

User Guide: Manufacturing Guidelines

(Note: This document is also posted on www.pcb.com.)

PURPOSE:

This procedure provides clarification and additional requirements for the following:

- Any parts that require dimensional inspection (e.g., machined, stamped, molded, etc.)
- Any parts that require secondary operations (plating, coating, painting, heat-treating, etc.)
- Any parts that require finishing operations (deburring, sandblasting, tumbling, etc.)
- Any printed circuit board assembly operation
- Any raw material supplier

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I. Engineering Drawing Notes

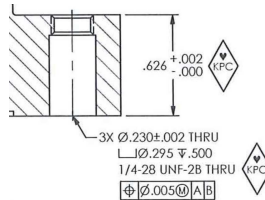
A. Feature Categories

1. PCB drawings will have four categories of dimensions:

- a. **Key Product Characteristics (KPCs)** — are designated in procedures, routers, and drawings by the KPC symbol or the previously used CI symbol.



Characteristics with this symbol need a higher level of control because i) the customer desires to attain a specific target as opposed to simply maintaining tolerance, ii) it is a “high risk” item for the customer, or iii) it is a safety or contractual requirement of a customer. Key Product Characteristics require that you verify that the process is capable using a 30 piece capability study with a Cpk > 1.33 or 100% inspection. The KPC symbol shall be placed adjacent to the note or dimension(s) defining that feature. Unless otherwise specified, when a KPC symbol is applied to a multi-dimensional feature identified by a single leader line, KPC conditions will apply to all dimensions of that feature.



- b. **Major Feature** — Any features having tighter tolerances than those specified on the drawing's standard tolerance block are designated as Major Features.
- c. **Standard Care Feature** — all other drawing dimensions.
- d. **Key (process) Control Characteristics (KCCs)** — are designated by the KCC symbol.



This symbol is similar to the KPC symbol, except it applies to a key process as opposed to a key characteristic. This symbol may be found on PCB drawings, routers, procedures, and equipment

B. Standard Title Block (Unless Otherwise Specified):

- Dimensions are in Inches.
- Decimals

| | |
|-------------|----------------|
| X | ±0.050 |
| XX | ±0.010 |
| XXX | ±0.005 |
| XXXX | ±0.0005 |
- Angles ±2 degrees.
- If a corner is not stated as sharp on the drawing, break all edges for fillets, chamfer, and radii to 0.001” – .005”.
- Polygon Dimension Tolerances:

| | |
|-----------|----------------------|
| External: | |
| ≤ 0.500 | +0.000/-0.003 |
| > 0.500 | +0.000/-0.005 |
| Internal: | |
| ≤ 0.500 | +0.003/-0.000 |
| > 0.500 | +0.005/-0.000 |
- Internal Thread Depth is a Minimum.
- External Thread Length is to the print tolerance.
- Remove All Burrs: See [Finishing Operations](#) for more details.
- Sharp for inside or outside corners target is R.000”, with R.003” being the maximum allowable.

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10. When the default (standard) tolerances are specified and the lower specification limit on the dimension is zero or less, the tolerance shall be +100% / -50% of the standard tolerance.
An example of this is R.005, where the tolerance will be +.005, -.0025.
11. Material — identifies the raw stock used to manufacture the product.
12. Heat treat — When heat treat is noted in material block, part is hardened prior to machining.
When heat treat is noted in the heat treat section of the title block, the part is heat treated after machining.
Part is expected to meet all dimensions after heat treat process. If heat treat is required after machining, the oxide layer created during the heat treatment process must be present on all surfaces unless otherwise indicated on the drawing.
13. Concentricity: Unless otherwise specified, Concentricity tolerance is .005".
14. Parallelism: Unless otherwise specified, Parallelism tolerance is .002".
15. Flatness:
Unless otherwise specified, Flatness tolerance is .002" maximum.
1 light band = 11.6 μ in (0.0000116").
PCB uses optical flats to measure the flatness of lapped and polished surfaces, however when a part requires measurements too difficult to obtain using a standard flatness method such as an optical flat, the print will specify the region requiring interferometric measurements.
16. Circular Runout: Unless otherwise specified, Circular Runout tolerance is .005".
17. Perpendicularity: Unless otherwise specified, Perpendicularity tolerance is .005".
18. Symmetry: Unless otherwise specified, dimensional tolerance symmetrical about centerline is .005".
19. Centerline: Features shown on centerline must be within \pm .0025 of centerline.

C. Stock (STK) Material:

1. Dimension labeled as STK shall use the manufacturer's finish, dimensions and tolerance, and does not require machining or further processing.

D. Drill Points:

1. Unless otherwise specified, if a drawing shows a drill point but does not specify an angle, 118° is the standard, but 90° – 180° drill point is allowable. Drawings that specify "drill point acceptable" may use any drill angle. Depth callouts will be measured from the surface to the edge of the shoulder, not the center of the point unless otherwise specified. If a sectional view shows no drill point on a hole, the bottom shall be flat within the dimensions on the detail.

E. Chamfer on Hexagon and Octagon Shapes

Unless otherwise specified:

1. External Chamfers on hexagon or octagon shapes are defined as 30° \pm 5° starting from a circle inscribed inside the points with a tolerance of minus .001" to .015"
2. Internal Chamfers on hexagon or octagon shapes are defined as 30° \pm 5° starting from a circle inscribed outside the points with a tolerance of plus .001" to .015"

F. Grind/Lap/Polishing and Stock Allowance:

1. The manufacturer is responsible for determining what each sub-process should be to achieve final dimensions that meet the drawing specification. The one exception to this is when PCB Engineering has determined that either product performance or appearance (quality) will be improved by following a certain series of sub-processes. In this case, it will be explicitly called out on the drawing.
2. The information below is a guideline.
 - a. When a $\sqrt[16]{}$ or better ($\sqrt[16]{}$ GRIND) grind finish is called out, .001" to .002" of stock per side (above nominal) needs to be left over to grind. In some instances, it is possible to achieve a 16 finish directly off a mill or lathe, which is acceptable unless otherwise specified.
 - b. When a $\sqrt[8]{}$ or better ($\sqrt[8]{}$ LAP) lapped finish is called out, a .001" to .002" of stock per side (above nominal) needs to be left over for lapping. Hand lapping is not acceptable unless otherwise specified on the drawing.

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- c. When a $\sqrt{4}$ or better (polished finish) is called out, no extra stock is required. Hand polishing is not acceptable unless otherwise specified on the drawing.

G. Part Identification/Etching

1. On some PCB drawings, Engineering will specify that certain information be identified on a specific surface of the part(s) on the drawing. If the drawing says "ETCH", it means that manufacturer will utilize Laser etching where the font and text height used produces a legible identification.
2. If the drawing says "MARK", it means that the manufacturer could use another method to permanently identify the part at the manufacturer's discretion where the font and text height used produces a legible identification.
3. Fixtures, identified by the "FIX-" prefix in the title block of the drawing, must be marked with a unique identifier (e.g. "FIX-" part number) except in some instances of a fixture assembly (see 4b below). This includes Multi-use jigs and fixtures.
4. Fixture identification falls into one of two categories: Single Component Fixtures and Fixture Assemblies.
 - a. Single Component Fixtures - These drawings will have a note stating to either "Etch" or "Mark" the part number at a specific location on the component. See above for etching and marking guidelines. If component is too small to "ETCH" or "MARK" then contact PCB for additional instructions.
 - b. Fixture Assemblies - These are fixtures that have more than one component. All fixture assemblies will have a BoM and a drawing associated with them. For fixture assemblies that remain assembled, one component in the assembly must be marked with the ASSEMBLY number. When a fixture assembly is taken apart as part of the process, then each individual component shall be identified with a part number.

H. PCB Drawing Revision

1. It is the responsibility of the Supplier to ensure that they are supplying product to the latest revision of the drawing and specifications provided by PCB Piezotronics unless otherwise specified in writing. Drawings take precedence over any CAD models or GERBERS that may be provided or approved by PCB. In the case of any conflict between the drawing and computer models, contact PCB's Purchasing Department for clarification.

II. Inspection and Quality Guidelines

A. Thread Depth/Thread Length and Pitch Checking:

1. Use the appropriate attribute thread gage as called out on the PCB drawing. To determine thread depth, calculate the number of gage turns required by multiplying the thread pitch by the depth or length of thread, then subtracting one (1) turn for the lead of the gage.
2. Thread Length: Measure to last full thread profile, excluding run out.
3. Example: $\frac{1}{4}$ - 28 threads x .250 deep. See Figure 1.
 $28 \times .250 = 7 \text{ turns} - \frac{1}{2} \text{ turn for chamfer part and } \frac{1}{2} \text{ turn for lead of gauge} = 6 \text{ turns of thread.}$

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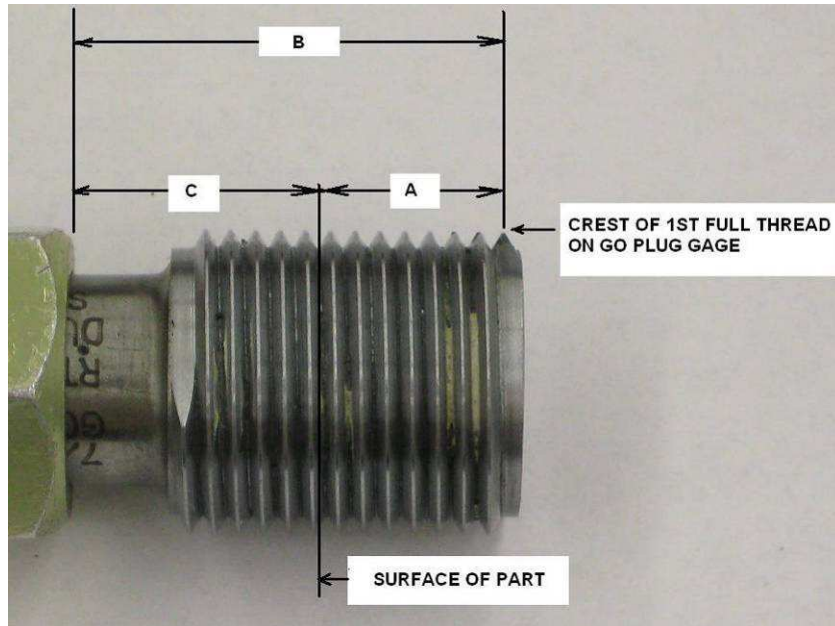


Figure 1 Alternative Method to Verify Thread Depth

Measure B distance of GO Gauge to crest of 1st full thread.

Install GO Gauge fully into hole to measure distance C.

Thread Depth $A = B - C$

Thread Length: Measure to last full thread profile, excluding run out.

4. When go/no go gauges are used to check thread pitch diameter, up to two (2) turns on the no go gauge will be allowed. When there are less than three (3) turns of thread on a part feature, ½ of the available threads will be used to determine the number of turns allowed.
5. When the thread does not meet the appropriate ring or plug gage as specified by the PCB quality staff, and the supplier's gages give a different result, PCB reserves the right to use a variable thread gaging system, such as that manufactured by the Johnson Gage Company, as the master gage of record to determine if the threads are acceptable. Both the pitch diameter and the functional size of the threads must pass the gage.
6. If a "perfect thread" depth is called out on a PCB drawing, it will indicate the length of usable thread that is required.

B. Thread Quality/Tap Drill Size and Depth

1. Unless the thread surface is otherwise specified on the drawing, the surface finish of the thread flanks and roots shall be no greater than a 63 finish for external threads and a 100 finish for internal threads.
2. Tap Drill Size may not be listed on print; if listed, hole tolerance is prior to threads.
3. Unless otherwise specified on print:
For all holes (including flat bottom holes), maximum tap drill hole depth will be 2.5 x pitch deeper than thread depth.
4. Tap Drill hole size is based on 70% thread engagement. Reference MS070.
5. Internal Threads:
 - a. Major diameter and undercut width: See Machinist Handbook for reference:
 - b. Major diameter undercut tolerance:
Pitch > 20: +.010 / -.000 larger than major diameter.
Pitch ≤ 20: +.015 / -.000 larger than major diameter.
 - c. Major diameter undercut width: 1 x Pitch ±.005"
 - d. Lead Chamfer:
 - i. Size: Major Diameter plus .001" to .015"

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- ii. Angle: 85° to 125° included angle
- 6. External Threads (see Figure 2):
 - a. Minor diameter undercut tolerance:
 - Pitch > 20: +.000/-.010 smaller than minor diameter
 - Pitch ≤ 20: +.000/-.015 smaller than minor diameter
 - b. Minor diameter undercut width: 1 x Pitch ±.005"

NOTE: For thin walled cross sections (less than 0.010) refer to Machinist Handbook for minor diameter.

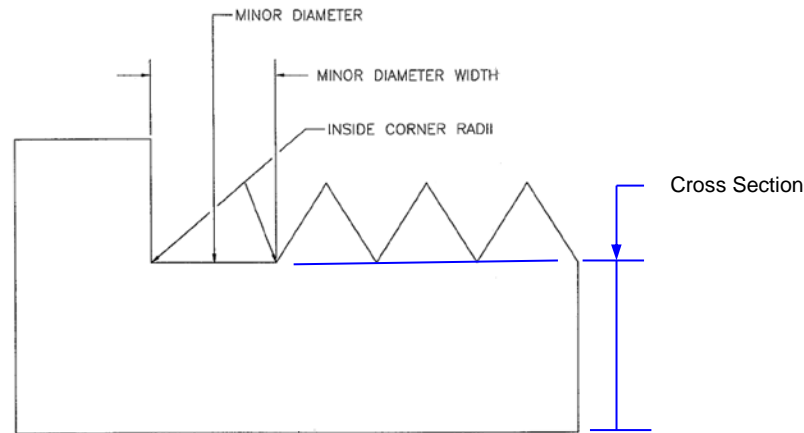


Figure 2 External Thread Dimensions

- c. Inside corner Radii:

| Standard: | Metric: | Inside Corner Radii |
|---------------------|----------------------|---------------------|
| 60 pitch or finer: | .5 pitch or finer | 0–.005" |
| 33–59 pitch | .80–.55 pitch | 0–.010" |
| 32 pitch or coarser | .85 pitch or coarser | 0–.010" |

- d. Lead Chamfer:

- i. Size: Minor diameter minus .001" to .015"
- ii. Angle: 85° to 125° included angle

C. Material Certifications and Lot Segregation:

1. All suppliers will provide a Certificate of Conformance for each item supplied when specified on the Purchase Order. Machined metal products and raw metal materials require a mill-direct Certificate of Analysis indicating chemical composition.
2. The part drawing or material description will denote the appropriate material standard. If no standard is referenced on the drawing or in the material description, then the material must be certified to the appropriate UNS number referenced in Table 1.
3. Print will note if Material Lot Segregation is required.
4. The Quantity on the Certificate of Conformance must match the quantity of parts received. If product provided by PCB Piezotronics designated "PROGRAM-Controlled" is scrapped at the supplier's facility, it must be rendered unusable for its intended purpose and then properly discarded. A written statement must be provided to PCB Piezotronics certifying that the supplier conforms to this requirement.
5. Material Supplier and component manufacturers will purchase material from original manufacturer or authorized distributors with traceability to the original manufacturer.
6. When suppliers must use raw material from a source other than those provided directly from the manufacturer or authorized distributor, they are required to notify PCB prior to delivery. If PCB authorizes the receipt of material without traceability to the original manufacturer, they must provide a documented

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counterfeit parts risk assessment and risk mitigation plan. The risk mitigation plan shall document tests and/or inspections utilized commensurate with the risk including acceptance and rejection criteria.

D. Inspection Requirements:

1. All products manufactured for PCB Piezotronics shall be inspected for dimensional and visual features in accordance with standard ANSI Z 1.4 and/or additional specifications defined on drawings and purchase orders. The required A.Q.L is 0.065 minimum.
2. No nonconforming or out of tolerance/specification product, process or service shall be delivered to PCB Piezotronics unless accompanied by a Material Deviation Notice-MDN (form EN082) with the appropriate approval authority.
3. Supplier shall retain product inspection records. Inspection records must be retrievable to facilitate review by PCB upon request. Records must be held for 10 years.
4. All variable characteristics with a tolerance that has 3 decimal places or fewer on machined components must be measured and reported to one extra decimal point. Part pass or fail decisions will be made based on measurements taken to the extra decimal (for example, if a 1.500" +/- .001" OD measures 1.5013" it is rejectable).
5. PCB uses Ra measured in micro inches unless otherwise specified.
6. Part surface finish for all features and details will maintain a surface finish of $\sqrt{63}$ unless otherwise specified.
7. When knurling is called out on the drawing, dimensions are prior to knurling unless otherwise specified.
8. When using Pin Gauges for measurement of inside diameters, Plus (+) diameter gauges shall be used to verify to the lower specification while Minus (-) gauges shall be used to verify to the upper specification.

III. Finishing Operations

A. Deburring

1. Burr Definition: a non-functional piece of material extending from the parent surface of a part. A burr can be a sharp, ragged projection, firmly adhered, or a loosely hanging projection.
2. Due to the sensitive nature of PCB product, it is important that all components be delivered both deburred and contaminant free without having a process that is excessively aggressive so as to change the print dimensions (most common are broken outside corners). Specifically, any product or process that utilizes silicone cannot be used to deburr product because this material is very difficult to identify and remove after it has been applied. Processes such as AFM (Abrasive Flow Machining), TEM (Thermal Energy Method), ECD (Electro-Chemical Deburring), ECP (Electro-Chemical Polishing), and ECM (Electro-Chemical Machining) are all approved methods due to their perceived ability to deburr without changing drawing dimensions.
3. The only other standard approved method for deburring is the use of hand tools such as carbide knives, scalpels, and scrapes, woven fiber tools such as 3M Scotchbrite®, and rotary air tools utilizing Cratex® standard bond, extra fine grit or equivalent silicon carbide soft tools with 180 or finer grit. Any other method is considered not acceptable unless approved in advance by PCB Engineering.
4. Use 10X magnification for inspection of parts. If higher magnification is required, the print will note it.
5. Examples of burrs:

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- a. Whisker Burr (see Figure 3):
- Loosely attached material generally around thread areas, countersunk holes, and edges of part.
 - Whisker burrs may be quite small and can peel around edges of feature.

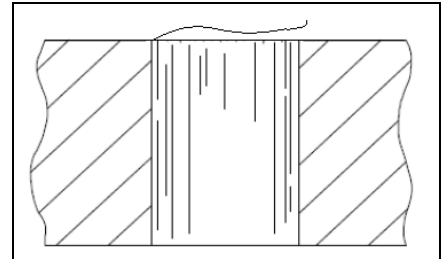


Figure 3 Whisker Burr

- b. Sliver Burr (see Figure 4):
- Loose sliver of material attached to edge of feature.

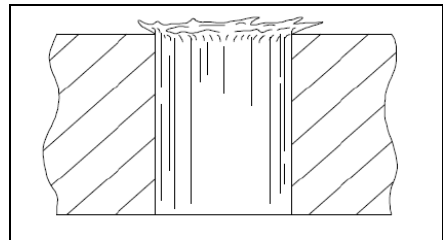


Figure 4 Sliver Burr

- c. Crowned Burr (see Figure 5):
- Loosely attached material generally around countersunk hole.

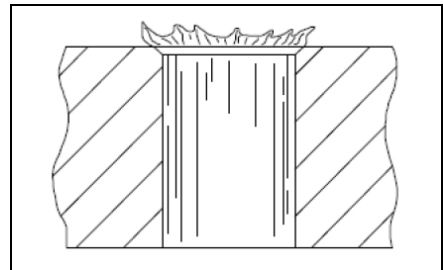


Figure 5 Crowned Burr

- d. Hinged Burr: (see Figure 6):
- Loose material generally in hole and milled features.

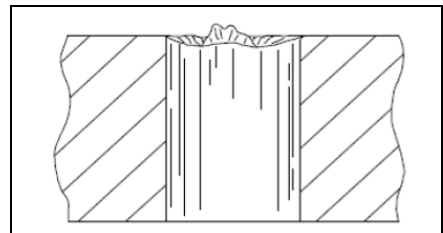


Figure 6 Hinged Burr

- e. Rolled Burr (see Figure 7):
- Loose or attached burr on holes, milled and turned features.

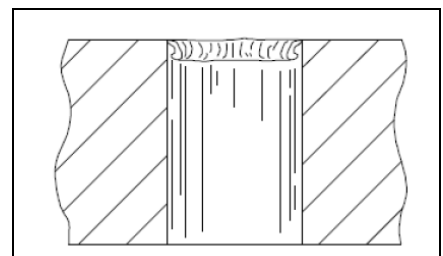


Figure 7 Rolled Burr

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- f. Feathered Burr (see Figure 8):
- Loose burr generally found on an edge where two dissimilar surface finishes meet.

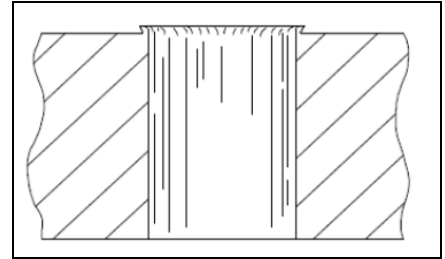


Figure 8 Feathered Burr

- g. Doughnut Burr (see Figure 9):
- Loose burr that tends to flatten and blend itself into the adjacent material.

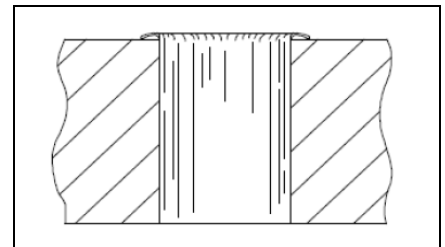


Figure 9 Doughnut Burr

- h. Extended Burr (see Figure 10):
- Raised material generally caused by drilling of malleable material.
 - This type of burr does not exhibit evidence of material that can break away.

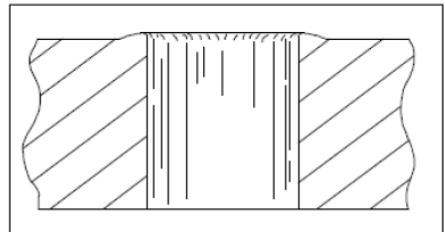
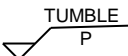


Figure 10 Extended Burr

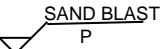
6. Burrs on Stamped Parts:
- Unless otherwise specified on the drawing, a burr not greater than 10% of material thickness is acceptable provided the burr cannot be detached during normal handling or use.

B. Tumbling

1. Symbol — 

- When this symbol is used in the finish block, it means that tumbling is required. If tumbling is not specified on the drawing, manufacturer may tumble for finishing purposes as long as drawing dimensions are maintained. If drawing has any "sharp" corners denoted, tumbling is not permitted.

C. Media Blasting (includes sand blasting, grit blasting, glass bead, corn cob, etc.)

1. Symbol — 

- When this symbol is used in the finish block or called out in the drawing, it means that media blasting is required. If media blasting is not specified on the drawing, manufacturer is not permitted to use it for finishing purposes.

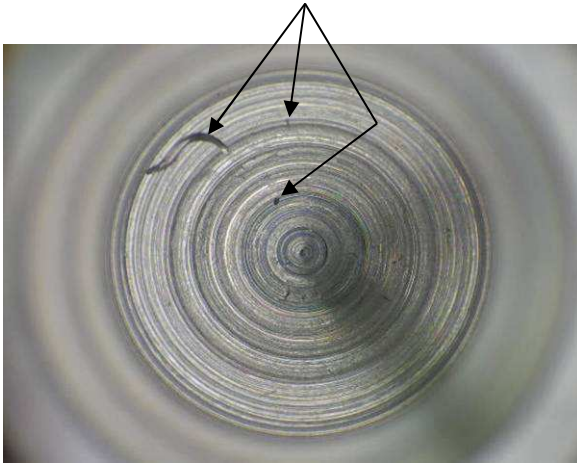
IV. Cleanliness Requirements

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A. Requirements and Examples

1. All parts are to be clean and free of any oil, silicones, cutting fluid, grease pen marks or other contaminants. Parts will be cleaned in an aqueous based cleaning system, alcohol wash, solvent clean or other manner as stated in internal PCB cleaning procedures or router steps. Any questions on obtaining approval for a cleaning process should be directed to PCB Engineering (internal suppliers) or PCB Purchasing (external suppliers) prior to cleaning.
2. Parts are visually inspected for cleanliness at 10X magnification to ensure parts are clean and free of any metal chips, dirt, oil, coolant or other contaminants.
3. Examples of an unacceptable vs. an acceptable cleanliness part (see [Figure 11](#)):

Unacceptable or Dirty Part



Acceptable or Clean Part

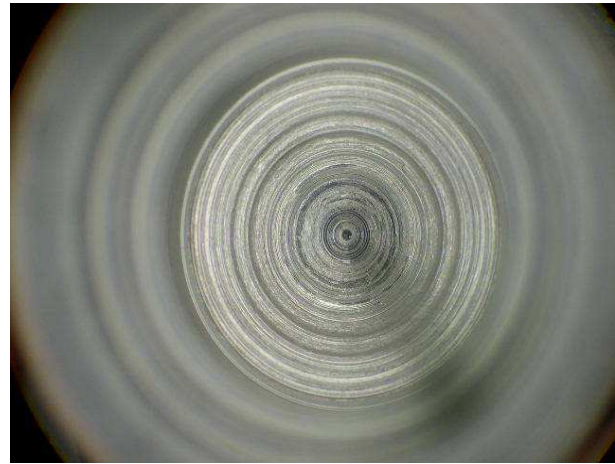


Figure 11 Bottom of Counter Bore Cleanliness Examples

V. Plating/Painting/Coating Operations

A. Plating/Coating/Painting Requirements

1. Unless otherwise specified on the drawing, all dimensions are prior to plating/coating/painting.
2. Uniform plating coverage is required. If unsure as to uniform coverage, submit a First Article Inspection Piece to QA for review and approval.
3. Unless otherwise specified, the following plating thickness tolerances shall apply:
+ .0002 / - .0000”.
4. For painted, Powder-Coated (and Silk Screened) parts, rack marks are unacceptable unless identified on the drawing.

B. Plating/Coating Threads

1. For some small threads, the thickness of the plating/coating can cause a defective thread. In these cases, PCB engineering has specified a special pitch diameter on the drawing which will need to be undersized/oversized as machined. In these instances, PCB also utilizes the same drawing to specify the plating/coating process thickness and/or the thread tolerance after the plating/coating process.
2. Unless otherwise specified threads shall not be painted but must be masked prior to painting.

C. Product Color

1. The PCB standard for drawing call outs on color specifications is either the Federal Standard Color Chart – 595 or the Pantone Matching System. In some instances, PCB will identify the paint manufacturer’s name and that manufacturer’s color name/number. In the case of anodized and hard coat (Sanford process) products, PCB requires compliance to MIL-A-8625, and the following color ranges:
 - Blue: to be no darker than FS 35109 and no lighter than FS 35450.

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- Black: to be no darker than FS 17038 and no lighter than FS 36081.
- Gold: to be no darker than FS 20266 and no lighter than FS 23594.
- Green: to be no darker than FS 14062 and no lighter than FS 34259.
- Red: to be no darker than FS 11136 and no lighter than FS 31400.

VI. Cosmetic/Appearance Criteria

A. Requirements and Examples

1. Unless otherwise specified, all machined part surfaces are to be free of any cosmetic defects such as nicks, scratches, dents, protuberances, weld indentations, weld splatter, or gouges. However, typical machine tooling marks on the surface are acceptable provided that they meet the surface finish specification. These characteristics will be considered defects if they are larger than .003" deep or .003" wide or long.
2. Examples of Unacceptable Conditions (see Figure 12, Figure 13 and [Figure 14](#)):

Scratches on part greater than .003" long



Figure 12 Unacceptable Scratches on Part Example

Machining scars and weld splatter greater than .003" wide and tall

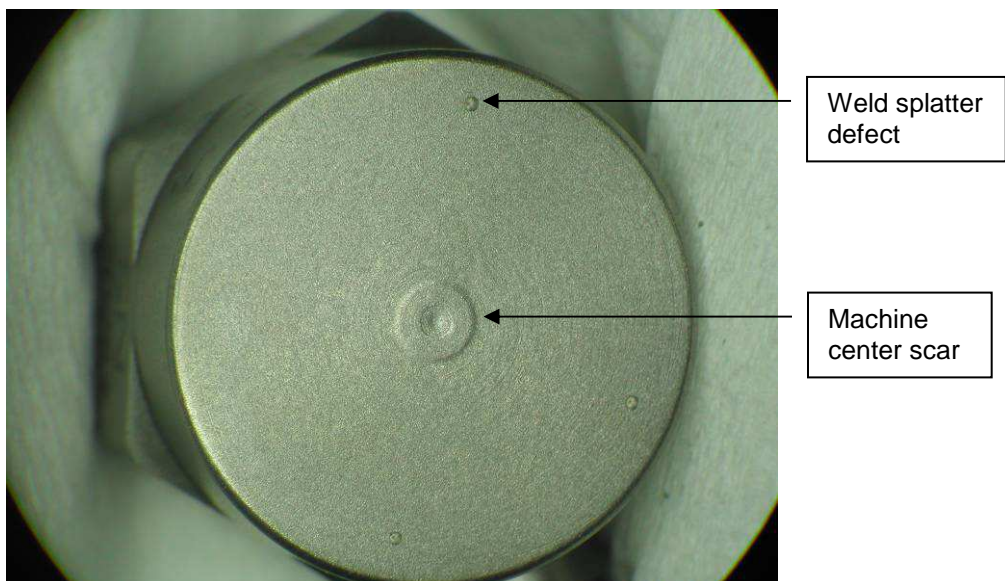


Figure 13 Unacceptable Machining Scar and Weld Spatter Example

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Notes:

- Lapped parts may have micro scratches on flat surface from lapping media.
- Part must pass surface roughness and flatness requirements.
- Print will specify "No Scratches" if lapped surface must be pristine.

Nicked/damaged thread greater than .003" deep
(disregard the etched letter X and arrow on part)

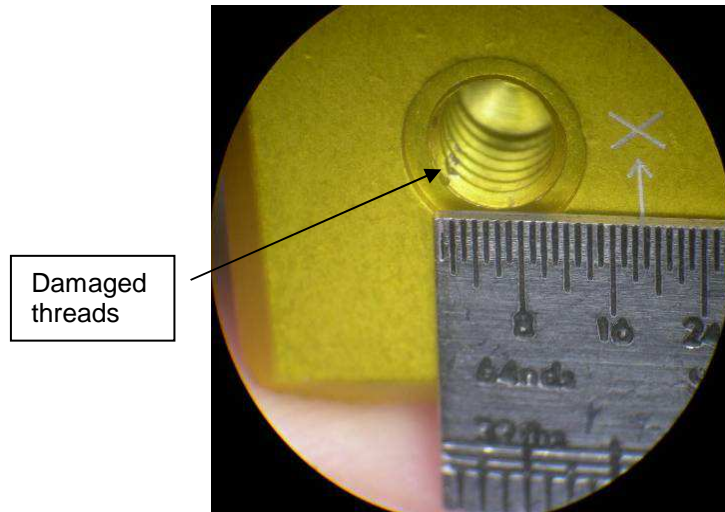


Figure 14 Unacceptable Thread Damage Example

VII. Packaging Guidelines

A. Requirements

Packaging requirements for suppliers are detailed in procedure EN1107. If you need a copy of EN1107 please contact your purchasing agent.

VIII. Printed Circuit Board Assembly Requirements

A. Requirements

1. Testing for assembly will not be required unless there is a specific test procedure listed on the Bill of Materials (BOM).
2. Fixtures specific to PCB testing shall be provided by PCB. General test equipment, Function Generators, Oscilloscopes, Digital Volt Meters, or cables are not provided unless requested.
3. Assembly procedures may be provided. The assembly procedure is a reference and may be superseded by supplier core competency practices.
4. Unless otherwise noted on assembly documentation, the square pad on a pc board footprint denotes the positive (+) lead for a polarized capacitor .
5. Assemblies are NOT required to be RoHS compliant unless specifically required by the assembly documentation. Contact PCB with specific component questions related to RoHS compliance.
6. PCB must approve gerber files for pc board material.
7. Unless otherwise stated, functional equivalents for all capacitors and resistors up to 10Megohm may be used. Equivalents must meet or exceed the part description on the bill of materials. Actual part numbers used must be recorded as part of the contract manufacturer's production record
8. Contact PCB for long lead time, spacing/ fit, minimum quantity, lack of manufacturer information, RoHS, or obsolete components to assist with procurement issues.
9. Assemblies are to be built to meet or exceed IPC 610 Class 2 standards.

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10. When separating panelized assemblies, clean singulation not required unless specified on assembly drawing.
11. Assemblies must be cleaned to remove flux residue and particulate material. Visual inspection, 10x magnification minimum, of the completed assembly must not yield any flux or particulate. Additional [cleaning may be required for some assemblies](#), as called out on the documentation for the assembly.
12. The BOM is the controlling document for board production, it supercedes all other documentation that may be provided by PCB. If an item is not listed on the BOM or identified by "NA", it is not to be populated on the board.
13. Test set-up and performance time estimates documented in test procedures are just that – estimates. The ultimate responsibility for test set-up and performance remains the suppliers'.
14. PC Board Supplier will purchase electronic components from original component manufacturers or authorized distributors.
15. When PC Board Suppliers must use electronic components from an unauthorized source they are required to notify PCB prior to delivery. In addition they must provide a documented counterfeit parts risk assessment and risk mitigation plan. This risk assessment must address the likelihood of receiving a suspect or confirmed counterfeit electronic component from the source and the consequences of a suspect or confirmed counterfeit part being installed (e.g., human safety, reliability, performance). The risk mitigation plan shall document tests and/or inspections utilized commensurate with the risk including acceptance and rejection criteria.

IX. Printed Circuit Board Repair Guidelines

A. Warranty Repairs- no charge to PCB

1. Units returned to Suppliers against RMA's in response to MRR or CAR's from PCB Piezotronics Inc. should be credited upon receipt. If the units are repaired, they should then be re-invoiced at the PO cost as credited. This is standard PCB Piezotronics Inc. procedure.

B. Non Warranty Repairs - this would include units not considered a warranty repair by the Supplier. Refer to the following guidelines:

1. If the supplier decides that a unit is not covered by their warranty, PCB should be contacted immediately. Non-warranty repair work should not be done unless PCB approval is granted.
2. A repair cost should not exceed 25% of the purchase cost of the unit. Suppliers should not repair units unless it is certain that the cost will not exceed this allowance.
3. Upon approval from PCB to repair a board, a purchase order will be issued to cover the repair cost. In this case, the supplier should re-invoice the original PO cost that was credited and also prepare a separate invoice for the repair cost as approved.
4. There may be circumstances that dictate actions outside these guidelines. A stock out at PCB, a large lot quantity or a special run board could be exceptions. PCB will provide specific actions in these cases. If in doubt, contact PCB.

C. Repair Expectations - repaired units will be considered like new.

1. Functional testing, if required, for repaired assemblies must be performed prior to returning the assembly to PCB. Contact PCB for fixture and procedure if necessary.
2. A Certificate of Compliance must be provided with the repaired units' and needs to include the revision level that the assembly was repaired to.

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3. Programming for components may be the original revision when the assembly was built.
4. All cleaning and manufacturing guidelines (lead trimming or component placement) listed in the assembly documentation must be met.
5. Notify PCB Piezotronics, Inc. if units are scrapped so PO(s) can be adjusted.

D. Definitions

1. RMA- Return Merchandise Authorization
2. MRR- Material Rejection Report
3. CAR- Corrective Action Request

TABLE 1 – Material Composition Identification

| Description | Type / Grade | UNS Number |
|---------------------------|---------------------|------------|
| Alloys/Exotics | HAYNES(R) 242(R) | UNS N10242 |
| Nickel Iron Alloy | Alloy 52 | UNS N14052 |
| Nickel Iron Alloy | Alloy 42 | UNS K94100 |
| Aluminum Alloy Casting | A356-T6 | UNS A13560 |
| Aluminum | 1100-0 | UNS A91100 |
| Aluminum | 2024 | UNS A92024 |
| Aluminum | 4047 | UNS A94047 |
| Aluminum | 5052-H32 | UNS A95052 |
| Aluminum | 7075-T6 | UNS A97075 |
| Aluminum | 6061-T6 | UNS A96061 |
| Aluminum | GLIDCOP Al-15 | UNS C15715 |
| Beryllium Copper | BeCu C17200 | UNS C17200 |
| Beryllium Copper | BeCu C17300 | UNS C17300 |
| Brass | 26000 (CDA260) | UNS C26000 |
| Brass | 36000 (CDA360) | UNS C36000 |
| Brass | 46400 | UNS C46400 |
| Carbon Steel | 236 (SA36) | UNS K02600 |
| Carbon Steel | 1002 | UNS G10020 |
| Carbon Steel | 1008 | UNS G10080 |
| Carbon Steel | 1018 | UNS G10180 |
| Carbon Steel | 1020 | UNS G10200 |
| Carbon Steel | 1095 | UNS G10950 |
| Carbon Steel | 1117 | UNS G11170 |
| Carbon Steel | 1144 | UNS G11440 |
| Carbon Steel | 12L14 | UNS G12144 |

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| | | |
|-------------------------------|-------------|-------------------|
| Carbon Steel | 4140 | UNS G41400 |
| Carbon Steel | 4340 | UNS G43400 |
| Copper | | UNS C11000 |
| Copper | | UNS C12200 |
| Copper | | UNS C18200 |
| Copper | | UNS C46400 |
| Inconel | 625 | UNS N06625 |
| Inconel | 750 | UNS N07750 |
| Inconel | 600 | UNS N06600 |
| Inconel | 718 | UNS N07718 |
| Invar | | UNS K93603 |
| Invar | | UNS K93050 |
| Invar | | UNS K93500 |
| Marraging Steel | | UNS K93120 |
| Monel | 400 | UNS N04400 |
| Monel | R405 | UNS N04405 |
| Nickel | 200 | UNS N02200 |
| Nickel | 201 | UNS N02201 |
| Nickel | 270 | UNS N02270 |
| Nickel Alloy Brazing Matl. | BNi-2 | UNS N99620 |
| Palladium | Grade 99.8 | UNS P03980 |
| Platinum | Grade 99.95 | UNS PO4995 |
| Stainless Steel | 218 | UNS S21800 |
| Stainless Steel | 310 | UNS S31000 |
| Stainless Steel | 316 | UNS S31600 |
| Stainless Steel | 316L | UNS S31603 |
| Stainless Steel | 13-8 | UNS S13800 |
| Stainless Steel | 15-5 | UNS S15500 |
| Stainless Steel | 17-4 | UNS S17400 |
| Stainless Steel | 17-7 | UNS S17700 |
| Stainless Steel | 302 | UNS S30200 |
| Stainless Steel | 304 | UNS S30400 |
| Stainless Steel | 304L | UNS S30403 |
| Stainless Steel | 416 | UNS S41600 |
| Stainless Steel | 303 | UNS S30300 |
| Stainless Steel | 403 | UNS S40300 |
| Stainless Steel | 410 | UNS S41000 |
| Stainless Steel | 440C | UNS S44004 |
| Stainless Steel | 430 | UNS S43000 |

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| | | |
|-----------------|-----------------|------------|
| Stainless Steel | 465 | UNS S46500 |
| Stainless Steel | 660 | UNS S66286 |
| SUPREMEX | 640XA | N/A |
| Titanium | 6AL4V | UNS R56400 |
| Titanium | Grade 5 | UNS R56400 |
| Titanium | A70 | UNS R50700 |
| Tool Steel | A2 | UNS T30102 |
| Tool Steel | D2 | UNS T30402 |
| Tool Steel | O1 | UNS T31501 |
| Tungsten | HD-17 - Class 1 | N/A |
| Tungsten | HD-18 – Class 3 | N/A |
| Kovar | Class 1 | UNS K94610 |