

Design-For-Manufacturability Guidelines



Introduction

This DFM manual was written by Summit Interconnect's management team to assist our customers towards designing Printed Circuit Boards for manufacturability. Following these guidelines will provide higher yields, lower cost, and PCBs fabricated in a timely manner.

Thank you for allowing Summit Interconnect to support your complex, time-critical prototype through production printed circuit board requirements.

Certification and Qualifications and capabilities

□ **Underwriters Laboratories**

ISO 9001:2000 Certified: Issued since February 2004 File #A12757
Flammability Rating UL 94 V-O
RoHS and Lead Free Products (compliant)

□ **Military**

Full Qualification for Mil-PRF-55110 - Qualification for GF
Qualification for GI-(polyimide)
AS-9100 2016 Certification through March 20, 2023
ISO-9001 2015 Certification through March 20, 2023
Mil – PRF-31032
Mil-P-50884, NADCAP

□ **Other**

ITAR Certified
RoHS Compliant
IPC-6012, IPC-6013, IPC-6015 & IPC-6018 Class 2 & 3
IPC-6012DS Space
NADCAP
NIST SP. 800-171

Design Guidelines

The following Summit Interconnect design guidelines are separated by technology into three categories (**Standard**, **Advanced** and **Emerging**).

"Standard" - To achieve the lowest cost for your PCB project, your design should stay within the Standard category. Standard capability with no premium.

"Advanced" - Current advanced capability with a small premium.

"Emerging" - Advanced Technology our Engineering Team maintains experience with and can fabricate on request with a significant premium. Also, requires Engineering surveillance throughout the manufacturing process.

Rigid PCB Design Guidelines

| | Standard | Advanced | Emerging |
|-------------------------------------|--|-----------|-----------|
| Panel Size | 12" X 18" 18" X 24" 21" X 24" & 19" X 25" | 24" X 30" | 26" X 36" |
| Layer Count | 2 to 36 | 48 | >48 |
| Laminate Materials | | | |
| FR4 Tg 170 | Yes | Yes | Yes |
| Rogers/Taconic- PTFE and Ceramic | Yes | Yes | Yes |
| Polyimide | Yes | Yes | Yes |
| Rogers Duroid | Yes | Yes | Yes |
| RoHS Lead Free Compatible Materials | Yes | Yes | Yes |

| | Standard | Advanced | Emerging |
|---|----------------|---------------|------------------------------------|
| Isola 370 HR | Yes | Yes | Yes |
| Panasonic Megtron 6 | Yes | Yes | Yes |
| Panasonic Megtron 7 | Yes | Yes | Yes |
| Isola Tachyon 100g | Yes | Yes | Yes |
| Isola I-Tera MT-40 | Yes | Yes | Yes |
| Isola Astra MT 77 | Yes | Yes | Yes |
| EMC EM-827 | Yes | Yes | Yes |
| EMC EM-370B | Yes | Yes | Yes |
| TUC | Yes | Yes | Yes |
| Halogen Free | Yes | Yes | Yes |
| Finished PCB Thickness [Multilayer] | .005" to .180" | .181"-.250" | Greater than .250" |
| Minimum Core Thickness | .003" | .002" | .001" |
| Finished Thickness Tolerance [+/-] | 10% | 8% | <8% |
| Multiple Laminations | 1 | 5 | 7 as permitted by laminate type |
| Copper Foil Weights Internal | 1/4 to 2 | Up to 4 ounce | Up to 6 ounce |
| Copper Foil Weights External | 1/4 to 3 | Up to 4 ounce | Greater than 6 ounce |
| Lines, Spaces, & Pad Diameters | | | |
| Internal Line Width | .004" | .003" | .0018" |
| Internal Spacing | .004" | .003" | .002" |

| | | | |
|---|--------------------------------|----------------------------------|----------------------------------|
| External Line Width | .0045" | .0035" | .003" |
| External Spacing | .005" | .004" | .003" |
| Annular Ring: Mechanically Drilled Hole | Class 2 .005" Class 3 .007" | Class 2 .004" Class 3 .006" | Class 2 <.004" Class 3 <.006" |
| Annular Ring: Laser Drilled Microvias | Class 2 .003" Class 3 .003" | Class 2 .0025" Class 3 .0025" | Class 2 <.002" Class 3 <.002" |
| Impedance | 10% | 5% | 5% |
| Electroplating | | | |
| Tin Lead Plating Thickness | .0003"-.0005" | Greater than .0005" | >.0005" |
| Nickel Plating Thickness | 150 Microinches | 250 Microinches | >250 Microinches |
| Low Stress Nickel | 100 Microinches | 250 Microinches | >250 Microinches |
| Gold Plating Thickness | 30 Microinches | 100 Microinches | >100+ Microinches |
| Minimum Mech Drilled Hole Size | 0.010" | 0.008" | 0.006" |
| Hole Aspect Ratio: Mechanical | 10:1 | 14:1 | 20:1 |
| Hole Aspect Ratio: Laser Microvia | 0.6:1 | 0.75:1 | >.7:1 |
| Hole Aspect Ratio: Buried/ blind/ Thru Via | 10:1 | 14:1 | >20:1 |
| Conductor Finishes | | | |
| HASL | Yes | Yes | Yes |
| Solder with Reflow | Yes | Yes | Yes |
| White Tin | Yes | Yes | Yes |
| Lead Free Finishes | | | |
| Electroless Nickel / Electroless Palladium / Immersion Gold | Per IPC - 4556 | Per IPC - 4556 | Per IPC - 4556 |



| | | | |
|-------------------------------------|----------------|----------------------------------|---|
| Electroless Nickel / Immersion Gold | Per IPC - 4552 | Per IPC - 4552 | Per IPC - 4552 |
| Immersion Silver | Per IPC - 4553 | Per IPC - 4553 | Per IPC - 4553 |
| OSP Entek Plus HT | Yes | Yes | Yes |
| HASL, Lead Free HASL | Yes | Yes | Yes |
| Tolerances | | | |
| Drilled Hole To Copper | .010" | .008" | .006" |
| Non-Plated Hole Tolerances [+/-] | .002" | .002" / .001" | <.001" |
| Fabrication Tolerances [+/-] | .005" | .003" | <.003" |
| Via Capabilities | | | |
| Laser Drilled Micro Vias | .005" - .006" | .004" | <.004" |
| Microvia Aspect Ratio | >0.5:1 | 0.7:1 | >.7:1 |
| Blind/Buried/Epoxy Filled Vias | .008" | .006" | .004" |
| Thru Via | .010 | .008" | .006" |
| Filled Back Drill | Yes | Yes Depth tolerance +/- .005" | .008" larger than Primary Drill (Smallest .016") Depth tolerance +/- .002" |
| Back-Drill Anti-pad | Yes | Yes | .020" larger than Primary Drill |
| Castellation | Yes | Yes | Yes |
| Via Protection for IPC- 4761 | Yes | Yes | Yes |
| Plugged UV Curable [no solvent] | Maximum .020" | Yes | Yes |
| | | | |

| | | | |
|--|-------------------------|----------------------------|-------------------------|
| | Yes | Yes | Yes |
| Non-Conductive Via Fill Taiyo THP 100DX1 San-Ei PHP 900 | Yes | Yes | Yes |
| Soldermask and Legend | | | |
| Minimum Mask Clearance [LDI LPI] | .003" | .002" | .0015" |
| Minimum Soldermask Thickness | 0.0004" | 0.0004" | 0.0004" |
| Soldermask Type | LDI / LPI | LDI / LPI / Dry Film | As required |
| Soldermask Color | Green | Any Color | Any Color |
| Soldermask Web Minimum | .004" | .0035" | .003" |
| Legend Color | White | Any Color | Any Color |
| Ink Jet Legend Feature Size | .008" wide x .045" high | .006" wide x .03" high min | LPI Legend .004" x .03" |
| Flatness (Symmetrical construction) | IPC Standard | IPC Standard | Review Required |
| | | | |

Flex PCB Design Guidelines

| | Standard | Advanced |
|---|-----------------------|-----------------------|
| Single-Side Flexible Panel Size | 12" X 18" & 18" X 24" | 21" X 24" & 24" X 36" |
| Double-Side Flexible Panel Size | 12" X 18" | 24" X 36" |
| Multi-Layer Flex Panel Size | 12" X 18" | 18" X 24" and Up |
| Layer Count | 3 to 12 | 13+ |
| Rigid Flex Panel Size | 12" X 18" | 18" X 24" and Up |
| Layer Count | 2 to 12 | 13+ |
| Multiple Lamination | | |
| Copper Foil Weights Internal/ External | ¼ to 2 ounce | Up to 3 ounce |
| Kapton Polyimide Stiffener | .001" to .007" | .008" and Up |
| FR4 Stiffener | .003" to .062" | .063" and Up |
| Polyimide Rigid Stiffener | .003" to .062" | .063" and Up |
| Lines, Spaces & Pad Diameters | | |
| Internal Line Width | .0035" | .002" |
| Internal Spacing | .0035" | .002" |
| External Line Width | .004" | .003" |
| External Spacing | .004" | .003" |
| SMT Pitch | .0197" | .0157" |
| Impedance | 10% | 7% |

| | | |
|---|------------------|------------------|
| Via Hole Finish | | |
| Laser Micro Vias | .006" | .004" |
| Blind/Buried Vias | .010" | .006" |
| Laser Drilled Via Aspect Ratio | 0.6:1 | 0.75:1 |
| Minimum Mechanically Drilled Hole Size | .010" | .008" |
| Drilled Hole to Copper | .010" | .008" |
| Castellation | Yes | Yes |
| Surface Finish | | |
| Tin Lead Plating Thickness | .0003" to .0005" | <.0005" |
| Nickel Plating Thickness | 150 Micro Inches | 250 Micro Inches |
| Low Stress Nickel | 100 Micro Inches | 250 Micro Inches |
| Gold Plating Thickness | 30 Micro Inches | As Specified |
| Electroless Nickel / Immersion Gold | Yes | Yes |
| Electroless Nickel / Electroless Palladium / Immersion Gold | Yes | Yes |
| Immersion Silver | Yes | Yes |
| Entek Plus HT | Yes | Yes |
| HASL | Yes | Yes |
| Tolerances | | |
| Plated Hole Tolerances [+/-] | .003" | .002" |



DFM Guidelines

1410 Martin Avenue
Santa Clara, Ca 95050
408 727 1418 Phone
408 727 8971 Fax

| | | |
|------------------------------------|-------|--------|
| Non Plated Hole Tolerances [+/-] | .002" | .0015" |
|------------------------------------|-------|--------|

| | | |
|---------------------------------|-------|-----------|
| Fabrication Tolerances [+/-] | .005" | .003 " |
| Vision Rout [+/-] | .003" | .002 " |
| Laser Rout [+/-] | .003" | .002 " |

Website link for sending data to Summit
<https://www.summit-pcb.com/request-a-quote/>

Key Items required

- 1) Read me file: Describing all files. Information such as file format.
- 2) Fabrication print with all dimensions and requirements
- 3) NC Drill file with all the drill sizes
- 4) PCB design data in one of the following formats:
 - ODB++ is the preferred data format
 - Gerber RS274X (Extended Gerber Data) format.
- 5) IPC D 356A format Net List Data

If an IPC netlist is not included with the released data package, our CAM department will extract a netlist from the Gerber files.

If you have questions regarding data formats please see our contact information at
<https://www.summit-pcb.com/contact-us/>

It is also critical to give us a 24-hour contact on all quick turns to ensure success on all deliveries.

Please provide a readme file incorporated in the zip file. This file should provide the names, titles, work numbers, and cell numbers of the key people involved in the design.

Customers can also give this contact information to Summit's Customer Service Representative. This will allow us to contact you or your team in a timely manner with all product improvements or technical issue.

□ Common Data Issues

Inconsistent data formats: Data where the format is different in each file.

Incomplete Fabrication Information: Including a readme.txt file is highly recommended. Including a fab drawing in the data is also helpful.



No Board Outline: We need either a board outline or a (0, 0) reference with measurements, otherwise

we will have to contact you to get it. Base the board edge from a hole. If the PCB outline is provided on the silkscreen layer, please isolate its aperture size from other elements on the layer - a one mil outline is a good choice.

Mask Expansion: We recommend you do not expand your pads for the solder mask file (i.e. 01:1 with the outer layer mil expansion) unless the design contains solder mask defined features. Our CAM department would prefer to deal with the expansion themselves to optimize our process requirements.

Silkscreen on Pads: Silkscreen ink on pads can cause soldering problems. We clip silkscreen off the pads as standard practice (.003" away from the solder mask).

Data Intensive Ground & Power Planes: When generating a ground plane, never use small fill widths as this can cause needlessly large file sizes. The preferred method is to provide negative planes with flashed anti pads and thermals.

Acid Trap: Maintain the minimum trace/space parameters, even if two close elements electrically connected elsewhere. A .001" or .002" sliver can result in a piece of photo resist film tearing off, and falling across the design, possibly creating opens or shorts.

Tooling Holes: (2 x 0.062") the holes need to be on opposite corners of the board for routing.

Logo and Date Code: Due to ISO/UL requirements, we need a 0.5" x 0.3" space to put our logo and date code. Our preferred method of applying the silkscreen is with our Ink Jet printer, and if allowed, we will put this information into the silkscreen image. If the Ink Jet process is not allowed, we will put this information in copper, typically on the solder side.

UL Markings: If UL markings are required, we need a 0.5" x 0.3" space.

Labels on Gerber Layers: It is a good idea to put a layer identifier on each Gerber layer.

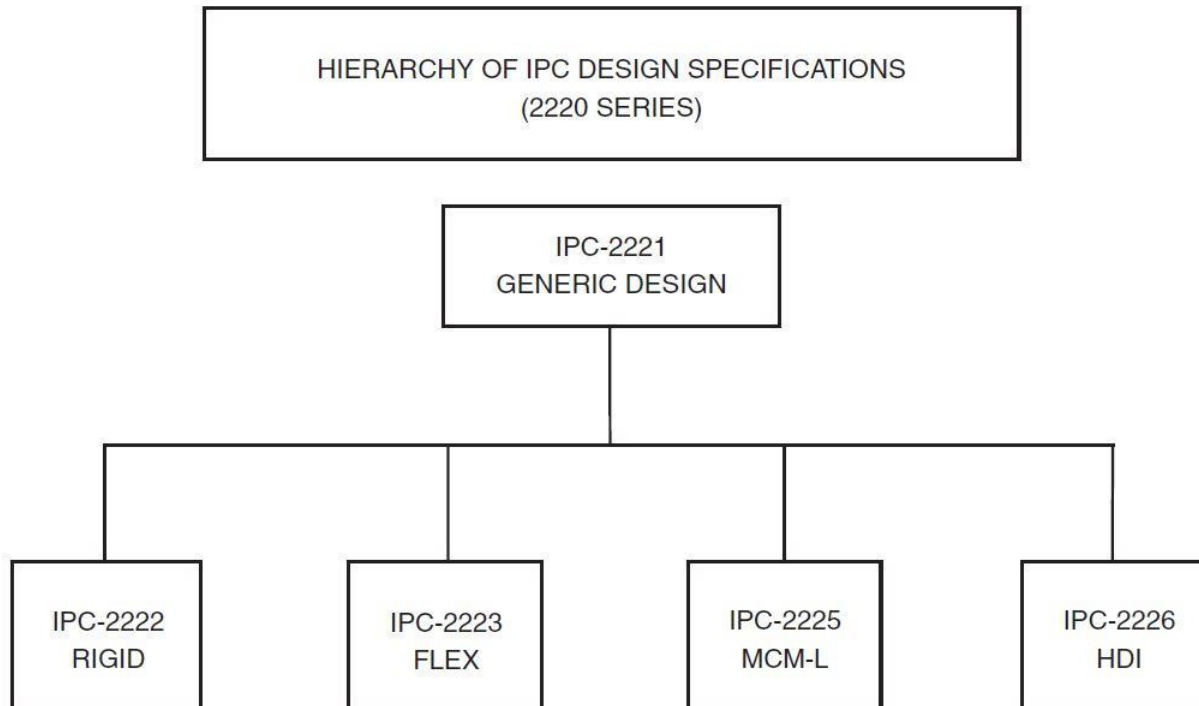
Netlist Comparison: This allows the CAD netlist generated from your original PCB design file, to be compared to a net list generated from the Gerber and NC drill manufacturing data. This will ensure your Gerber files are accurate. For best results, an IPC356A netlist supplied with the data will verify the electrical integrity of the design against the customer supplied Gerber files. Please also make sure you keep your netlist under 14 characters per net name. Any discrepancies can be rectified prior to expensive tooling, circuit board production and component placement. Without 'Netlist Comparison', Gerber faults may not be identified unless by chance or after board production.

Isolated thermals: Over-sizing clearance pads at the post-processing stage can cause some power connections to be isolated from the main power net.

Design Recommendations

Summit Interconnect recommends that all PCB designs are consistent with the requirements of:

- IPC-2221: Generic Standard on Printed Board Design
- IPC-2222: Sectional Design Standard for Rigid Printed Boards
- IPC-2223: Sectional Design Standard for Flexible/Rigid-Flexible Printed Boards
- IPC-2225: Sectional Design Standard for Organic Multichip Modules (MCM-L)
- IPC-2226: Sectional Design Standard for High Density Interconnect (HDI) Printed Boards

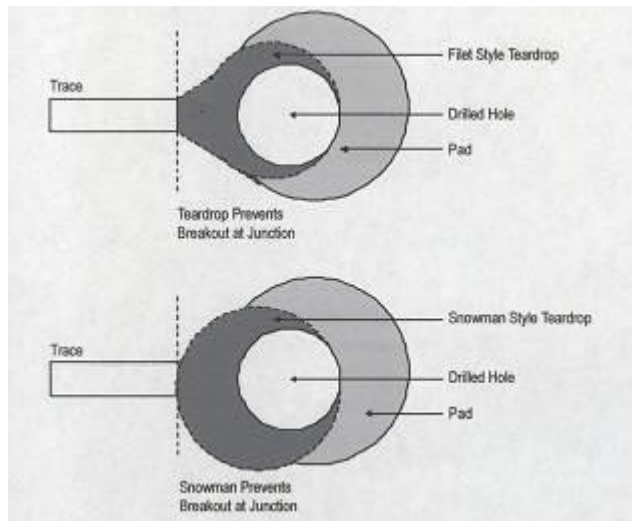


Unless otherwise specified, Summit Interconnect will adhere to the workmanship standards defined in

- IPC-6012 (latest Revision): Qualification and Performance Specification for Rigid Printed Boards
- IPC-6013 (latest Revision): Qualification and Performance Specification for Flexible/Rigid-Flexible Printed Boards

Remove non-functional pads

Tear dropping is recommended and required for IPC-6012 Revision E Class 2 and tangency allowance



Line Width and Feature Spacing:

The smallest line width and feature spacing that can be produced on any given board is contingent on the thickness of the starting copper foil used on each layer in the stack up. The minimum line width currently in use is .002" (50 micron) on quarter ounce foil for print and etch applications. Thicker starting copper foil and/or any copper plating requirements will necessitate using a larger line widths and feature spacing. The spacing between any copper feature and the board profile edge should be 0.010".

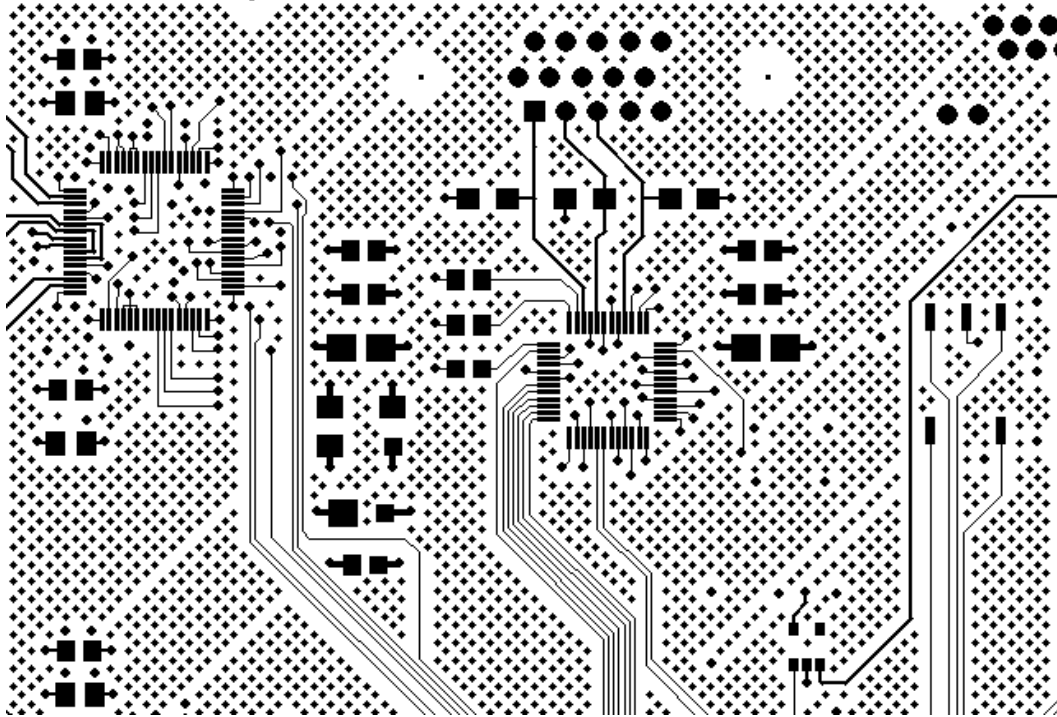
- 1) Keep line widths consistent
- 2) Keep line centered between pads
- 3) Whenever possible, use 45 degree angles

Trace to non-plated hole spacing should be min of .008". This will allow tenting of the non-plated hole and will allow us to drill the hole to be drilled on the primary program.

Conductor to PCB edge should be .018" minimum. Values below this will require an AABUS condition to exist per IPC-6012 section 3.3.1.

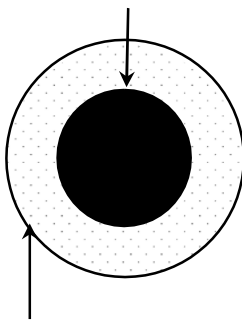
Balance circuit design across the board. This is especially important on the outer layers to achieve uniform plating thickness in plated holes and plated layers.

Non-conductive Thieving: Used for CU distribution: A diamond pattern such as the one seen below can be added for this purpose.



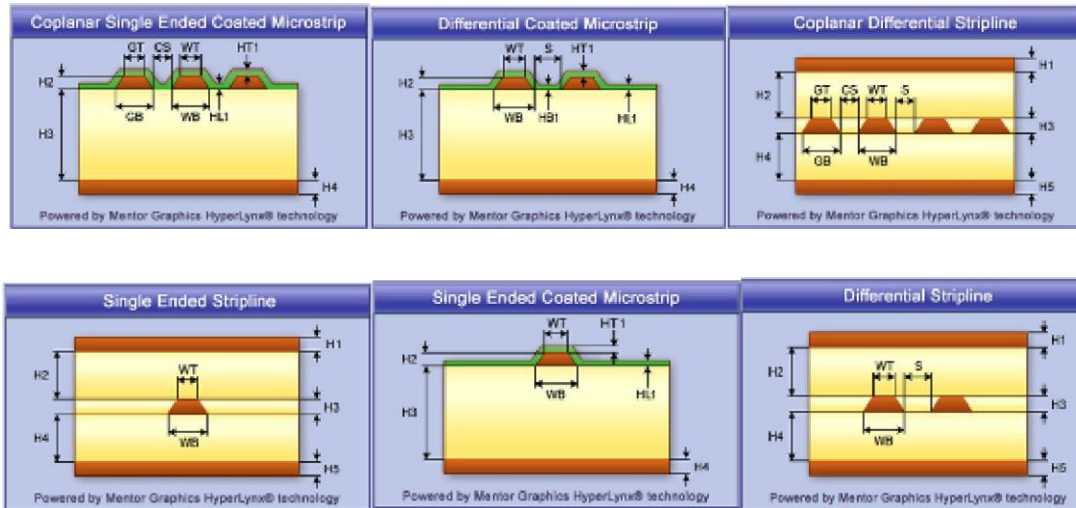
Anti-Pad Diameter:

Pad/Hole



Relief from plane should be .010" min.

Impedance Control



Allow a $\pm 10\%$ tolerance on impedance requirements: Tighter impedance tolerance may be available on a premium basis. Please contact Summit for details.

The impedance requirements should be consistent with the requirements of IPC-2141: Design Guide for High Speed Controlled Impedance Circuit Boards.

Copper Specifications

Copper foil comes in various thicknesses and grades. Common foil thickness range from a quarter ounce per square foot to three ounces per square foot and even thicker. Copper foil grades include

- ED: Electro Deposited
- RA: Rolled/Annealed
- RTF: Reverse Treated Foil
- VLP and VLP2: Very Low Profile
- HVLP: Hyper Very Low Profile

Take care to select the appropriate foil thickness and grade based on the design rules employed and the specific requirements of the application. Contact Summit for additional details.

Annular Ring and Aspect Ratio (Depth/Diameter)

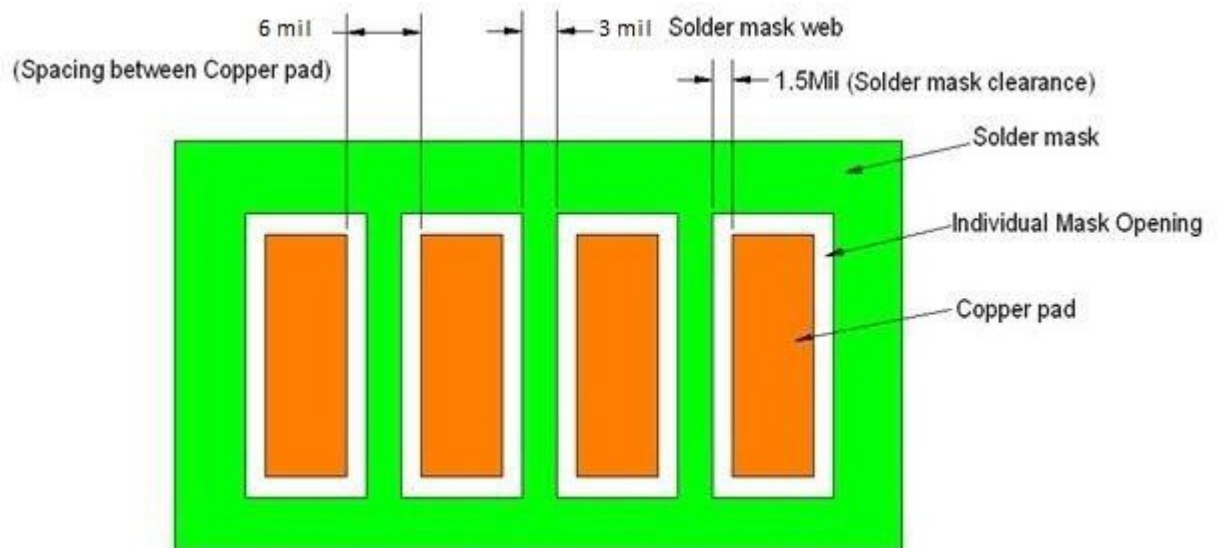
Annular ring and via aspect ratio are two of the most critical design considerations to obtain a high performance and reliable printed circuit board. For an IPC 6012 class 2 requirement:

- Laser drilled MicroVias: The recommended minimum diameter for laser drilled microvias is .006" The recommended aspect ratio (which is hole depth including copper foil divided by hole diameter) for such a feature is between 0.6:1 and 0.75:1. The pad diameter should be hole diameter plus 6 mils, or a 3 mil annular ring.
- Microvia diameters less than 0.006" are not considered as reliable as 0.006" or greater; this concern has been identified in IPC-6012 revision E section 3.6

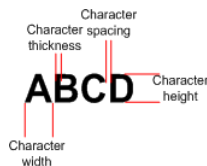
- Buried/Blind/Through Vias: The recommended minimum diameter for mechanically drilled buried/blind/through via is 6 mils. The minimum diameter for such a feature is .004" and performed on a premium basis. These vias must also adhere to aspect ratio limitations. Unfilled vias: 15:1 aspect ratio. Copper or epoxy filled vias: 10:1 aspect ratio. It is possible to fill higher aspect ratio holes, but there may possibly be slight fill voids towards the center of the hole. The minimum hole diameter for via fill is .008" drill with 10:1 aspect ratio.
- Strategies for the protection of via structures should be consistent with the requirements listed in IPC-4761 (latest Revision): Design Guide for the Protection of Printed Board Via Structures.

Solder Mask and Legend

Unless otherwise specified, Summit Interconnect uses Laser Direct Imaging technology to expose solder mask patterns. This technology represents the most advanced and accurate method of exposing solder mask available in the industry. The minimum solder mask clearance for green colored mask is 1.5 mils, and the minimum solder mask web is 3 mils. Gang solder mask relief patterns should be used for fine pitch designs whenever possible.



Summit has advanced Ink Jet printing. Character size can be 0.030" with Diameter of 0.003"



Preferred Constructions

- The following examples are Summit Interconnect preferred most cost-effective constructions.

Key:

F = Foil P = Power G = Ground S = Signal

Four Layer

| Layer | Type | CU Weight | CU % | Material Description | Via Structure | Segment | Glass Style | Material Family | Dielectric constant @ 1GHz | Thickness After lamination [mil] |
|------------|--------|-----------|------|----------------------|---------------|---------|-------------|-----------------|----------------------------|----------------------------------|
| Soldermask | | | | | | | | | | 0.80 |
| 1 | Signal | H | 25 | Press thk = 7.96 mil | | Foil | 2113(58) | Foil | 4.10 | 1.60 |
| | | | | | | Prepreg | 2113(58) | EM-827B | 4.10 | 7.96 |
| 2 | Plane | 1 | 80 | 39.0 mil 1/1 | | Core | 5-7628 | EM-827 | 4.40 | 1.20 |
| 3 | Plane | 1 | 80 | Press thk = 7.96 mil | | Prepreg | 2113(58) | EM-827B | 4.10 | 39.00 |
| | | | | | | Foil | 2113(58) | EM-827B | 4.10 | 1.20 |
| 4 | Signal | H | 25 | Press thk = 7.96 mil | | Foil | 2113(58) | Foil | 4.10 | 7.96 |
| Soldermask | | | | | | | | | | 0.80 |

| | |
|---|-----------|
| Specification (Over mask on plated copper): | mil |
| Overall Board Thickness: | 62.0 |
| Tolerance: | +6.2/-6.2 |
| Min-Max Board Thickness: | 55.8-68.2 |

| | |
|------------------------------|-------|
| Anticipated Board Thickness: | mil |
| After lamination: | 58.52 |
| Over mask on plated copper: | 62.12 |

Six Layer

| Layer | Type | CU Weight | CU % | Material Description | Via Structure | Segment | Glass Style | Material Family | Dielectric constant @ 1GHz | Thickness After lamination [mil] |
|------------|--------|-----------|------|----------------------|---------------|---------|-------------|-----------------|----------------------------|----------------------------------|
| Soldermask | | | | | | | | | | 0.80 |
| 1 | Signal | H | 25 | Press thk = 9.16 mil | | Foil | 2113(58) | Foil | 4.10 | 1.60 |
| | | | | | | Prepreg | 2116(58) | EM-827B | 3.80 | 9.16 |
| 2 | Plane | 1 | 80 | 14.0 mil 1/1 | | Core | 2-7628 | EM-827 | 4.40 | 1.20 |
| 3 | Signal | 1 | 25 | Press thk = 8.80 mil | | Prepreg | 2116(58) | EM-827B | 3.80 | 14.00 |
| | | | | | | Foil | 2116(58) | EM-827B | 3.80 | 1.20 |
| 4 | Signal | 1 | 25 | Press thk = 8.80 mil | | Prepreg | 2116(58) | EM-827B | 3.80 | 8.80 |
| | | | | | | Foil | 2116(58) | EM-827B | 3.80 | 1.20 |
| 5 | Plane | 1 | 80 | 14.0 mil 1/1 | | Core | 2-7628 | EM-827 | 4.40 | 14.00 |
| | | | | | | Prepreg | 2116(58) | EM-827B | 3.80 | 1.20 |
| 6 | Signal | H | 25 | Press thk = 9.16 mil | | Foil | 2113(58) | Foil | 4.10 | 9.16 |
| Soldermask | | | | | | | | | | 0.80 |

| | |
|----------------------------|-----------|
| Specification (Over foil): | mil |
| Overall Board Thickness: | 62.0 |
| Tolerance: | +6.2/-6.2 |
| Min-Max Board Thickness: | 55.8-68.2 |

| | |
|------------------------------|-------|
| Anticipated Board Thickness: | mil |
| After lamination: | 61.12 |
| Over foil: | 61.12 |

8 Layer

| Layer | Type | CU Weight | CU % | Material Description | Via Structure | Segment | Glass Style | Material Family | Dielectric constant @ 1GHz | Thickness After lamination [mil] |
|------------|--------|-----------|------|----------------------|---------------|---------|-------------|-----------------|----------------------------|----------------------------------|
| Soldermask | | | | | | | | | | 0.80 |
| 1 | Signal | H | 25 | Press thk = 4.56 mil | | Foil | | Foil | | 1.60 |
| 2 | Plane | 1 | 80 | 8.0 mil 1/1 | | Prepreg | 2116(55) | EM-827B | 4.10 | 4.56 |
| 3 | Signal | 1 | 25 | Press thk = 8.46 mil | | Core | 1-7628 | EM-827 | 4.40 | 1.20 |
| 4 | Plane | 1 | 80 | 8.0 mil 1/1 | | Prepreg | 2116(55) | EM-827B | 4.10 | 8.00 |
| 5 | Plane | 1 | 80 | Press thk = 8.46 mil | | Core | 2116(55) | EM-827B | 4.10 | 1.20 |
| 6 | Signal | 1 | 25 | 8.0 mil 1/1 | | Prepreg | 2116(55) | EM-827B | 4.10 | 8.00 |
| 7 | Plane | 1 | 80 | Press thk = 8.46 mil | | Core | 1-7628 | EM-827 | 4.40 | 1.20 |
| 8 | Signal | H | 25 | Press thk = 4.56 mil | | Prepreg | 2116(55) | EM-827B | 4.10 | 4.56 |
| Soldermask | | | | | | Foil | | Foil | | 1.60 |
| | | | | | | | | | | 0.80 |

| | |
|---|-----------|
| Specification (Over mask on plated copper): | mil |
| Overall Board Thickness: | 62.0 |
| Tolerance: | +6.2/-6.2 |
| Min-Max Board Thickness: | 55.8-68.2 |

| | |
|------------------------------|-------|
| Anticipated Board Thickness: | mil |
| After lamination: | 58.44 |
| Over mask on plated copper: | 62.04 |

10 Layer

| Layer | Type | CU Weight | CU % | Material Description | Via Structure | Segment | Glass Style | Material Family | Dielectric constant @ 1GHz | Thickness After lamination [mil] |
|------------|--------|-----------|------|----------------------|---------------|---------|-------------|-----------------|----------------------------|----------------------------------|
| Soldermask | | | | | | | | | | 0.80 |
| 1 | Signal | H | 25 | Press thk = 3.86 mil | | Foil | | Foil | | 1.60 |
| 2 | Plane | 1 | 80 | 6.0 mil 1/1 | | Prepreg | 2113(58) | EM-827B | 4.10 | 3.86 |
| 3 | Signal | 1 | 25 | Press thk = 5.40 mil | | Core | 2-1080 | EM-827 | 3.90 | 1.20 |
| 4 | Signal | 1 | 25 | 6.0 mil 1/1 | | Prepreg | 1080(65) | EM-827B | 3.90 | 6.00 |
| 5 | Plane | 1 | 80 | Press thk = 5.72 mil | | Core | 2113(58) | EM-827B | 4.10 | 1.20 |
| 6 | Plane | 1 | 80 | 6.0 mil 1/1 | | Core | 2-1080 | EM-827 | 3.90 | 6.00 |
| 7 | Signal | 1 | 25 | Press thk = 5.72 mil | | Prepreg | 1080(65) | EM-827B | 3.90 | 1.20 |
| 8 | Signal | 1 | 25 | 6.0 mil 1/1 | | Prepreg | 1080(65) | EM-827B | 3.90 | 5.40 |
| 9 | Plane | 1 | 80 | Press thk = 5.40 mil | | Core | 2113(58) | EM-827B | 4.10 | 1.20 |
| 10 | Signal | H | 25 | 6.0 mil 1/1 | | Core | 2-1080 | EM-827 | 3.90 | 6.00 |
| Soldermask | | | | Press thk = 3.86 mil | | Prepreg | 2113(58) | EM-827B | 4.10 | 3.86 |
| | | | | | | Foil | | Foil | | 1.60 |
| | | | | | | | | | | 0.80 |

| | |
|---|-----------|
| Specification (Over mask on plated copper): | mil |
| Overall Board Thickness: | 62.0 |
| Tolerance: | +6.2/-6.2 |
| Min-Max Board Thickness: | 55.8-68.2 |

| | |
|------------------------------|-------|
| Anticipated Board Thickness: | mil |
| After lamination: | 59.04 |
| Over mask on plated copper: | 62.64 |

12 Layer

| Layer | Type | CU Weight | CU % | Material Description | Via Structure | Segment | Glass Style | Material Family | Dielectric constant @ 1GHz | Thickness After lamination [mil] |
|------------|--------|-----------|------|----------------------|---------------|---------|-------------|-----------------|----------------------------|----------------------------------|
| Soldermask | | | | | | | | | | 0.80 |
| 1 | Signal | H | 25 | Press thk = 5.96 mil | | Foil | 1080(65) | Foil | 3.90 | 1.60 |
| | | | | | | Prepreg | 1080(65) | EM-827B | 3.90 | 5.96 |
| 2 | Plane | 1 | 80 | 8.0 mil 1/1 | | Core | 1-7628 | EM-827 | 4.40 | 1.20 |
| 3 | Signal | 1 | 25 | Press thk = 5.80 mil | | Prepreg | 1080(62) | EM-827B | 3.70 | 5.80 |
| | | | | | | | 2116(55) | EM-827B | 4.10 | 1.20 |
| 4 | Signal | 1 | 25 | 8.0 mil 1/1 | | Core | 1-7628 | EM-827 | 4.40 | 1.20 |
| 5 | Plane | 1 | 80 | Press thk = 6.46 mil | | Prepreg | 1080(62) | EM-827B | 3.70 | 6.46 |
| | | | | | | | 2116(55) | EM-827B | 4.10 | 1.20 |
| 6 | Signal | 1 | 25 | 8.0 mil 1/1 | | Core | 1-7628 | EM-827 | 4.40 | 1.20 |
| 7 | Signal | 1 | 25 | Press thk = 6.46 mil | | Prepreg | 2116(55) | EM-827B | 4.10 | 6.46 |
| | | | | | | | 1080(62) | EM-827B | 3.70 | 1.20 |
| 8 | Plane | 1 | 80 | 8.0 mil 1/1 | | Core | 1-7628 | EM-827 | 4.40 | 1.20 |
| 9 | Signal | 1 | 25 | Press thk = 5.80 mil | | Prepreg | 2116(55) | EM-827B | 4.10 | 5.80 |
| | | | | | | | 1080(62) | EM-827B | 3.70 | 1.20 |
| 10 | Signal | 1 | 25 | 8.0 mil 1/1 | | Core | 1-7628 | EM-827 | 4.40 | 1.20 |
| 11 | Plane | 1 | 80 | Press thk = 5.96 mil | | Prepreg | 1080(65) | EM-827B | 3.90 | 5.96 |
| | | | | | | | 1080(65) | EM-827B | 3.90 | 1.60 |
| 12 | Signal | H | 25 | | | Foil | | Foil | | 0.80 |
| Soldermask | | | | | | | | | | 0.80 |

| | |
|---|------------|
| Specification (Over mask on plated copper): | mil |
| Overall Board Thickness: | 93.0 |
| Tolerance: | +9.3/-9.3 |
| Min-Max Board Thickness: | 83.7-102.3 |

| | |
|------------------------------|-------|
| Anticipated Board Thickness: | mil |
| After lamination: | 89.64 |
| Over mask on plated copper: | 93.24 |

14 Layer

| Layer | Type | CU Weight | CU % | Material Description | Via Structure | Segment | Glass Style | Material Family | Dielectric constant @ 1GHz | Thickness After lamination [mil] |
|------------|--------|-----------|------|----------------------|---------------|---------|-------------|-----------------|----------------------------|----------------------------------|
| Soldermask | | | | | | | | | | 0.80 |
| 1 | Signal | H | 25 | Press thk = 4.56 mil | | Foil | 2116(55) | Foil | 4.10 | 1.60 |
| 2 | Plane | 1 | 80 | 6.0 mil 1/1 | | Prepreg | 2-1080 | EM-827B | 3.90 | 4.56 |
| 3 | Signal | 1 | 25 | Press thk = 5.76 mil | | Core | 1080(62) | EM-827 | 3.70 | 1.20 |
| 4 | Plane | 1 | 80 | 6.0 mil 1/1 | | Prepreg | 2113(58) | EM-827B | 4.10 | 6.00 |
| 5 | Signal | 1 | 25 | Press thk = 5.76 mil | | Core | 1080(62) | EM-827 | 3.90 | 1.20 |
| 6 | Plane | 1 | 80 | 6.0 mil 1/1 | | Prepreg | 2113(58) | EM-827B | 4.10 | 5.76 |
| 7 | Signal | 1 | 25 | Press thk = 6.40 mil | | Core | 2-1080 | EM-827 | 3.90 | 1.20 |
| 8 | Plane | 1 | 80 | 6.0 mil 1/1 | | Prepreg | 2113(58) | EM-827B | 4.10 | 6.00 |
| 9 | Signal | 1 | 25 | Press thk = 5.76 mil | | Core | 1080(62) | EM-827 | 3.70 | 1.20 |
| 10 | Plane | 1 | 80 | 6.0 mil 1/1 | | Prepreg | 2113(58) | EM-827B | 4.10 | 5.76 |
| 11 | Signal | 1 | 25 | Press thk = 5.76 mil | | Core | 2-1080 | EM-827 | 3.90 | 1.20 |
| 12 | Plane | 1 | 80 | 6.0 mil 1/1 | | Prepreg | 2113(58) | EM-827B | 4.10 | 6.00 |
| 13 | Signal | 1 | 25 | Press thk = 4.56 mil | | Foil | 2116(55) | Foil | 4.10 | 1.60 |
| Soldermask | | | | | | | | | | 0.80 |

| | |
|---|------------|
| Specification (Over mask on plated copper): | mil |
| Overall Board Thickness: | 93.0 |
| Tolerance: | +9.3/-9.3 |
| Min-Max Board Thickness: | 83.7-102.3 |

| | |
|------------------------------|-------|
| Anticipated Board Thickness: | mil |
| After lamination: | 90.16 |
| Over mask on plated copper: | 93.76 |

16 Layer

| Layer | Type | CU Weight | CU % | Material Description | Via Structure | Segment | Glass Style | Material Family | Dielectric constant @ 1GHz | Thickness After lamination [mil] |
|------------|--------|-----------|------|----------------------|---------------|---------|-------------|-----------------|----------------------------|----------------------------------|
| Soldermask | | | | | | | | | | 0.80 |
| 1 | Signal | H | 25 | Press thk = 5.06 mil | | Foil | 2116(58) | Foil | 3.80 | 1.60 |
| 2 | Plane | 1 | 80 | 5.0 mil 1/1 | | Prepreg | 1080(62) | EM-827B | 3.70 | 5.06 |
| 3 | Signal | 1 | 25 | Press thk = 3.80 mil | | Core | 1-2116 | EM-827 | 4.10 | 1.20 |
| 4 | Signal | 1 | 25 | Press thk = 3.80 mil | | Prepreg | 1080(62) | EM-827B | 3.70 | 5.00 |
| 5 | Plane | 1 | 80 | 5.0 mil 1/1 | | Core | 1-2116 | EM-827 | 4.10 | 1.20 |
| 6 | Signal | 1 | 25 | Press thk = 4.46 mil | | Prepreg | 1080(62) | EM-827B | 3.70 | 4.46 |
| 7 | Plane | 1 | 80 | 5.0 mil 1/1 | | Core | 1-2116 | EM-827 | 4.10 | 1.20 |
| 8 | Signal | 1 | 25 | Press thk = 4.46 mil | | Prepreg | 1080(62) | EM-827B | 3.70 | 5.00 |
| 9 | Signal | 1 | 25 | 5.0 mil 1/1 | | Core | 1-2116 | EM-827 | 4.10 | 1.20 |
| 10 | Plane | 1 | 80 | Press thk = 4.46 mil | | Prepreg | 1080(62) | EM-827B | 3.70 | 4.46 |
| 11 | Signal | 1 | 25 | 5.0 mil 1/1 | | Core | 1-2116 | EM-827 | 4.10 | 1.20 |
| 12 | Plane | 1 | 80 | Press thk = 4.46 mil | | Prepreg | 1080(62) | EM-827B | 3.70 | 5.00 |
| 13 | Signal | 1 | 25 | 5.0 mil 1/1 | | Core | 1-2116 | EM-827 | 4.10 | 1.20 |
| 14 | Signal | 1 | 25 | Press thk = 3.80 mil | | Prepreg | 1080(62) | EM-827B | 3.70 | 3.80 |
| 15 | Plane | 1 | 80 | 5.0 mil 1/1 | | Core | 1-2116 | EM-827 | 4.10 | 1.20 |
| 16 | Signal | H | 25 | Press thk = 5.06 mil | | Prepreg | 2116(58) | EM-827B | 3.80 | 5.06 |
| Soldermask | | | | | | Foil | | Foil | | 1.60 |
| | | | | | | | | | | 0.80 |

| | |
|---|------------|
| Specification (Over mask on plated copper): | mil |
| Overall Board Thickness: | 93.0 |
| Tolerance: | +9.3/-9.3 |
| Min-Max Board Thickness: | 83.7-102.3 |

| | |
|------------------------------|-------|
| Anticipated Board Thickness: | mil |
| After lamination: | 88.56 |
| Over mask on plated copper: | 92.16 |

18 Layer

| Layer | Type | CU Weight | CU % | Material Description | Via Structure | Segment | Glass Style | Material Family | Dielectric constant @ 1GHz | Thickness After lamination [mil] |
|------------|--------|-----------|------|----------------------|---------------|---------|-------------|-----------------|----------------------------|----------------------------------|
| Soldermask | | | | | | | | | | 0.80 |
| 1 | Signal | H | 25 | Press thk = 3.86 mil | | Foil | 2113(58) | Foil | 4.10 | 1.60 |
| 2 | Plane | 1 | 80 | 4.0 mil 1/1 | | Prepreg | 1-3313 | EM-827B | 4.00 | 3.86 |
| 3 | Signal | 1 | 25 | Press thk = 4.40 mil | | Core | 1080(65) | EM-827 | 3.90 | 1.20 |
| 4 | Signal | 1 | 25 | 4.0 mil 1/1 | | Prepreg | 1080(65) | EM-827B | 3.90 | 4.00 |
| 5 | Plane | 1 | 80 | Press thk = 4.26 mil | | Core | 106(76) | EM-827B | 3.60 | 1.20 |
| 6 | Signal | 1 | 25 | 4.0 mil 1/1 | | Prepreg | 1-3313 | EM-827 | 4.00 | 4.26 |
| 7 | Signal | 1 | 25 | Press thk = 4.26 mil | | Core | 1080(65) | EM-827B | 3.90 | 1.20 |
| 8 | Plane | 1 | 80 | 4.0 mil 1/1 | | Prepreg | 106(76) | EM-827B | 3.60 | 4.00 |
| 9 | Signal | 1 | 25 | Press thk = 4.40 mil | | Core | 1080(65) | EM-827 | 4.00 | 1.20 |
| 10 | Signal | 1 | 25 | 4.0 mil 1/1 | | Prepreg | 1-3313 | EM-827B | 3.90 | 4.26 |
| 11 | Plane | 1 | 80 | Press thk = 4.26 mil | | Core | 106(76) | EM-827B | 3.60 | 1.20 |
| 12 | Signal | 1 | 25 | 4.0 mil 1/1 | | Prepreg | 1080(65) | EM-827B | 3.90 | 4.00 |
| 13 | Signal | 1 | 25 | Press thk = 4.26 mil | | Core | 1-3313 | EM-827 | 4.00 | 1.20 |
| 14 | Plane | 1 | 80 | 4.0 mil 1/1 | | Prepreg | 106(76) | EM-827B | 3.60 | 4.26 |
| 15 | Signal | 1 | 25 | Press thk = 4.40 mil | | Core | 1080(65) | EM-827B | 3.90 | 1.20 |
| 16 | Signal | 1 | 25 | 4.0 mil 1/1 | | Prepreg | 1-3313 | EM-827 | 4.00 | 4.00 |
| 17 | Plane | 1 | 80 | Press thk = 3.86 mil | | Core | 1080(65) | EM-827B | 3.90 | 1.20 |
| 18 | Signal | H | 25 | | | Prepreg | 2113(58) | Foil | 4.10 | 3.86 |
| Soldermask | | | | | | | | | | 0.80 |

| | |
|---|------------|
| Specification (Over mask on plated copper): | mil |
| Overall Board Thickness: | 93.0 |
| Tolerance: | +9.3/-9.3 |
| Min-Max Board Thickness: | 83.7-102.3 |

| | |
|------------------------------|-------|
| Anticipated Board Thickness: | mil |
| After lamination: | 90.36 |
| Over mask on plated copper: | 93.96 |

20 Layer

| Layer | Type | CU Weight | CU % | Material Description | Via Structure | Segment | Glass Style | Material Family | Dielectric constant @ 1GHz | Thickness After lamination [mil] |
|------------|--------|-----------|------|----------------------|---------------|---------|-------------|-----------------|----------------------------|----------------------------------|
| Soldermask | | | | | | | | | | 0.80 |
| 1 | Signal | H | 25 | Press thk = 3.98 mil | | Foil | | Foil | | 1.60 |
| 2 | Plane | H | 80 | 4.0 mil H/H | | Prepreg | 2113(58) | EM-827B | 4.10 | 3.98 |
| 3 | Signal | H | 25 | Press thk = 4.23 mil | | Core | 1-3313 | EM-827 | 4.00 | 0.60 |
| 4 | Plane | H | 80 | 4.0 mil H/H | | Prepreg | 2116(55) | EM-827B | 4.10 | 4.23 |
| 5 | Signal | H | 25 | Press thk = 4.23 mil | | Core | 1-3313 | EM-827 | 4.00 | 0.60 |
| 6 | Plane | H | 80 | 4.0 mil H/H | | Prepreg | 2116(55) | EM-827B | 4.10 | 4.23 |
| 7 | Signal | H | 25 | Press thk = 4.23 mil | | Core | 1-3313 | EM-827 | 4.00 | 0.60 |
| 8 | Plane | H | 80 | 4.0 mil H/H | | Prepreg | 2116(55) | EM-827B | 4.10 | 4.23 |
| 9 | Signal | H | 25 | Press thk = 4.11 mil | | Core | 1-3313 | EM-827 | 4.00 | 0.60 |
| 10 | Plane | 1 | 80 | 4.0 mil 1/1 | | Prepreg | 2116(55) | EM-827B | 4.10 | 4.11 |
| 11 | Plane | 1 | 80 | Press thk = 4.11 mil | | Core | 1-3313 | EM-827 | 4.00 | 1.20 |
| 12 | Signal | H | 25 | 4.0 mil H/H | | Prepreg | 2116(55) | EM-827B | 4.10 | 4.00 |
| 13 | Plane | H | 80 | Press thk = 4.23 mil | | Core | 1-3313 | EM-827 | 4.00 | 0.60 |
| 14 | Signal | H | 25 | 4.0 mil H/H | | Prepreg | 2116(55) | EM-827B | 4.10 | 4.23 |
| 15 | Plane | H | 80 | Press thk = 4.23 mil | | Core | 1-3313 | EM-827 | 4.00 | 0.60 |
| 16 | Signal | H | 25 | 4.0 mil H/H | | Prepreg | 2116(55) | EM-827B | 4.10 | 4.23 |
| 17 | Plane | H | 80 | Press thk = 4.23 mil | | Core | 1-3313 | EM-827 | 4.00 | 0.60 |
| 18 | Signal | H | 25 | 4.0 mil H/H | | Prepreg | 2116(55) | EM-827B | 4.10 | 4.23 |
| 19 | Plane | H | 80 | Press thk = 3.98 mil | | Core | 1-3313 | EM-827 | 4.00 | 0.60 |
| 20 | Signal | H | 25 | | | Prepreg | 2113(58) | EM-827B | 4.10 | 3.98 |
| Soldermask | | | | | | Foil | | Foil | | 1.60 |
| | | | | | | | | | | 0.80 |

| | |
|---|------------|
| Specification (Over mask on plated copper): | mil |
| Overall Board Thickness: | 93.0 |
| Tolerance: | +9.3/-9.3 |
| Min-Max Board Thickness: | 83.7-102.3 |

| | |
|------------------------------|-------|
| Anticipated Board Thickness: | mil |
| After lamination: | 90.76 |
| Over mask on plated copper: | 94.36 |

22 Layer

| Layer | Type | Cu Weight | Cu % | Material Description | Via Structure | Segment | Glass Style | Material Family | Dielectric constant @ 1GHz | Thickness After lamination [mil] |
|------------|--------|-----------|------|----------------------|---------------|---------|-------------|-----------------|----------------------------|----------------------------------|
| Soldermask | | | | | | | | | | 0.80 |
| 1 | Signal | H | 25 | Press thk = 3.98 mil | | Foil | 2113(58) | Foil | 4.10 | 1.60 |
| 2 | Plane | H | 80 | 3.5 mil H/H | | Prepreg | 2113(58) | EM-827B | 4.10 | 3.98 |
| 3 | Signal | H | 25 | Press thk = 3.53 mil | | Core | 1-3313 | EM-827 | 4.30 | 0.60 |
| 4 | Plane | H | 80 | 3.5 mil H/H | | Prepreg | 2113(58) | EM-827B | 4.10 | 3.50 |
| 5 | Signal | H | 25 | Press thk = 3.53 mil | | Core | 1-3313 | EM-827 | 4.30 | 0.60 |
| 6 | Plane | H | 80 | 3.5 mil H/H | | Prepreg | 2113(58) | EM-827B | 4.10 | 3.53 |
| 7 | Signal | H | 25 | Press thk = 3.53 mil | | Core | 1-3313 | EM-827 | 4.30 | 0.60 |
| 8 | Plane | H | 80 | 3.5 mil H/H | | Prepreg | 2113(58) | EM-827B | 4.10 | 3.50 |
| 9 | Signal | H | 25 | Press thk = 3.53 mil | | Core | 1-3313 | EM-827 | 4.30 | 0.60 |
| 10 | Plane | H | 80 | 3.5 mil H/H | | Prepreg | 2113(58) | EM-827B | 4.10 | 3.53 |
| 11 | Signal | H | 25 | Press thk = 3.53 mil | | Core | 1-3313 | EM-827 | 4.30 | 0.60 |
| 12 | Signal | H | 25 | Press thk = 4.70 mil | | Prepreg | 1080(62) | EM-827B | 3.70 | 4.70 |
| 13 | Plane | H | 80 | 3.5 mil H/H | | Core | 1-3313 | EM-827 | 4.30 | 0.60 |
| 14 | Signal | H | 25 | Press thk = 3.53 mil | | Prepreg | 2113(58) | EM-827B | 4.10 | 3.50 |
| 15 | Plane | H | 80 | 3.5 mil H/H | | Core | 1-3313 | EM-827 | 4.30 | 0.60 |
| 16 | Signal | H | 25 | Press thk = 3.53 mil | | Prepreg | 2113(58) | EM-827B | 4.10 | 3.53 |
| 17 | Plane | H | 80 | 3.5 mil H/H | | Core | 1-3313 | EM-827 | 4.30 | 0.60 |
| 18 | Signal | H | 25 | Press thk = 3.53 mil | | Prepreg | 2113(58) | EM-827B | 4.10 | 3.53 |
| 19 | Plane | H | 80 | 3.5 mil H/H | | Core | 1-3313 | EM-827 | 4.30 | 0.60 |
| 20 | Signal | H | 25 | Press thk = 3.53 mil | | Prepreg | 2113(58) | EM-827B | 4.10 | 3.53 |
| 21 | Plane | H | 80 | 3.5 mil H/H | | Core | 1-3313 | EM-827 | 4.30 | 0.60 |
| 22 | Signal | H | 25 | Press thk = 3.98 mil | | Prepreg | 2113(58) | EM-827B | 4.10 | 3.98 |
| Soldermask | | | | | | Foil | | Foil | | 1.60 |
| | | | | | | | | | | 0.80 |

| | |
|---|------------|
| Specification (Over mask on plated copper): | mil |
| Overall Board Thickness: | 93.0 |
| Tolerance: | +9.3/-9.3 |
| Min-Max Board Thickness: | 83.7-102.3 |

| | |
|------------------------------|-------|
| Anticipated Board Thickness: | mil |
| After lamination: | 89.10 |
| Over mask on plated copper: | 92.70 |

24 Layer

| Layer | Type | CU Weight | CU % | Material Description | Via Structure | Segment | Glass Style | Material Family | Dielectric constant @ 1GHz | Thickness After lamination [mil] |
|------------|--------|-----------|------|----------------------|---------------|---------|-------------|-----------------|----------------------------|----------------------------------|
| Soldermask | | | | | | | | | | 0.80 |
| 1 | Signal | H | 25 | Press thk = 3.98 mil | | Foil | 2113(58) | Foil | 4.10 | 1.60 |
| 2 | Plane | H | 80 | 3.5 mil H/H | | Prepreg | 1-3313 | EM-827B | 4.30 | 3.98 |
| 3 | Signal | H | 25 | Press thk = 3.53 mil | | Core | 2113(58) | EM-827 | 4.10 | 0.60 |
| 4 | Plane | H | 80 | 3.5 mil H/H | | Prepreg | 1-3313 | EM-827B | 4.30 | 3.50 |
| 5 | Signal | H | 25 | Press thk = 3.53 mil | | Core | 2113(58) | EM-827 | 4.10 | 0.60 |
| 6 | Plane | H | 80 | 3.5 mil H/H | | Prepreg | 1-3313 | EM-827B | 4.30 | 3.53 |
| 7 | Signal | H | 25 | Press thk = 3.53 mil | | Core | 2113(58) | EM-827 | 4.10 | 0.60 |
| 8 | Plane | H | 80 | 3.5 mil H/H | | Prepreg | 1-3313 | EM-827B | 4.30 | 3.50 |
| 9 | Signal | H | 25 | Press thk = 3.53 mil | | Core | 2113(58) | EM-827 | 4.10 | 0.60 |
| 10 | Plane | H | 80 | 3.5 mil H/H | | Prepreg | 1-3313 | EM-827B | 4.30 | 3.53 |
| 11 | Signal | H | 25 | Press thk = 3.53 mil | | Core | 2113(58) | EM-827 | 4.10 | 0.60 |
| 12 | Plane | H | 80 | 3.5 mil H/H | | Prepreg | 1-3313 | EM-827B | 4.30 | 3.50 |
| 13 | Signal | H | 25 | Press thk = 3.53 mil | | Core | 2113(58) | EM-827 | 4.10 | 0.60 |
| 14 | Plane | H | 80 | 3.5 mil H/H | | Prepreg | 1-3313 | EM-827B | 4.30 | 3.53 |
| 15 | Signal | H | 25 | Press thk = 3.53 mil | | Core | 2113(58) | EM-827 | 4.10 | 0.60 |
| 16 | Plane | H | 80 | 3.5 mil H/H | | Prepreg | 1-3313 | EM-827B | 4.30 | 3.50 |
| 17 | Signal | H | 25 | Press thk = 3.53 mil | | Core | 2113(58) | EM-827 | 4.10 | 0.60 |
| 18 | Plane | H | 80 | 3.5 mil H/H | | Prepreg | 1-3313 | EM-827B | 4.30 | 3.53 |
| 19 | Signal | H | 25 | Press thk = 3.53 mil | | Core | 2113(58) | EM-827 | 4.10 | 0.60 |
| 20 | Plane | H | 80 | 3.5 mil H/H | | Prepreg | 1-3313 | EM-827B | 4.30 | 3.50 |
| 21 | Signal | H | 25 | Press thk = 3.53 mil | | Core | 2113(58) | EM-827 | 4.10 | 0.60 |
| 22 | Plane | H | 80 | 3.5 mil H/H | | Prepreg | 1-3313 | EM-827B | 4.30 | 3.53 |
| 23 | Signal | H | 25 | Press thk = 3.53 mil | | Core | 2113(58) | EM-827 | 4.10 | 0.60 |
| 24 | Signal | H | 25 | Press thk = 3.98 mil | | Prepreg | 2113(58) | EM-827B | 4.10 | 3.98 |
| Soldermask | | | | | | Foil | | Foil | | 1.60 |
| | | | | | | | | | | 0.80 |

| | |
|---|-------------|
| Specification (Over mask on plated copper): | mil |
| Overall Board Thickness: | 100.0 |
| Tolerance: | +10.0/-10.0 |
| Min-Max Board Thickness: | 90.0-110.0 |

| | |
|------------------------------|-------|
| Anticipated Board Thickness: | mil |
| After lamination: | 96.16 |
| Over mask on plated copper: | 99.76 |

Summit Interconnect

Summit Interconnect: Material Comparison Chart

| Manufacturer | Product | Type | IPC-4101E | Lead Free Process Compatible | Halogen Free | Flammability UL94 | Glass Transition Tg Celcius | Decomposition Temp by TGA Celcius | Dk 1 GHz | Dk 2-3 GHz | Dk 10 GHz | Df 1 GHz | Df 2-3 GHz | Df 10 GHz | CTE Z Axis (ppm/C) Pre Tg | % CTE Z Axis (50-200C) | Highest of X, Y Axis (PPM/C) Pre Tg | Material Consideration |
|--------------|-------------------------|-----------------------------|-----------------------|------------------------------|--------------|-------------------|-----------------------------|-----------------------------------|--------------|------------|-----------|---------------|------------|-----------|---------------------------|------------------------|-------------------------------------|------------------------|
| ITEQ | ITEQ 180A | High Tg Epoxy | /98 /99 /101 /126 | Yes | No | V-0 | 180 | 350 | | 4.3 | 4.10 | | 0.015 | 0.016 | | | | Lead Free FR4 |
| Isola | 370HR | High Tg Epoxy | /98 /99 /101 /126 | Yes | No | V-0 | 180 | 340 | 4.17 | 4.04 | 3.92 | 0.0161 | 0.021 | 0.025 | 45 | 2.8% | 14 | |
| Isola | 185HR | High Tg Epoxy | /98 /99 /101 /126 | Yes | No | V-0 | 180 | 340 | 4.04 | 4.01 | 3.88 | 0.0192 | 0.02 | 0.0236 | 40 | 2.7% | 14 | |
| Isola | IS415 | High Tg Epoxy | /98 /99 /101 /126 | Yes | No | V-0 | 200 | 370 | | 3.7 | 3.68 | | 0.0135 | 0.0138 | 65 | 2.8% | 13 | |
| Ventec | VT-47 | High Tg Epoxy | /97 /98 /99 /101 /126 | Yes | No | V-0 | 180 | 345 | 4.3 | 4.2 | | 0.016 | 0.017 | | 35 | 3.0% | 13 | |
| Grace | GA-170LL | High Tg Epoxy | /98 /99 /101 /126 | Yes | No | V-0 | 170 | 340 | 4.38 | | | 0.0154 | | | 43 | 2.7% | 16 | |
| Nelco | N4000-29 | High Tg Epoxy | /98 /99 /126 /129 | Yes | No | V-0 | 185 | 350 | 4.3 | | 4.00 | | 0.015 | 0.017 | 55 | 3.0% | 17 | |
| Panasonic | R-175SV/R-1650V | High Tg Epoxy | /97 /98 /99 /101 /126 | Yes | No | V-0 | 173 | 350 | 4.4 | | | 0.016 | | | 44 | | 15 | |
| EMC | EM-827 | High Tg Epoxy | /98 /99 /101 /126 | Yes | No | V-0 | 175 | 350 | 4.2 | | | | 0.019 | | 45 | 2.6% | 15 | |
| EMC | EM-370D | Halogen Free High Tg Epoxy | /127 /128 /130 | Yes | Yes | V-0 | 175 | 385 | 4.1 | | 4.00 | 0.011 | | 0.015 | 40 | 2.2% | 15 | Halogen Free |
| Panasonic | R-1566W/R-1551W | Halogen Free High Tg Epoxy | /127 /128 | Yes | Yes | V-0 | 148 | 350 | 4.6 | | | 0.01 | | | 40 | | 15 | |
| Panasonic | Meg 2 (R-1577/R1570) | Halogen Free High Tg Epoxy | /127 /128 /130 | Yes | Yes | V-0 | 170 | 380 | 4.1 | | | 0.01 | | | 34 | | 16 | |
| Isola | I-Speed | Modified Epoxy | /98 / 99 /101 /126 | Yes | No | V-0 | 180 | 360 | 3.65 | 3.64 | 3.63 | 0.0058 | 0.006 | 0.0071 | 60 | 2.7% | 16 | Low Loss |
| Isola | FR408HR | Modified Epoxy | /98 / 99 /101 /126 | Yes | No | V-0 | 180 | 360 | 3.69 | 3.68 | 3.65 | 0.0091 | 0.0092 | 0.0095 | 60 | 3.5% | 14 | |
| Panasonic | Meg 4 (R-5725/R5620) | Modified Epoxy | /91 /102 | Yes | No | V-0 | 176 | 360 | 3.8 | | | 0.005 | | | 35 | | 15 | |
| EMC | EM-888 | Halogen Free Modified Epoxy | /127 /128 /130 | Yes | Yes | V-0 | 170 | 380 | 3.9 | | 3.80 | 0.006 | | 0.008 | 50 | 2.6% | 15 | |
| EMC | EM-888(S) | Halogen Free Modified Epoxy | /127 /128 /130 | Yes | Yes | V-0 | 170 | 380 | 3.9 | | 3.80 | 0.006 | | 0.008 | 45 | 2.4% | 15 | |
| EMC | EM-888K | Halogen Free Modified Epoxy | /127 /128 /130 | Yes | Yes | V-0 | 170 | 380 | 3.3 | | 3.20 | 0.005 | | 0.006 | 50 | 2.6% | 15 | |
| Nelco | N4000-13EP | Modified Epoxy | /29 | Yes | No | V-0 | 210 | 350 | 3.7 | 3.7 | 3.60 | | 0.009 | 0.009 | 65 | 3.4% | 14 | |
| Nelco | N4000-13EPSI | Modified Epoxy | /29 | Yes | No | V-0 | 210 | 350 | 3.4 | 3.2 | 3.20 | | 0.008 | 0.008 | 65 | 3.4% | 13 | |
| Isola | I-Tera MT40 /RF | Modified Epoxy | IPC-4103 /17 | Yes | No | V-0 | 200 | 360 | | 3.45 | 3.45 | 0.0031 | 0.0031 | 0.0031 | 55 | 2.8% | 12 | High Speed Digital |
| Isola | Tachyon 100G | Modified Epoxy | IPC-4103 /17 | Yes | No | V-0 | 200 | 380 | | 3.04 | 3.02 | | 0.0021 | 0.0021 | 45 | 2.5% | 15 | |
| Panasonic | Meg 6 (R-5775/R5670) | Modified Epoxy | /91 /102 | Yes | No | V-0 | 185 | 410 | 3.71 | | 3.61 | 0.002 | | 0.004 | 45 | | 16 | |
| Panasonic | Meg 6N (R-5775N/R5670N) | Modified Epoxy | /91 /102 | Yes | No | V-0 | 185 | 410 | 3.4 | | 3.35 | 0.0015 | | 0.004 | 45 | | 16 | |
| Panasonic | Meg 7 (R5785/R5680) | Modified Epoxy | /91 /102 | Yes | No | V-0 | 210 | 410 | 3.6 | | 3.60 | 0.0015 | | 0.003 | 42 | | 16 | |
| Panasonic | Meg 7N (R5785N/R5680N) | Modified Epoxy | /91 /102 | Yes | No | V-0 | 210 | 410 | 3.4 | | 3.40 | 0.001 | | 0.002 | 42 | | 16 | |
| EMC | EM-890 | Modified Epoxy | | Yes | No | V-0 | 205 | 430 | 3.5 | | 3.40 | 0.0033 | | 0.0037 | 45-50 | 2.2% | 13 | |
| EMC | EM-890K | Modified Epoxy | | Yes | No | V-0 | 205 | 430 | 3.1 | | 3.00 | 0.0019 | | 0.0022 | 45-50 | 2.2% | 13 | |
| EMC | EM-891K | Modified Epoxy | 102 | Yes | No | V-0 | 205 | 400 | 3.7 | | 3.60 | 0.004 | | 0.004 | 40-45 | 2.2% | 13 | |
| EMC | EM-891K | Modified Epoxy | 102 | Yes | No | V-0 | 205 | 400 | 3.2 | | 3.10 | 0.002 | | 0.003 | 40-45 | 2.2% | 13 | |
| Rogers | RO4450F | Hydrocarbon/Ceramic | IPC-4103A /11 /240 | Yes | No | V-0 | >280 | | | | 3.52 | | | 0.004 | | | 19 | |
| Rogers | RO4350B | Hydrocarbon/Ceramic | IPC-4103A /11 /240 | Yes | No | V-0 | 280 | | | | 3.48 | | 0.0031 | 0.0037 | 35 | | 16 | |
| Rogers | RO4360G2 | Hydrocarbon/Ceramic | IPC-4103A /11 /240 | Yes | No | V-0 | >280 | >350 | | | 6.15 | | 0.003 | 0.0038 | 28 | | 14 | |
| Rogers | RO4835 | Hydrocarbon/Ceramic | IPC-4103 /11 | Yes | No | V-0 | >280 | | | | 3.48 | | | 0.0037 | 26 | | 11 | |
| Rogers | RO4003 | Hydrocarbon/Ceramic | | Yes | No | V-0 | 280 | | | | 3.38 | | | 0.0027 | 46 | | 11 | |
| Rogers | RO4533 | Hydrocarbon/Ceramic | | Yes | No | V-0 | 280 | | | | 3.30 | | 0.002 | 0.0025 | | | | |
| Nelco | N4350-13-RF | Modified Epoxy | /29 | Yes | No | | 210 | 350 | | | 3.50 | | | 0.0065 | | 3.5% | 14 | |
| TUC | TU-883 | Modified Epoxy | | Yes | Yes | V-0 | 170 | 420 | 3.6 | | 3.57 | 0.003 | | 0.0046 | 35 | 2.5% | | |
| TUC | TU-883SP | Modified Epoxy | | Yes | Yes | V-0 | 170 | 420 | | | 3.22 | | | 0.0029 | 35 | 2.5% | | |
| Taconic | TLX | PTFE/Glass | | Yes | No | V-0 | | | | | 2.50 | | 0.0019 | 0.0019 | | | | RF |
| Taconic | TLX-5 | PTFE/Glass | | Yes | No | V-0 | | | | | 2.20 | | | 0.0009 | 217 | | | |
| Taconic | RF35 | Ceramic/PTFE | | Yes | No | V-0 | | | | 3.5 | | | 0.0018 | | 64 | | 24 | |
| Taconic | RF35TC | Ceramic/PTFE | | Yes | No | V-0 | | | | 3.5 | | | 0.0011 | | 34 | | 13 | |
| Taconic | TSM-D53 | Ceramic/PTFE | | Yes | No | | | 526 | | | 3.00 | | | 0.0011 | 23 | | 16 | |
| Isola | Astra MT77 | Epoxy | IPC-4103/17 | Yes | No | V-0 | 190 | 260-288 | | 3.0 | 3.00 | | 0.0017 | | 50-70 | | 12 | |
| Rogers | Duroid 5870 | PTFE/Glass | | Yes | No | V-0 | | 500 | | | 2.33 | 0.0005 (1MHz) | | 0.0012 | 173 | | 28 | |
| Rogers | Duroid 5880 | PTFE/Glass | | Yes | No | V-0 | | 500 | | | 2.20 | 0.0004 (1MHz) | | 0.0009 | 237 | | 48 | |
| Rogers | Duroid 6002 | Ceramic/PTFE | | Yes | No | V-0 | | 500 | | | 2.94 | | | 0.0012 | 24 | | 16 | |
| Rogers | Duroid 6006 | Ceramic/PTFE | | Yes | No | V-0 | | 500 | | | 6.15 | | | 0.0027 | 117 | | 47 | |
| Rogers | Duroid 6010 | Ceramic/PTFE | | Yes | No | V-0 | | | | | 10.20 | | | 0.0023 | 47 | | 24 | |
| Rogers | Duroid 6202 | Ceramic/PTFE | | Yes | No | V-0 | | 500 | | | 2.90 | | | 0.0015 | 30 | | 15 | |
| Rogers | RO3203 | Ceramic/PTFE | | Yes | No | V-0 | | 500 | | | 3.02 | | | 0.0016 | 58 | | 13 | |
| Rogers | RO3003 | Ceramic/PTFE | | Yes | No | V-0 | | 500 | | | 3.00 | | | 0.001 | 25 | | 17 | |
| Rogers | TMM-3 | Ceramic thermoset polymer | | Yes | No | | | 425 | | | 3.27 | | | 0.002 | 23 | | 15 | |
| Rogers | TMM-10 | Ceramic thermoset polymer | | Yes | No | | | 425 | | | 9.20 | | | 0.0022 | 20 | | 21 | |
| Isola | P85 | Polyimide | /40 /41 | Yes | No | HB | 260 | 416 | 3.95 | 3.76 | 3.74 | 0.018 | 0.017 | | 55 | | 14 | Polyimide |
| Isola | P96 | Polyimide | /40 /41 | Yes | No | HB | 250 | 382 | 3.78 | 3.76 | 3.73 | 0.0172 | 0.0179 | 0.021 | 55 | 1.5% | 14 | |
| Ventec | VT-901 | Polyimide | /40 /41 | Yes | No | V-1 | 250 | 390 | 4.1 | 4.00 | | 0.017 | 0.019 | | 50 | 1.5% | 14 | |
| Arlon/Rogers | 85N | Polyimide | /40 /41 /42 | Yes | No | HB | 260 | | 4.39 (1 MHz) | | | 0.008 (1MHz) | | | 50 | | 16 | |
| DuPont | HK04J | Buried Capacitance | IPC-4821 | Yes | No | V-0 | 225/315 | | 3.5 (1MHz) | | | 0.005 (1 MHz) | | | 18-21 | | | Buried Capacitance |
| DuPont | Pyralux AP | Polyimide | IPC-4204 /11 | Yes | No | V-0 | 220 | | 3.4 (1 MHz) | | | 0.003 (1 MHz) | | | | | | Flex |

Use the following table to determine the maximum, single 1-up PCB that can fit into a panel. Panel sizes are sub-divided into "Double sided" and "Multi-layer".

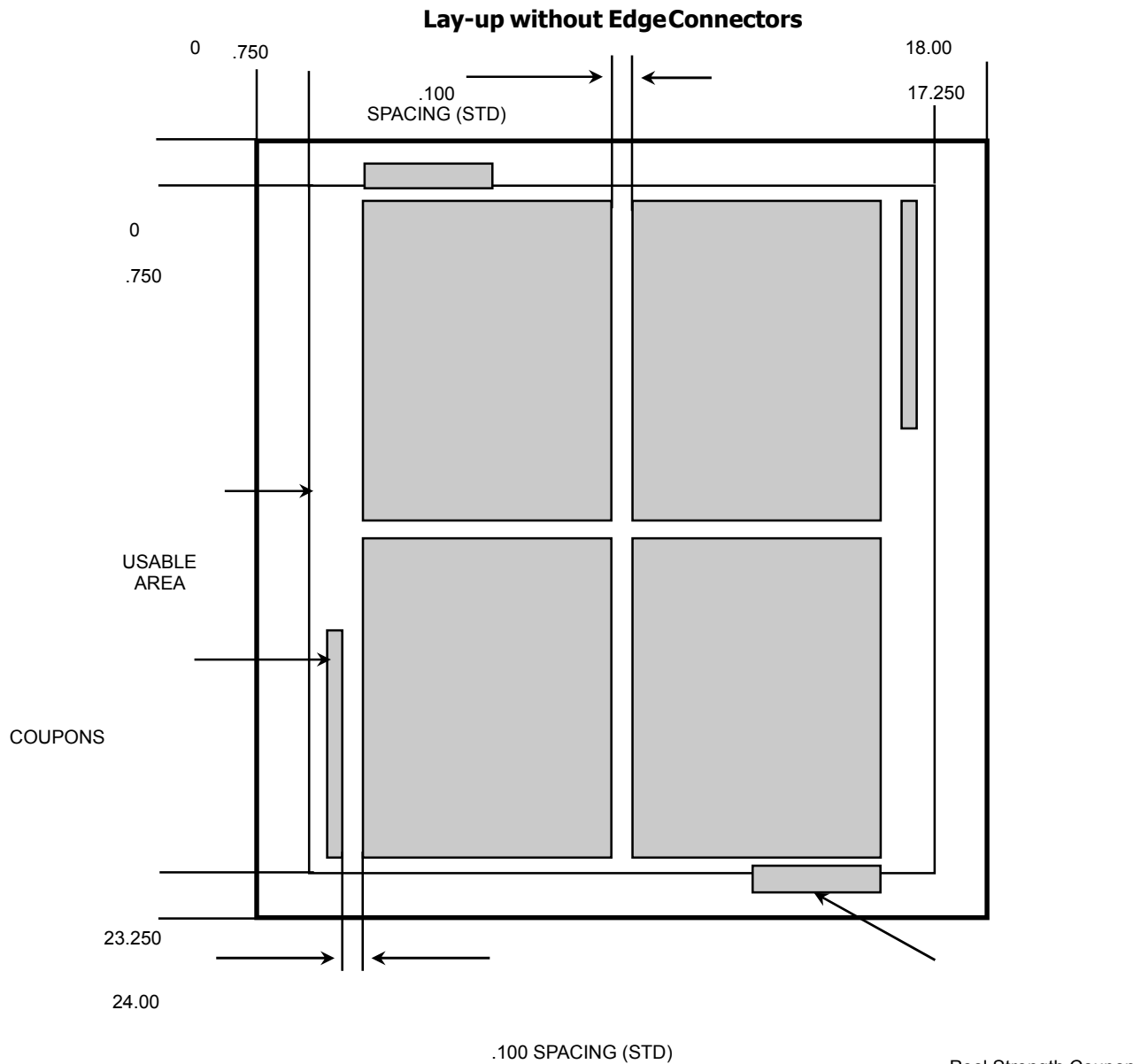
12 X 18 – 16 X 18 – 18 X 24 – 21 X 24 – 24 X 24 – 24 X 30 - 26 x 36

□ Panel Sizes & Useable Area

There are three general modifications to a panel, which will reduce the available useable area. These modifications include: (1) Step-and-repeat requirements, (2) Provisions for electroplating edge connectors, (3) Coupon requirements. (4) Design Tolerances

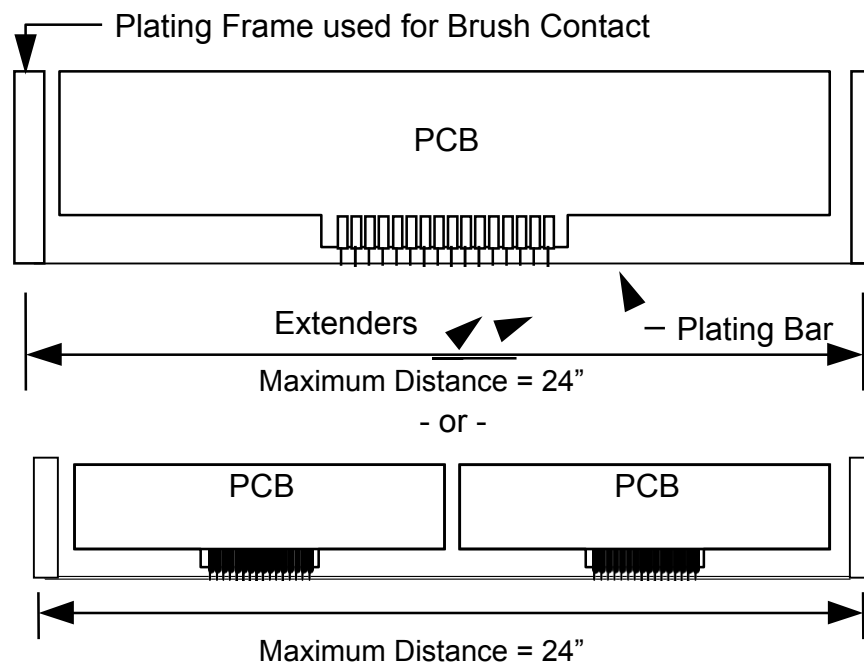
□ Step-and-Repeat

The term 'step-and-repeat' describes the process of reproducing successive images onto a panel. For printed circuit boards without gold-plated edge contacts, the standard step-and-repeat spacing between parts is normally 0.100". Below is a typical lay-up:



Gold-Electroplated Edge Connectors

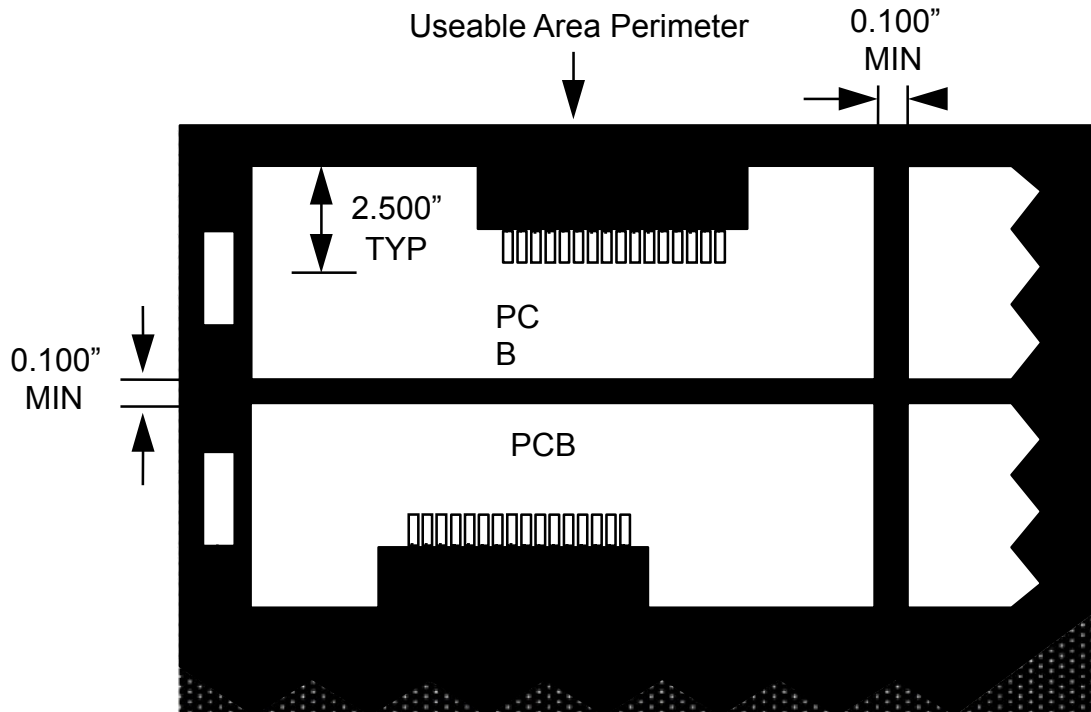
- For printed circuit boards with gold-plated edge connectors (a.k.a. tips, fingers, tabs), parts are usually arranged such that the edge connectors are either facing each other or opposite each other as in When the edge connectors are facing each other, the spacing between the part outlines needs to be at least 0.100" minimum. This allows space for extenders to interconnect to the connectors for electroplating and to allow room for a shearing operation to separate the pieces. When the edges opposite the edge connectors are facing each other, the space between the parts can be 0.150" (minimum 0.100") since there is no gold plating required in this area. Selective plating is available for internal tips.
- **It is also recommended to build the board with gold flash when gold emersion and tips are called out.**
- Maximum distance between buss bar connections: 24"
- Minimum PCB thickness: 0.005"
- Maximum PCB thickness: 0.300"
- Streamline is always available to work with our customers to achieve their goals



Gold Plating Interconnection Component

Lay-up with Edge Connectors

For printed circuit board with recessed gold-plated edge connectors, the same rules apply as those without recessed edge connectors with one exception.



Array Layouts

□ STANDARD SCORE DETAILS

SCORE WEB .015 +/- .003



30 DEGREE ANGLE



o

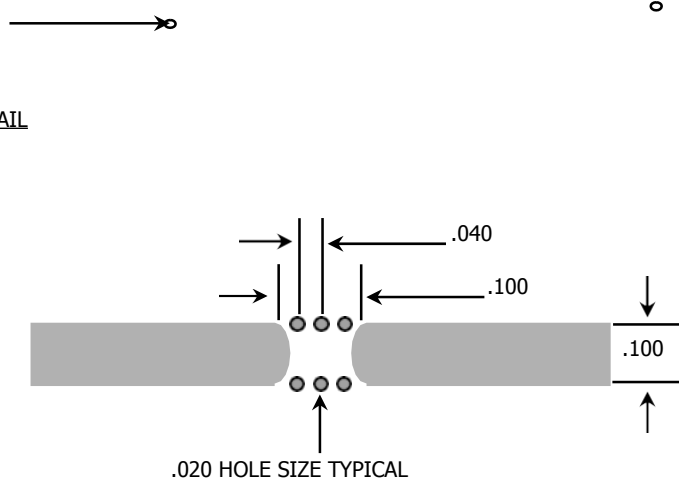
CONTINUOUS SCORE LINES



TOOLING HOLE, X 3 MIN



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General Rule

Keep the array simple. Don't design an array with multiple cut outs or complicated patterns. Detail the print from a hole or a pad or feature to feature. Please supply an outline of the array.

Plating Options

- **Electroless NI / Immersion AU:** (RoHS Compliant for lead free assembly) surface finish used for its coplanarity and solder ability characteristics. Also ensures that gold content in the solder joint is less than 3%. Greater than 3% will could cause solder joint embitterment. This process has 200 micro inches of electroless nickel and 2-5 micro inches of immersion gold.
- **Entek 106A HT:** (RoHS Compliant for lead free assembly) Entek Plus Cu-106A is an organic solder ability preservative (OSP) used when planarity across the board surface is critical. No solder will be present on the board prior to assembly. Thickness requirements for Entek 106 should be .2 to .5microns.
- **Hot Air Solder Level:** (This process can also be lead free) Hot air solder leveled boards will have a solder thickness of .00003 to .0015. IPC-6012 (supersedes IPC-RB-276) only specifies good solder ability and does not specify thickness.
- **Immersion Silver:** Alternate surface finish used for its coplanarity, ICT and solder ability characteristics. (RoHS Compliant for lead free assembly)
- **Gold Immersion:**

Nickel / Gold Plating: (Gold connectors usually 30 micro inches)

- **Hard Gold is Standard process at Summit**
- **Gold Body Plate:**
For gold wire bond applications, soft gold (60-90 Knoop Hardness) should be used (refer to Mil-G-45204). Although the above mentioned specification calls out a thickness of 50 - 100 micro inches, thickness requirements are typically in the 20 to 60 micro inches range with 200 micro inches nickel.
- **Aluminum wire bonding** applications typically require 2 to 7 micro inches of soft gold over 150 - 200 micro inches nickel. Electroless (immersion) plating process. 60 to 90 knoop
- **Gold wire bonding** applications typically require 20 to 60 micro inches of soft gold over 200 micro inches nickel. 60 to 90 knoop