLE

An example sensor design with integrated application will be shown in this section. The application schematic is not provided because it is not relevant for the scope of this sensor design layout example.

The PCB is 4-layer with overall dimensions of 78 mm wide by 89 mm high. The sensor is 12x9 electrodes with an active touch area of 70 mm wide by 53 mm high.

3.1 PCB Example - Top Layer

The top PCB layer is a ground shield for the sensor and for the application circuit in the non-sensor area.

The circuit ground is ~40% pour over the full board footprint. It is constructed as a grid of ~0.38 mm lines on ~1.27 mm pitch with a pour isolation distance of ~0.25 mm.

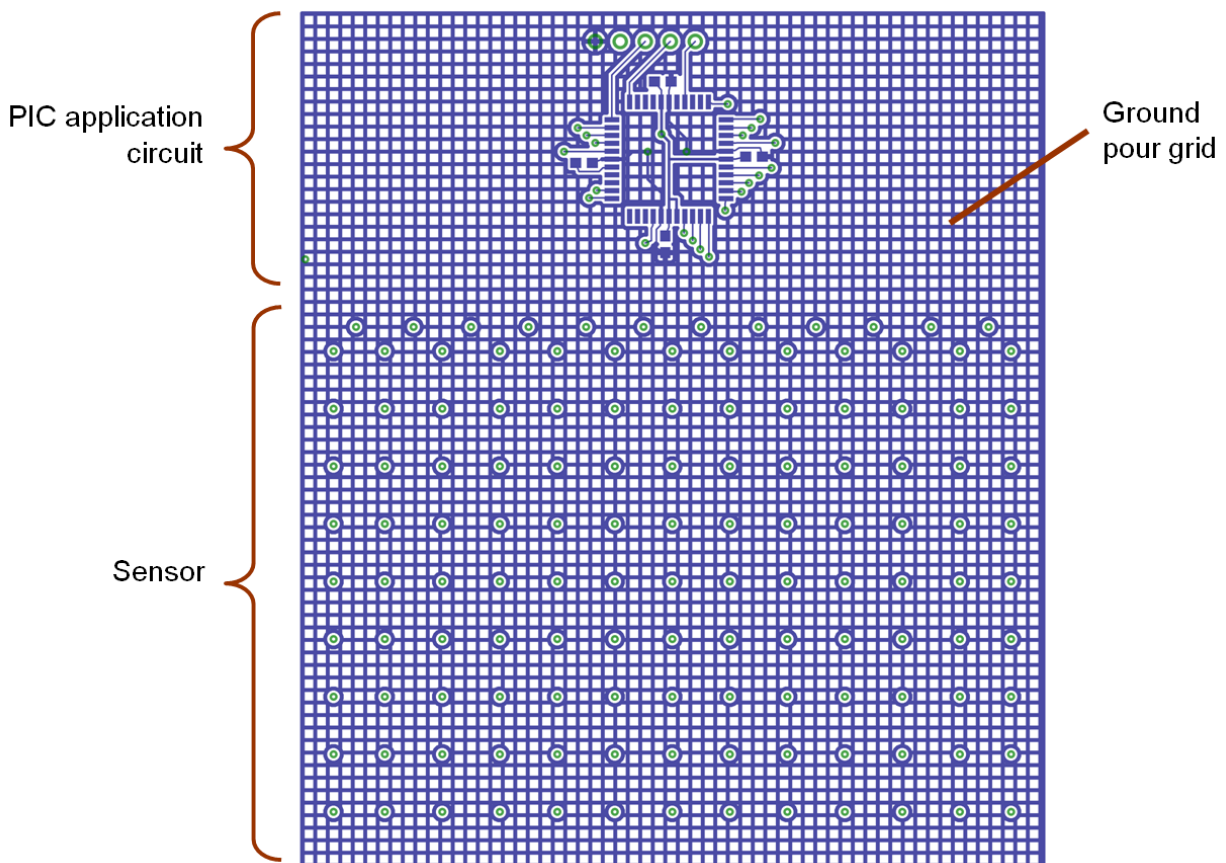**Figure 8 : PCB Example – Top Layer Copper**

3.2 PCB Example – 2nd Layer

The 2nd PCB layer is a ground shield for the sensor and for the application circuit in the non-sensor area.

The circuit ground is 100% pour in the sensor and electrode routing areas, which include the perimeter of the sensor and from the sensor to the application circuit.
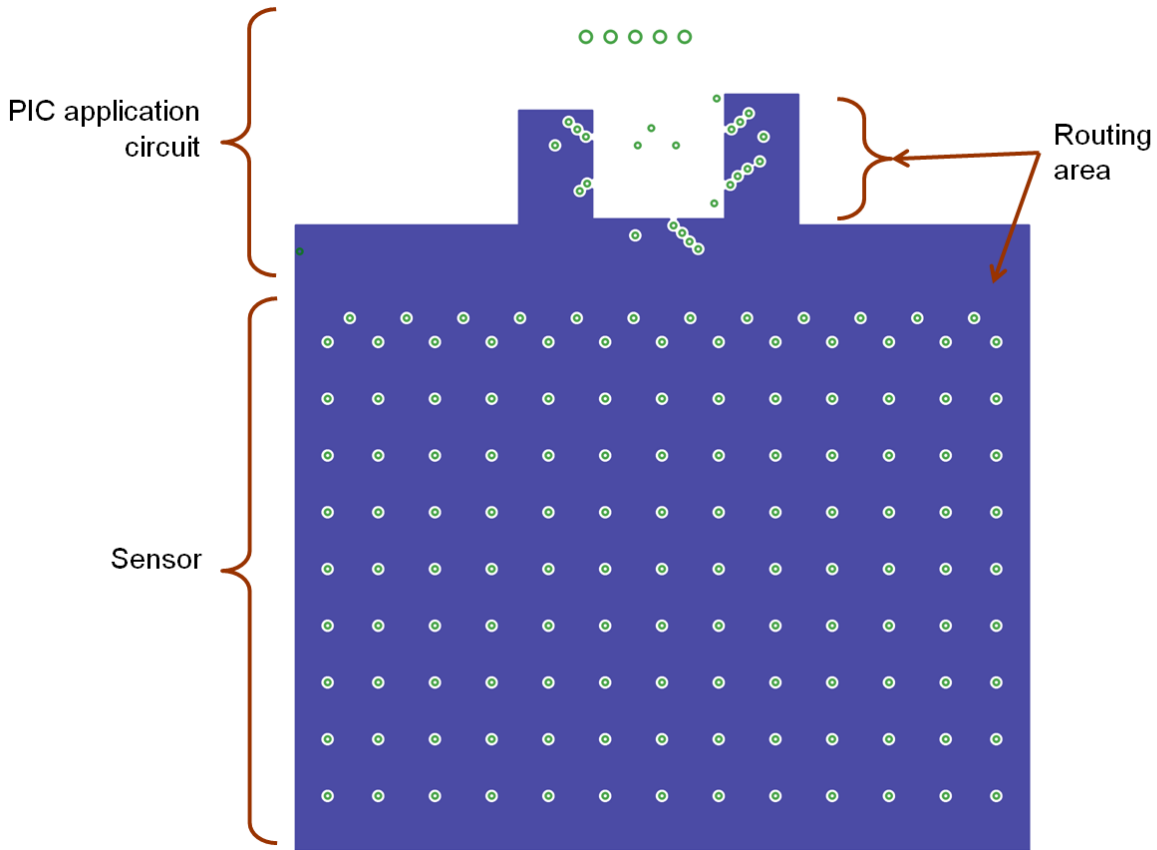

Figure 9 : PCB Example – 2nd Layer Copper

3.3 PCB Example – 3rd Layer

The 3rd PCB layer includes a perimeter ground shield for the sensor, routing to vias going to sensor electrodes on the bottom PCB layer, necks for one sensor axis electrodes, and additional application circuit in the non-sensor area.

A circuit ground 100% pour "U" shaped perimeter is placed around the sensor at three board edges. The width of the ground varies along its perimeter path from 0.7 mm to 2.5 mm in this example. The perimeter gap from electrodes on the bottom PCB layer is ~0.3 mm.

The controller routing includes vias going to 12 X-axis electrodes on the bottom PCB layer and necks with vias going to 9 Y-axis electrodes on the bottom PCB layer.

- Routings ~0.15 mm min. traces with ~0.3 mm min. spaces
- Necks ~0.15 mm wide
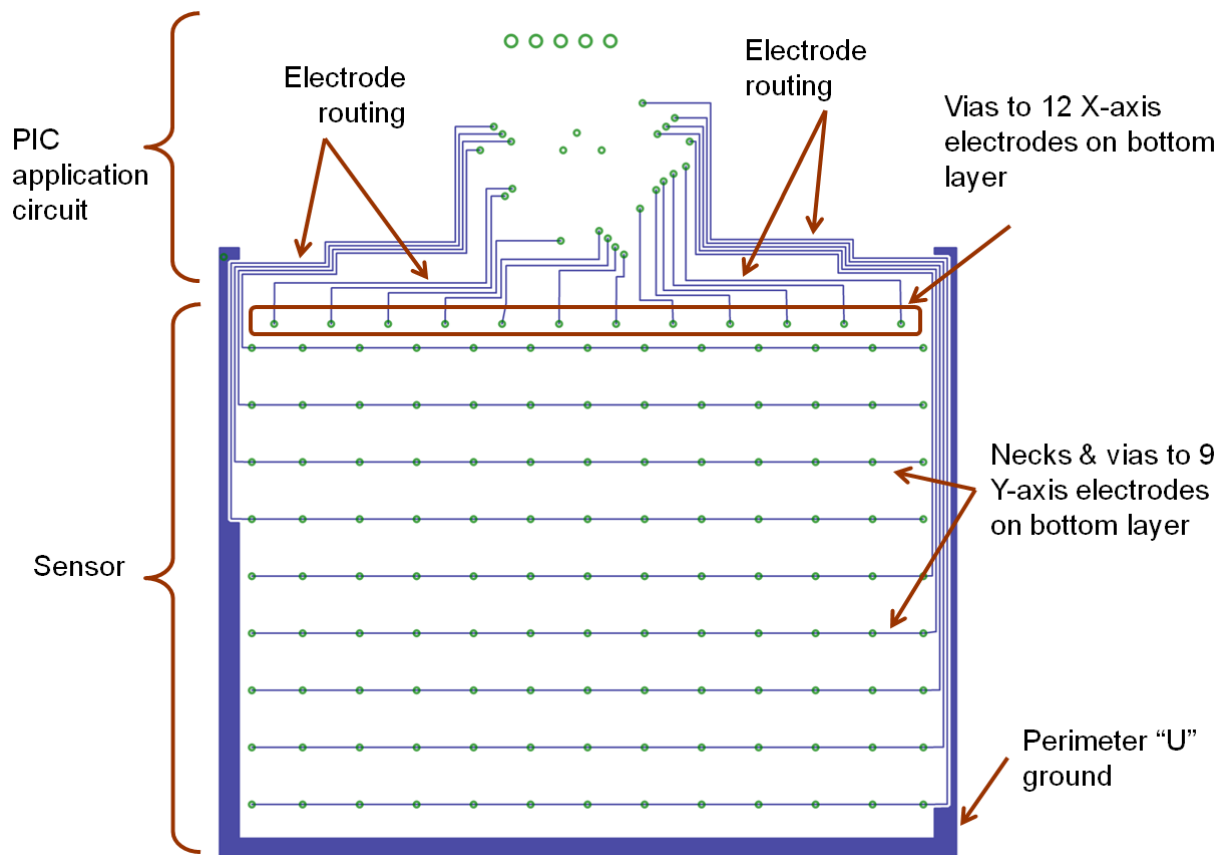- Via diameter ~0.79 mm outer, 0.64 mm inner, 0.38 mm drill

Figure 10 : PCB Example – 3rd Layer Copper

3.4 PCB Example – Bottom Layer

The bottom PCB layer includes a ring ground shield for the sensor, 12 X-axis sensor electrodes with necks, 9 Y-axis sensor electrodes with vias to necks on the 3rd PCB layer, and additional application circuit in the non-sensor area.

A circuit ground 100% pour ring is placed around the entire sensor perimeter, including the majority of the electrode routing to the application. The width of the ground is 2.5 mm in this example. The perimeter gap from electrodes is 0.3 mm.

The sensor electrode pattern includes X-axis sensor electrodes with their necks and Y-axis sensor electrodes with vias to their necks on the 3rd PCB layer.

- Necks ~0.15 mm wide
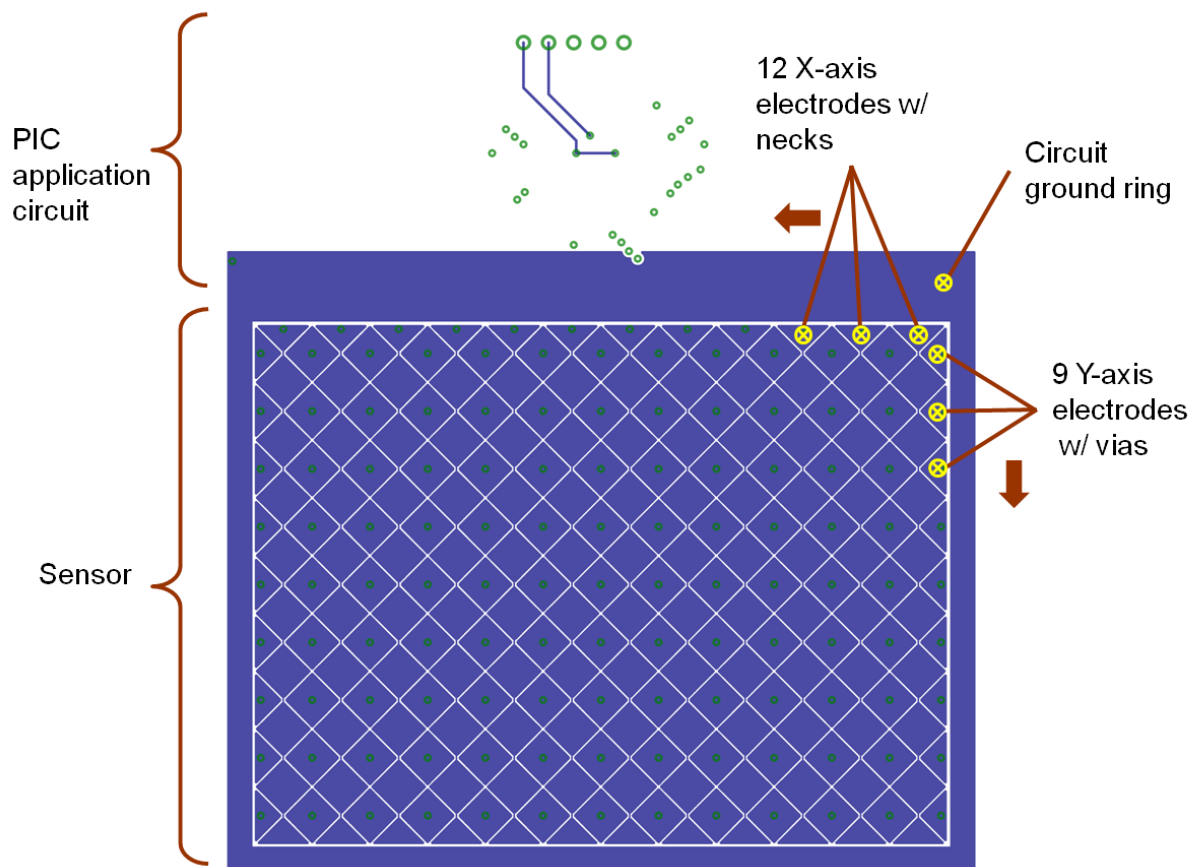- Via diameter ~0.79 mm outer, 0.64 mm inner, 0.38 mm drill

Figure 11 : PCB Example – Bottom Layer Copper

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