MCL Bootcamp

Panelization

Panelization

- Purpose: to secure PCBs during manufacturing, shipping, and assembly processes while making their separation as painless as possible
- Can be as simple as a rectangular board tab routed with a 100mil (0.100") space between boards and a 500mil (0.50") border on four edges

OR

- It can be as complex as a panel filled with a combination jump v-scores with tabs that are routed and retained
- Panelization can also be called an array, pallet, or matrix

Panelization

- Panels are described as how many boards in total make up the x- and y-axis
  - Commonly referred to as "xUP", x being a number
    - Ex: 20UP = 20 individual boards per panel
    - Ex: 10UP = 10 individual boards per panel
- The number of individual boards per panel should not exceed the maximum quantity requested
- NOTE: MCL does not want to quote more than 25UP panel, due to increased manufacturing costs
  - EXCEPTION: if the board size is very small (Ex: 1 x 1" board or smaller)

Benefits of Panelization

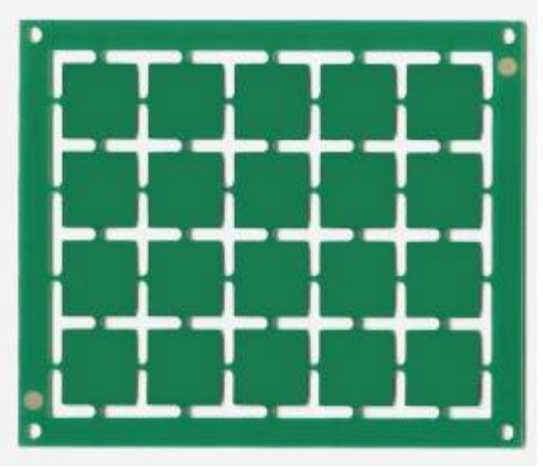
- Cost effective for the assembly company
- Board uniformity, without this some boards may not meet the requirements of the intended application
- Keeps smaller boards attached to one another – helps with quality in the manufacturing process
  - Increases throughput and allows the manufacturing process to maintain its standard panel size
- Allows manufacturers to use existing fixtures and equipment to keep efficient handling of boards high
- Smaller PCBs run the risk of being removed during routing due to the pressure used by the router's vacuum

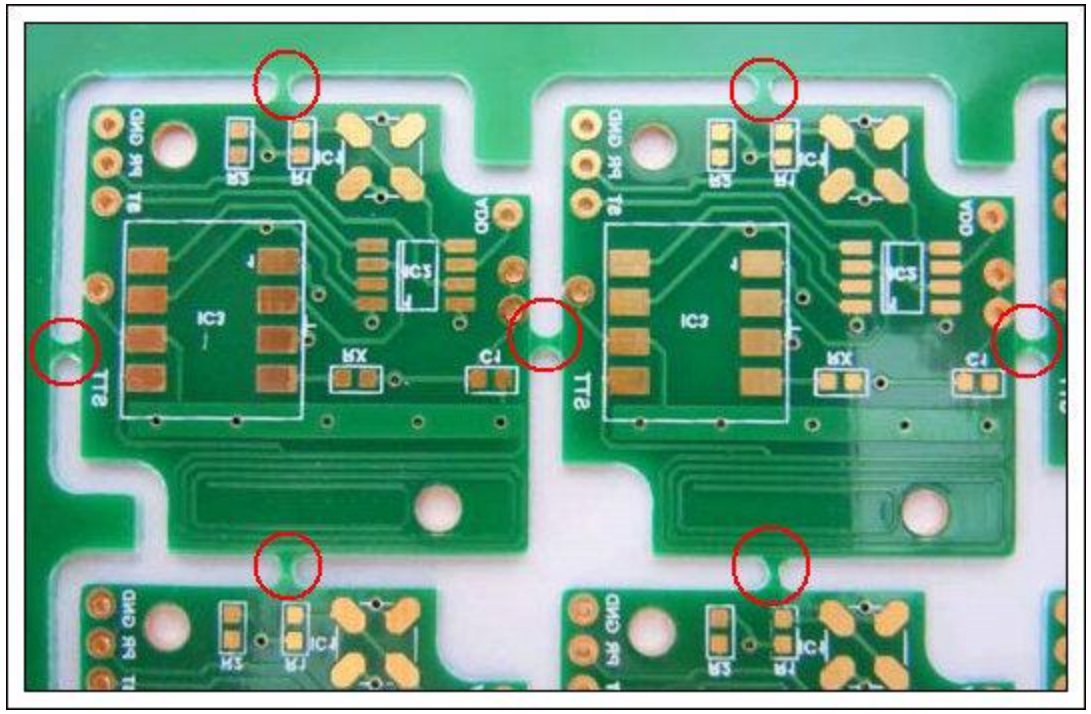
General Guidelines of Panelization

- Depends on customers' specific panel requirements
  - Most panels will require rails, tooling holes, and fiducials
- Domestic vs overseas
  - Domestic – standard panel sizes (for utilization) by U.S. manufacturers
    - More critical
    - Main sheet size: 18" x 24"
    - Other sizes:
      - 12" x 18"
      - 12" x 12"
    - NOTE: need 1" per side for all sizes for tooling
    - NOTE: need ¼" space between each PCB panel per sheet
  - Overseas – no specific panel sizes, can get many different material sizes
    - MCL generally uses a panel size close to 8.5 x 11"

Route and Retain (also called tab route)

- Can be done on any panel but typically done on round boards
- Will leave a small tab on one or more sides of the board attached to the other boards or the rails
- Adds tabs with small drill holes (“mouse bites”) in order to remove the boards from the panel
  - Tab: piece of material that is connected to the board (0.10” width) to hold the PCB in the panel
- Any PCB that has rounded edges, usually will have to be routed and retained with tabs
- Spacing for the tabs is typically 0.10” unless otherwise specified by the customers
  - This allows the manufacturer to easily route the PCBs without the risk of breaking a router bit
- Not as stiff as a v-score so it is easy to “snap” apart
- Leaves burrs where the tabs are, if it’s a tight enclosure, customer will have to sand those burrs down





V-score (scored array)

- Scoring is making a small "V" groove along the top and bottom of the board where it will separate
- The standard v-score is typically 1/3rd on top, 1/3rd on bottom, leaving 1/3 of the material remaining in place to hold the boards together
- The preferred method for most manufacturing operations due to the fact that it is less time consuming to separate the boards
- Greater efficiency of space
- Typically stronger structure than route and retain

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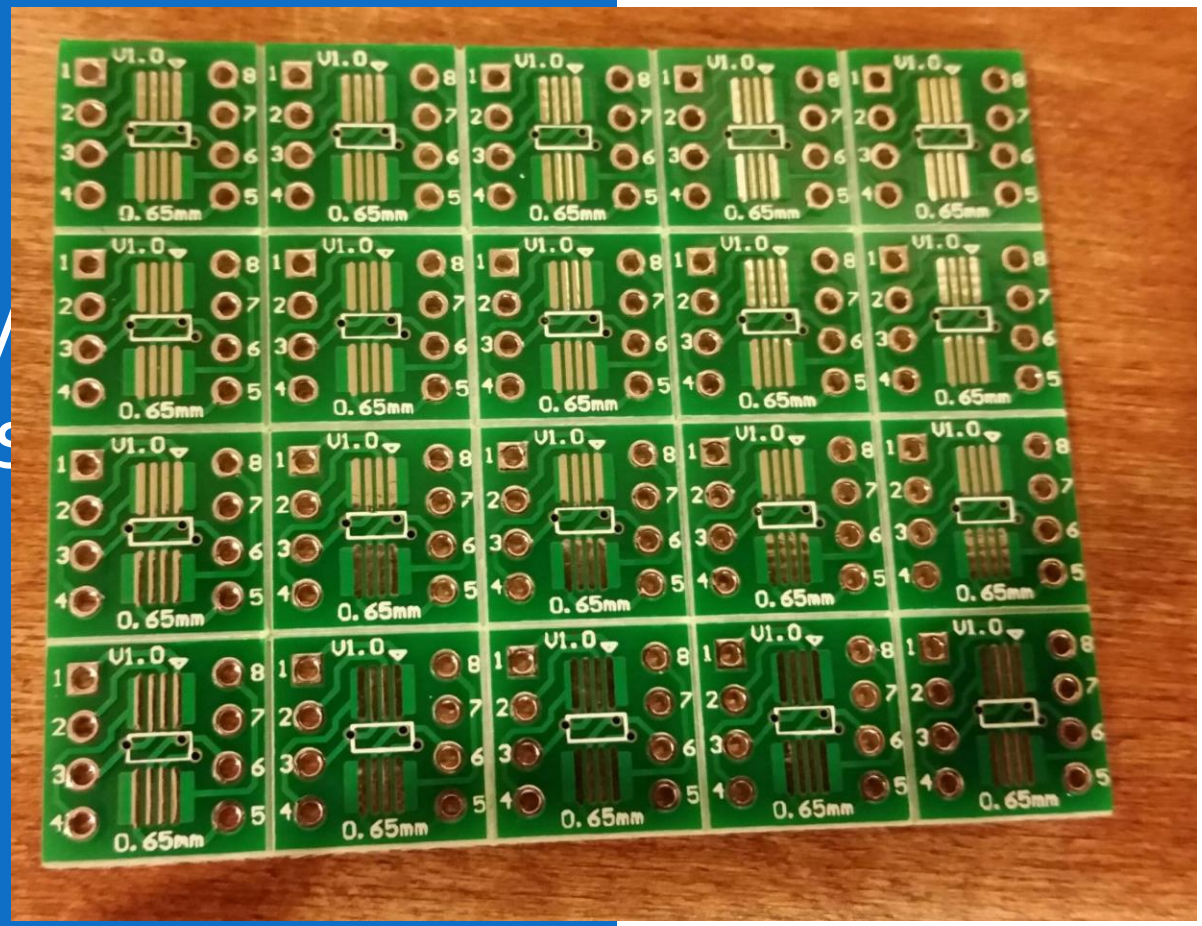
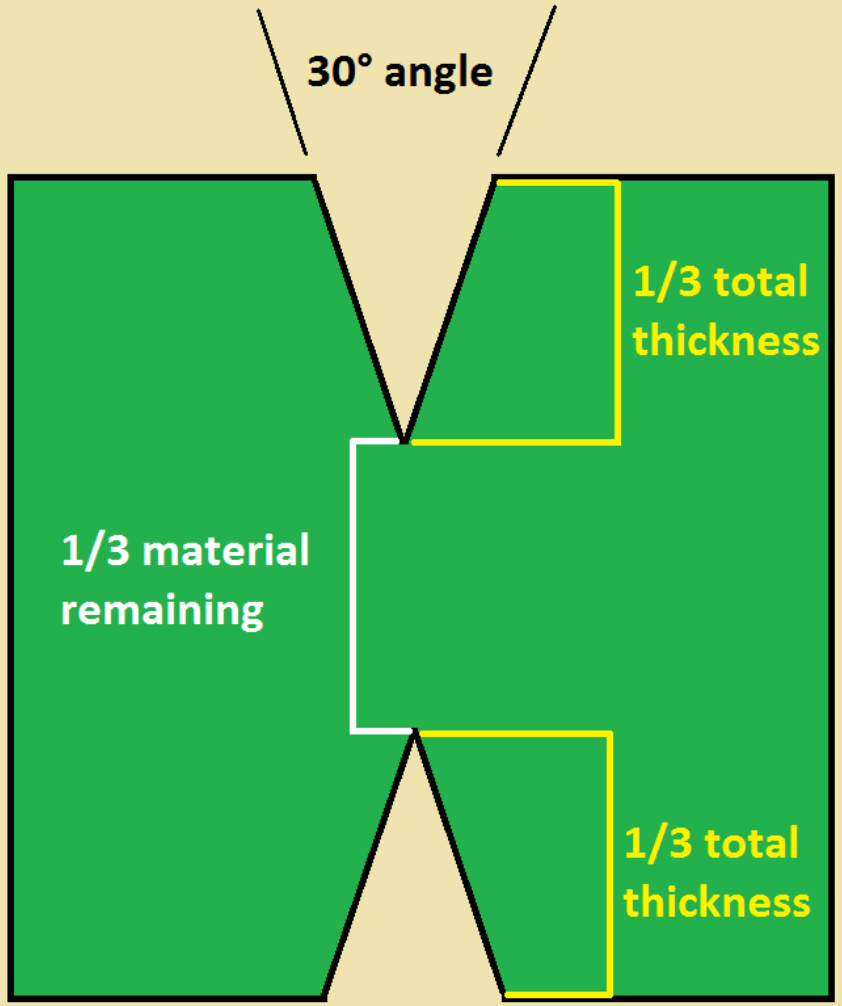


Scoring Cross Section



Rails

- Panels require rails during the manufacturing process for several reasons:
  - Clamped to a conveyor or machine during the assembly
  - Protects the components from solder flowing to the top side
  - Place to put fiducials and tooling holes

Tooling Holes

- Used during the board manufacturing process, bare board or assembly, to pin the board down so there is no movement
- Typically non-plated

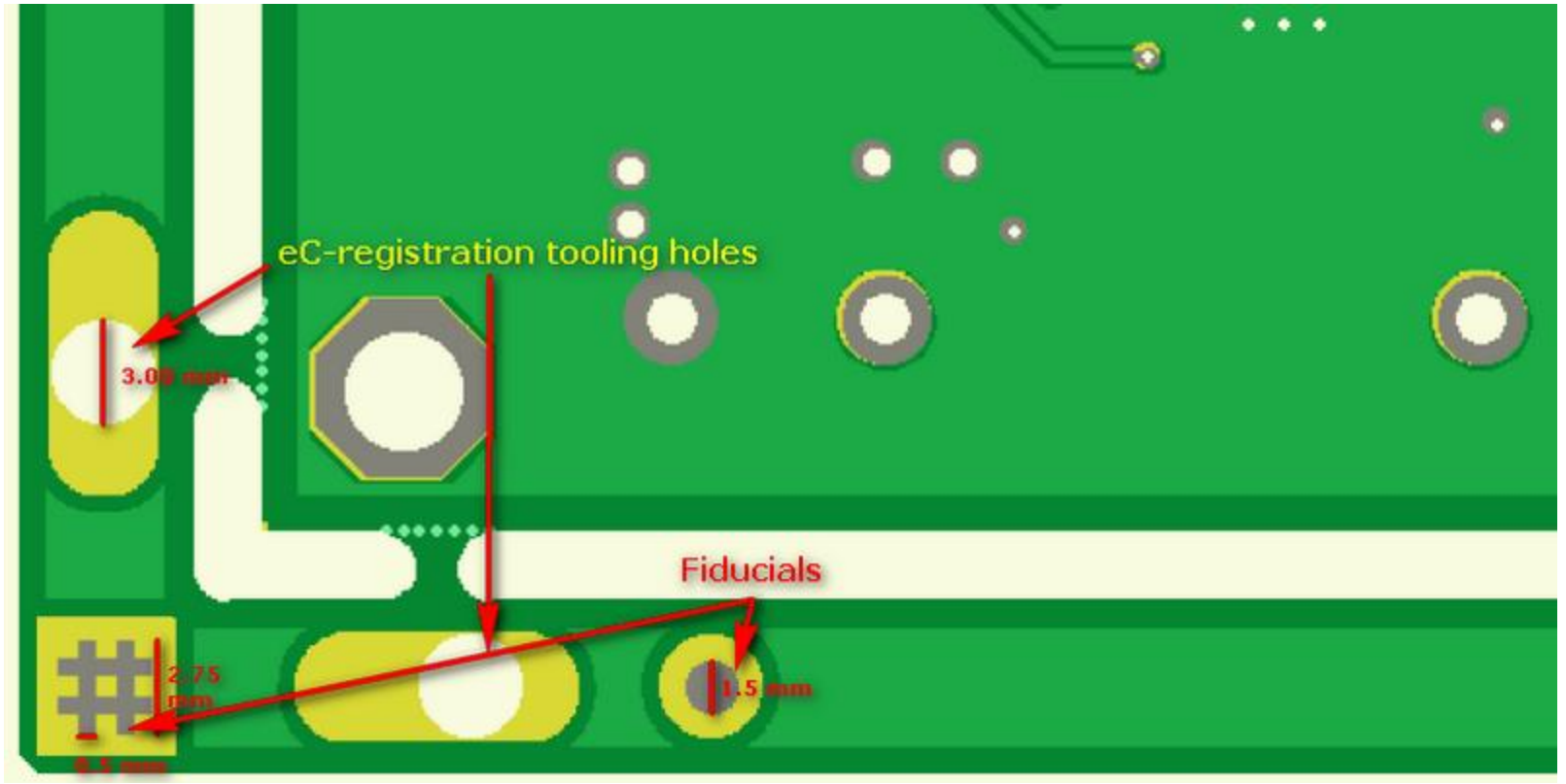
Fiducials

- Used during the assembly process as a x and y origin to base the rest of the assembly placements
  - Usually only for PCB surface mount components
- Precision targets built into a PCB surface which are used by a vision-equipped, pick-and-place machine during the assembly process to fine tune the machine's placement accuracy
  - The fiducial marks can be targets, "s", round dots, or other shapes
  - Typically 50mil (0.050") in diameter
- When viewing the Gerber files, the fiducials are usually seen in the copper layer (top and/or bottom)

Fiducials

- Usually 3 marks are placed on board or a panel so that during assembly the orientation of the board inserted into the machine remains consistent
- No holes drilled through fiducials
- INSERT PIC in Gerber and on Board

Rails, Tooling Hole, and Fiducials



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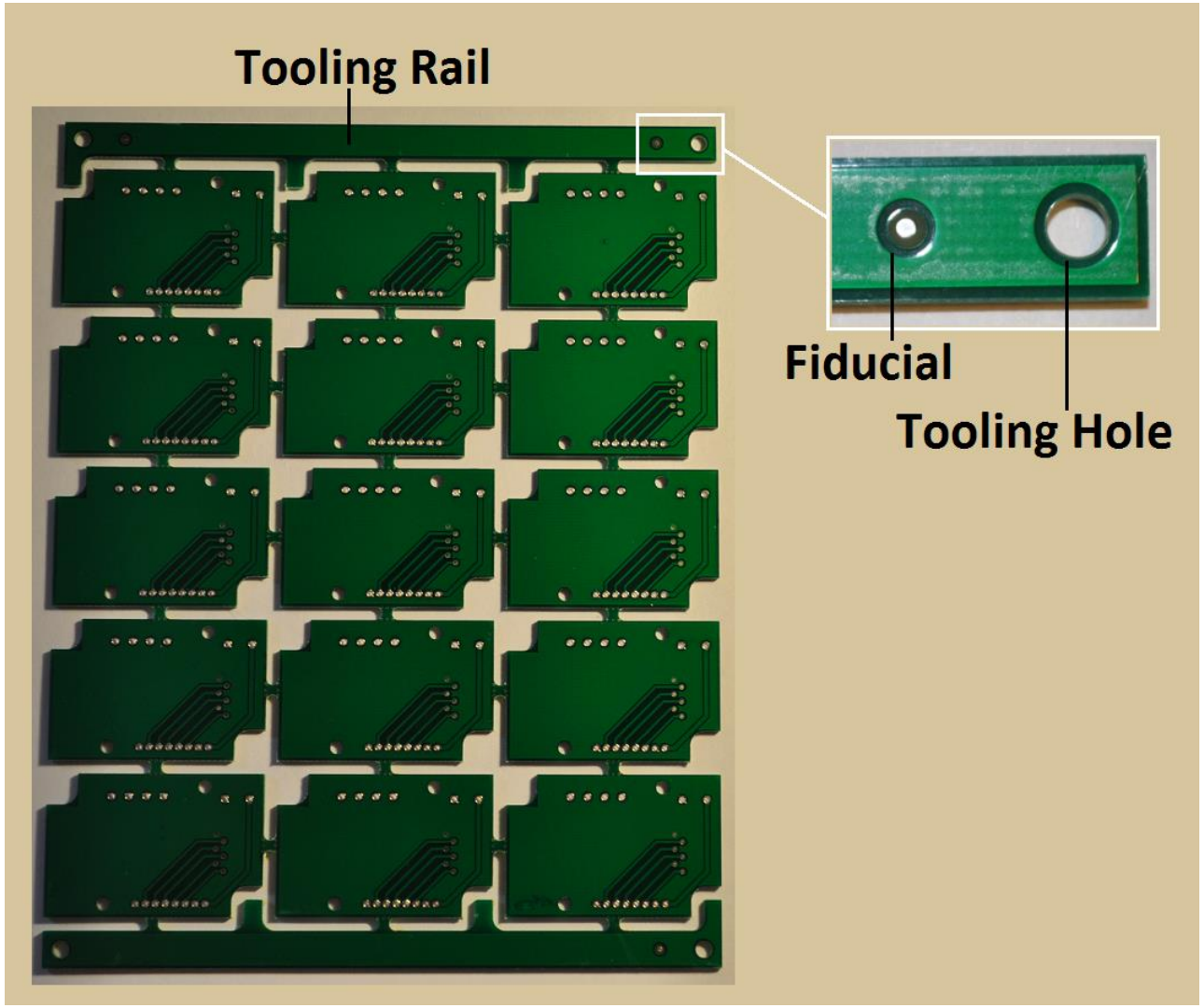

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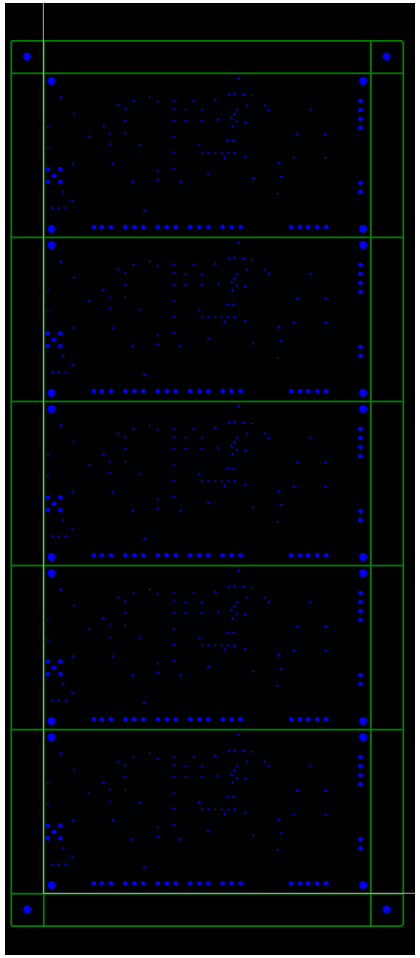
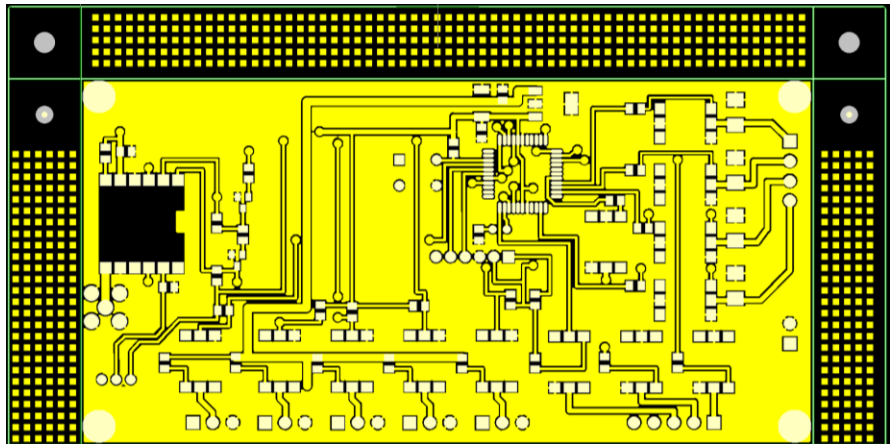




How to Calculate a Panel (with V-Score)

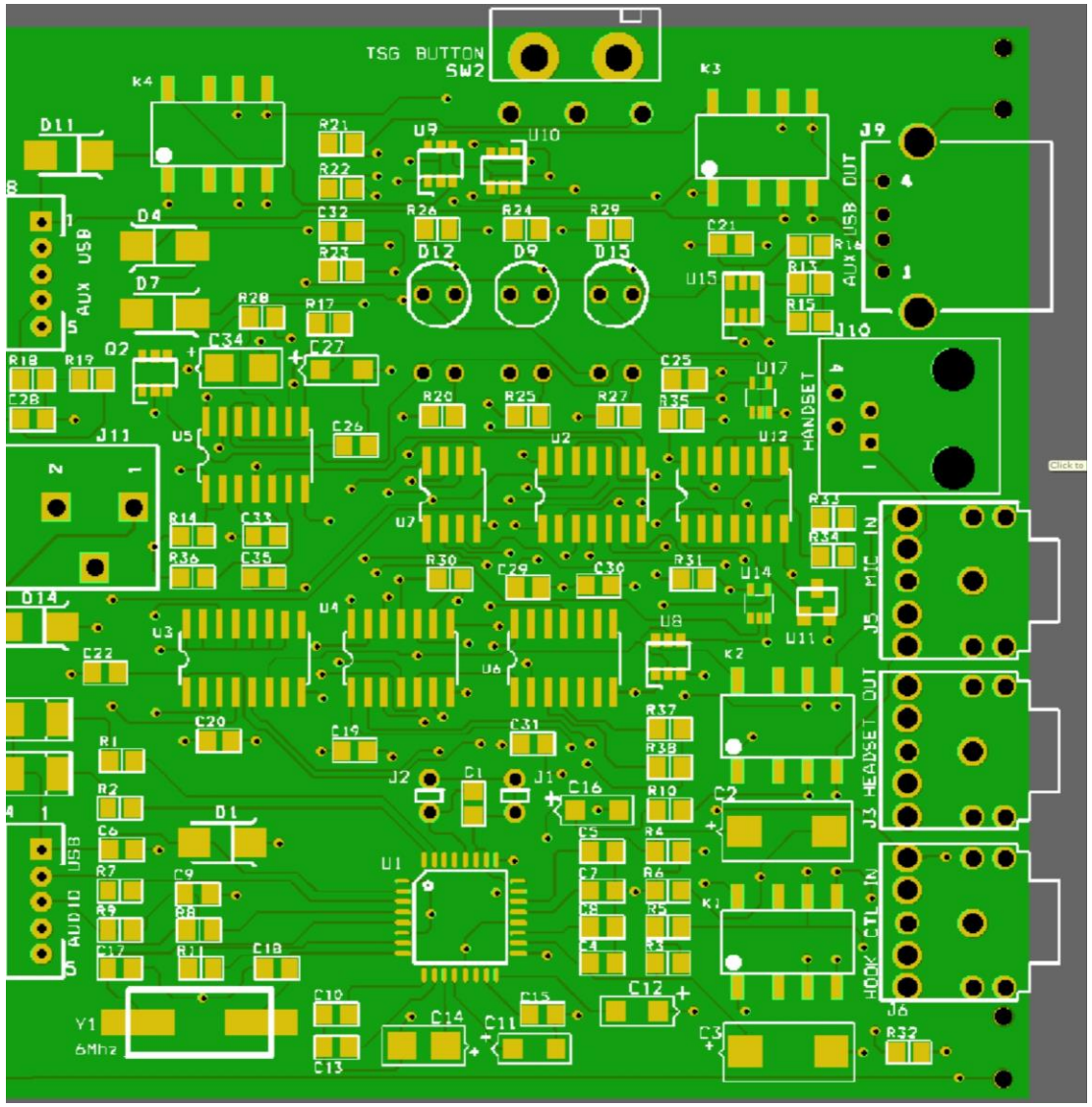
- 1. Obtain x and y dimension of the PCB from Gerber files
- 2. Is the board to be made domestic or overseas?
  - If domestic – need to follow the domestic utilization standards
  - If want domestic and overseas pricing – need to follow domestic utilization standards
  - If overseas – need to have panel fit within 8.5 x 11" dimensions
  - **NOTE: if customer has any specifics they take precedence**
    - Customer panels will also take precedence
    - Ex: ¼"rails on 4 sides
- 3. boards with surface mount technology will typically be panelized because there is more machine work involved
  - If it's a large board, greater than 6 x6", and has fiducials on the board, the customer may not want it panelized

How to Calculate a Panel (with V-Score)

- 4. boards that do not have surface mount technology, all through-hole, may not require panels due to the fact:
  - Don't need fiducials
  - Less processes are involved in assembly
- 5. Is the panel to be routed and retained or v-scored?
  - Look at the outline of the board to decide
    - If routed and retained, take into account the 0.10" between boards and add rails to four sides based on either the customer required rail size or MCL standards
    - If V-scored, there is no space between boards, add rails to four sides based on either the customer required rail size or MCL standards

How to Calculate a Panel (with V-Score)

6. Are there overhanging components?
   - Definition: a component that overhangs the edge of the board
   - Typically shown in silkscreen layers
   - Need to measure the distance the component overhangs the edge of the board and add 0.05” plus the distance of the overhang as a rail or route



How to Calculate a Panel (with V-Score)

- 7. Determine length and width of the board
  - Ex: 2 x 2”
- 8. Determine quantities the customer wants to make sure the panel multiples fit as closely as possible to the quantity
  - Ex: Customer wants 100 pieces
- 9. Determine panel size and work backwards to figure the number of boards per panel
  - Optimal panel size 8.5 x 11”, Board size: 2 x 2”, ¼” rails on 2 sides, v-scored
  - How many boards on x-axis? How many on y-axis? (can be vice versa)
    - X-axis: 4 boards (2 x 4 =8); Y-axis: 5 boards (2 x 5 = 10) 20UP Panel
      - NOTE: unless otherwise specified, add rails to the smaller dimension
  - Final panel size: 8.5” (8 + ¼ +1/4 = 8.5) x 10” (2 x 5= 10)
    - 20UP 8.50” x 10.00”

How to Calculate a Panel (with Route and Retain)

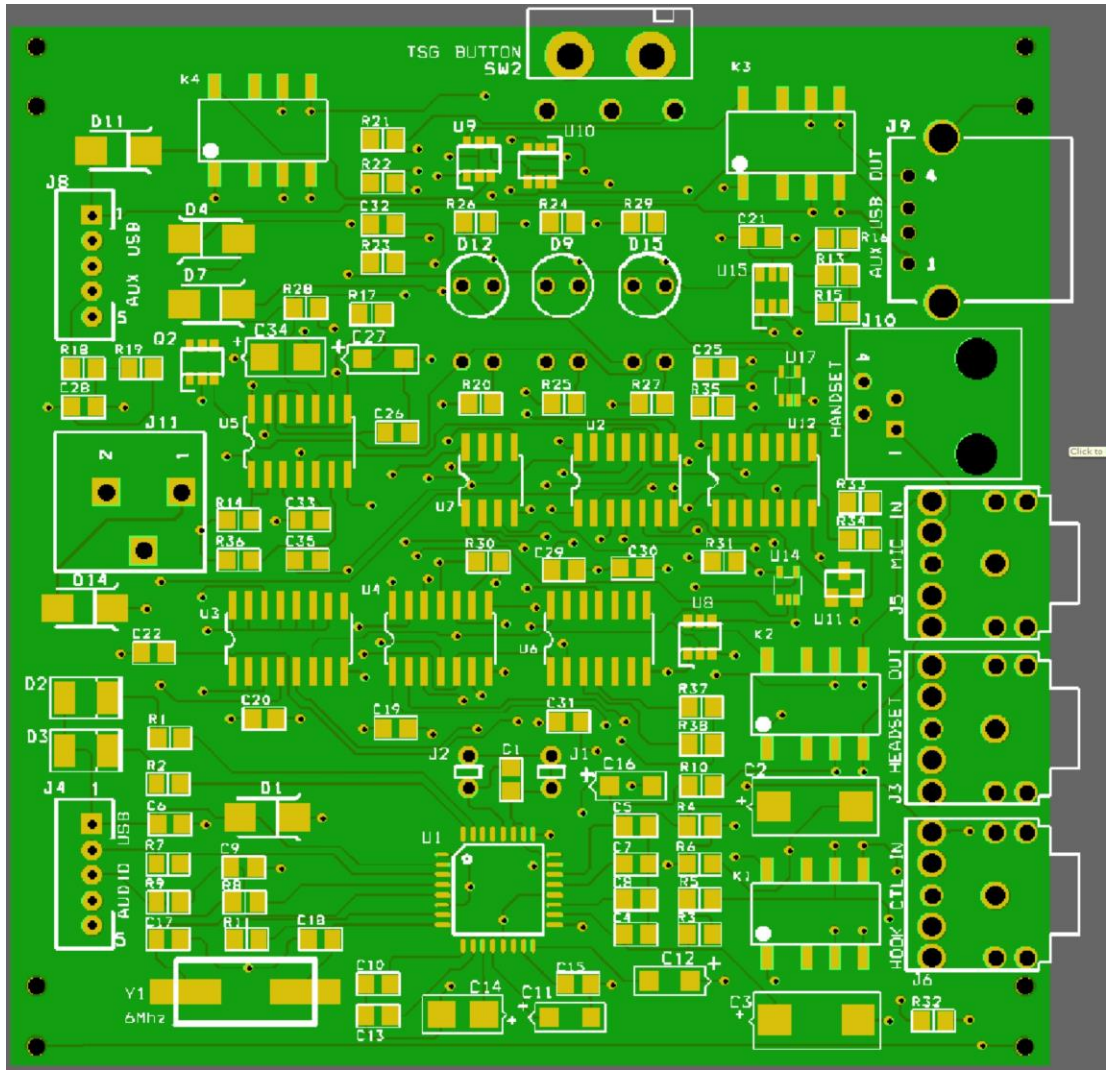
- 1. Obtain x and y dimension of the PCB from Gerber files
- 2. Is the board to be made domestic or overseas?
  - If domestic – need to follow the domestic utilization standards
  - If want domestic and overseas pricing – following domestic utilization standards
  - If overseas – need to have panel fit within 8.5 x 11" dimensions
  - NOTE: if customer has any specifics they take precedence
    - **Customer panels will also take precedence**
    - Ex: space between boards
- 3. boards with surface mount technology will typically be panelized because there is more machine work involved
  - If it's a large board, greater than 6 x6", and has fiducials on the board, the customer may not want it panelized

How to Calculate a Panel (with Route and Retain)

- 4. boards that do not have surface mount technology, all through-hole, may not require panels due to the fact:
  - Don't need fiducials
  - Less processes are involved in assembly
- 5. Is the panel to be routed and retained or v-scored?
  - Look at the outline of the board to decide
    - If routed and retained, take into account the 0.10" between boards and add rails to four sides based on either the customer required rail size or MCL standards

How to Calculate a Panel (with Route and Retain)

6. Are there overhanging components?
   - Definition: a component that overhangs the edge of the board
   - Typically shown in silkscreen layers
   - Need to measure the distance the component overhangs the edge of the board and add 0.05” plus the distance of the overhang as a rail or route



How to Calculate a Panel (with Route and Retain)

- 7. Determine length and width of the board
  - Ex: 3.125" x 1.33"
- 8. Determine quantities the customer wants to make sure the panel multiples fit as closely as possible to the quantity
  - Ex: Customer wants 75 pieces
- 9. Determine panel size and work backwards to figure the number of boards per panel
  - Optimal panel size 8.5 x 11", Board size: 3.125 x 1.33", ¼" rails on 4 sides, routed and retained
  - What numbers is the desired quantity easily divisible by?
  - How many boards on x-axis? How many on y-axis? (can be vice versa)
    - X-axis: 3 boards (3.125"x 3+.40"" = 9.775"); Y-axis: 5 boards (1.33"x5+.6"=7.25") 15UP Panel
      - NOTE: unless otherwise specified, add rails to the smaller dimension
  - Final panel size: 7.25" (7.25" + ¼" +1/4" = 7.75") x 9.775" (9.775" + ¼" + ¼"= 10.275")
    - 15UP 7.75" x 10.275"

Self Check
Does my figure make sense?

Questions