

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

I. Engineering Drawing Notes

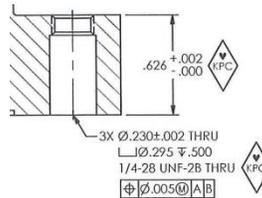
A. Feature Categories

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):

1. Dimensions are in Inches.
2. Decimals

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

User Guide: Manufacturing Guidelines

5. Polygon Dimension Tolerances:

External:

$\leq 0.500 +.000/-.003$

$> 0.500 +.000/-.005$

Internal:

$\leq 0.500 +.003/-.000$

$> 0.500 +.005/-.000$

6. Internal Thread Depth is a Minimum.
7. External Thread Length is to the print tolerance.
8. Remove All Burrs: See [Finishing Operations](#) for more details.
9. Sharp for inside or outside corners / edges target is R.000", with R.003" being the maximum allowable. Sharp corners / edges may be machined as a radii or chamfer (45 degree), unless dimensioned on drawing with specific requirements. This will be in lieu of PCB block tolerance and for manufacturing capabilities.
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 Octogon Shapes

Unless otherwise specified:

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

User Guide: Manufacturing Guidelines

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 ($\sqrt[16]{.001-.002}$ 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 ($\sqrt[8]{.001-.002}$ 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.
 - 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.

User Guide: Manufacturing Guidelines

28 x .250 = 7 turns – ½ turn for chamfer part and ½ turn for lead of gauge = 6 turns of thread.

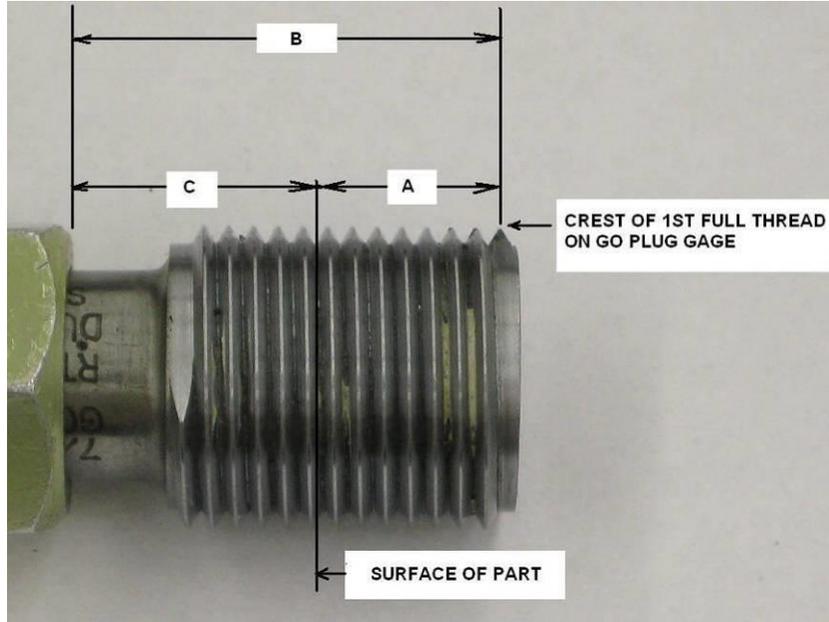


Figure 1 Alternative Method to Verify Thread Depth

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

Install GO Gage 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 gage 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".

User Guide: Manufacturing Guidelines

- d. Lead Chamfer:
 - i. Size: Major Diameter plus .001" to .015"
 - 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.

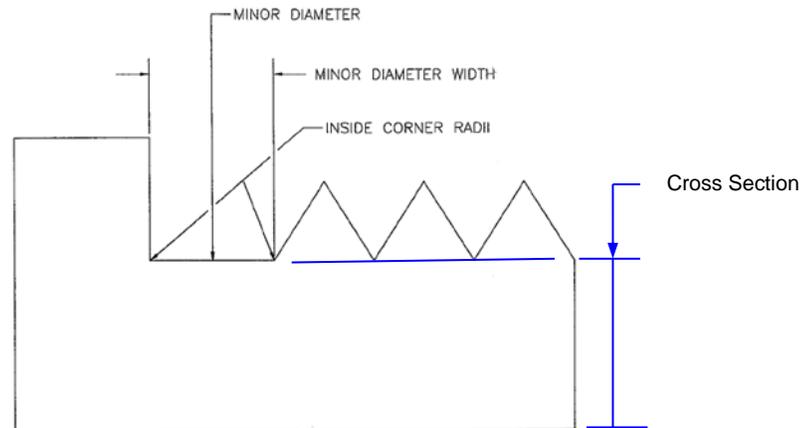


Figure 2 External Thread Dimensions

- 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. 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. 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.
3. 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).
4. PCB uses Ra measured in micro inches unless otherwise specified.
5. Part surface finish for all features and details will maintain a surface finish of $\sqrt{63}$ unless otherwise specified.
6. When knurling is called out on the drawing, dimensions are prior to knurling unless otherwise specified.

User Guide: Manufacturing Guidelines

7. 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.
8. Nonconforming product that is discovered prior to delivery to PCB shall be held until appropriate disposition has been obtained from PCB. This can be accomplished by utilizing PCB's Material Deviation Notice (EN082) or by the vendors internal deviation process. The vendors internal deviation process will be reviewed prior to approval for use.

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:

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.

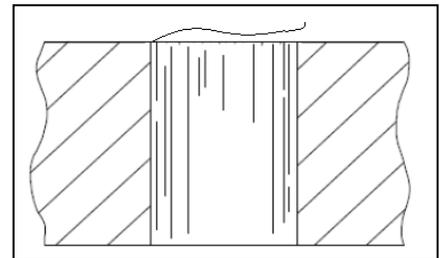


Figure 3 Whisker Burr

b. Sliver Burr (see Figure 4):

- Loose sliver of material attached to edge of feature.

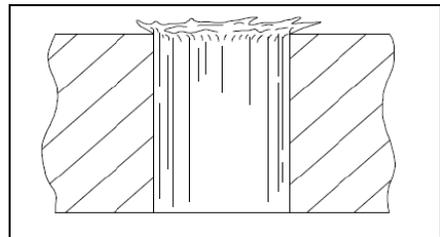


Figure 4 Sliver Burr

User Guide: Manufacturing Guidelines

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

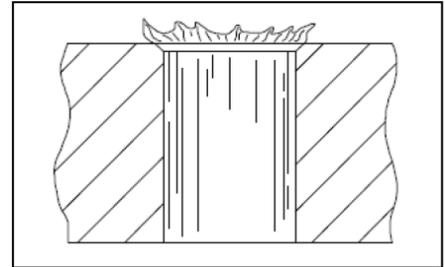


Figure 5 Crowned Burr

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

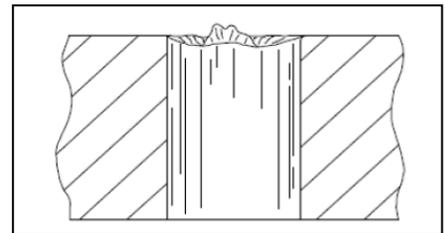


Figure 6 Hinged Burr

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

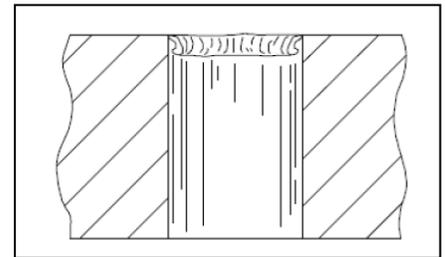


Figure 7 Rolled Burr

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

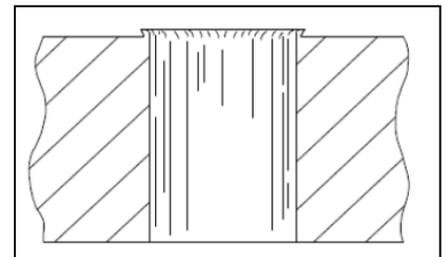


Figure 8 Feathered Burr

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

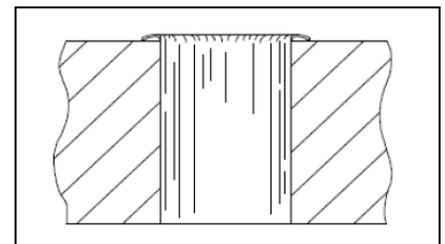


Figure 9 Doughnut Burr

User Guide: Manufacturing Guidelines

- 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.

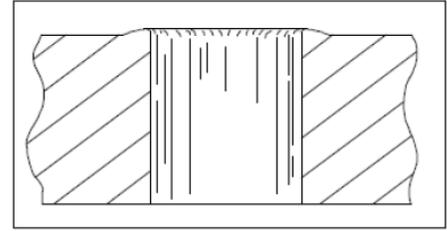


Figure 10 Extended Burr

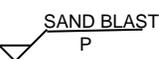
- 6. Burrs on Stamped Parts:
 - a. Unless otherwise specified on the drawing, a burr not greater than 10% of material thickness is acceptable provided the burr cannot be detached during normal handling or use.

B. Tumbling

- 1. Symbol — 

- a. 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 — 

- a. 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.

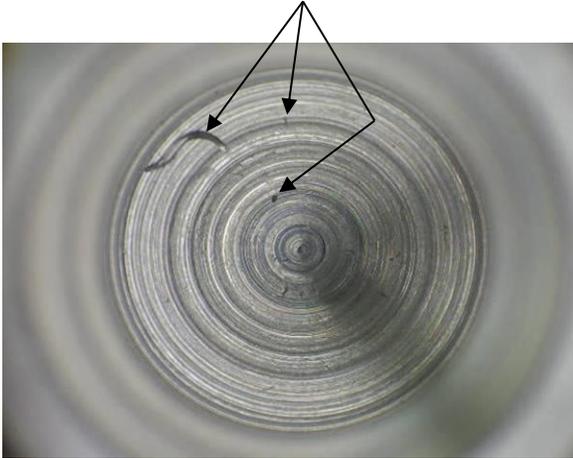
IV. Cleanliness Requirements

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](#)):

User Guide: Manufacturing Guidelines

Unacceptable or Dirty Part



Acceptable or Clean Part

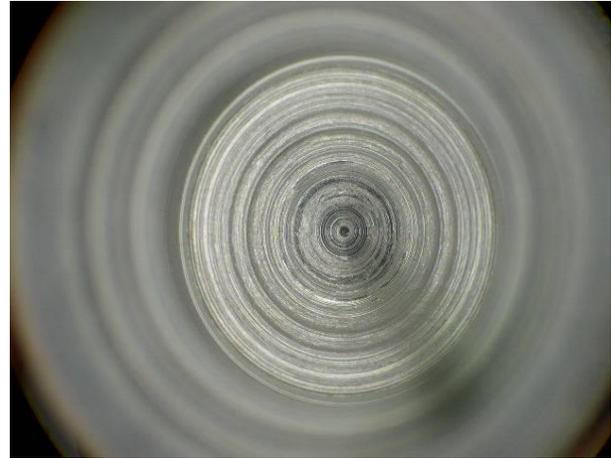


Figure 11 Bottom of Counter Bore Cleanliness Examples

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:
+0.0002/-0.0000”.
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.
 - 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

User Guide: Manufacturing Guidelines

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

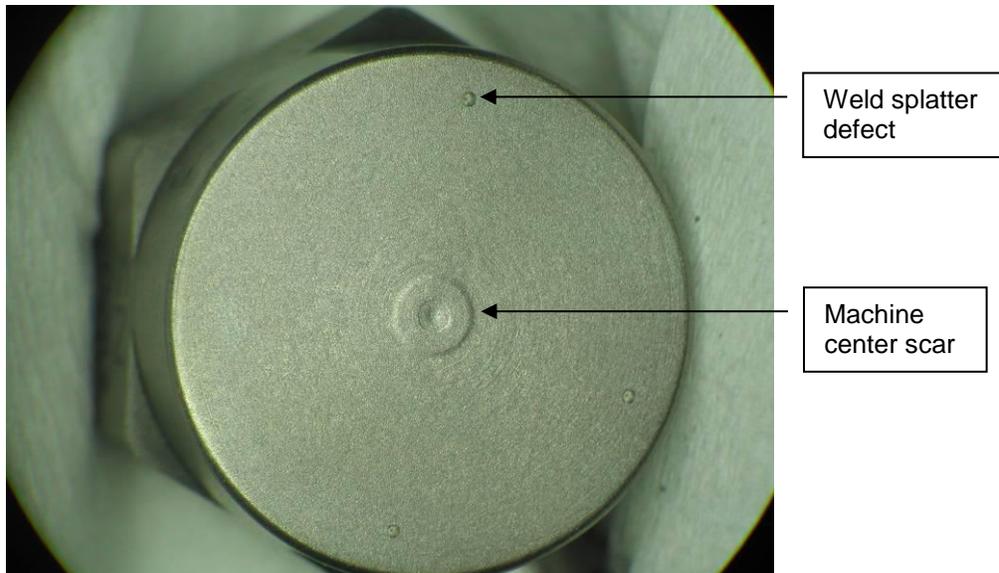


Figure 13 Unacceptable Machining Scar and Weld Spatter Example

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.

User Guide: Manufacturing Guidelines

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

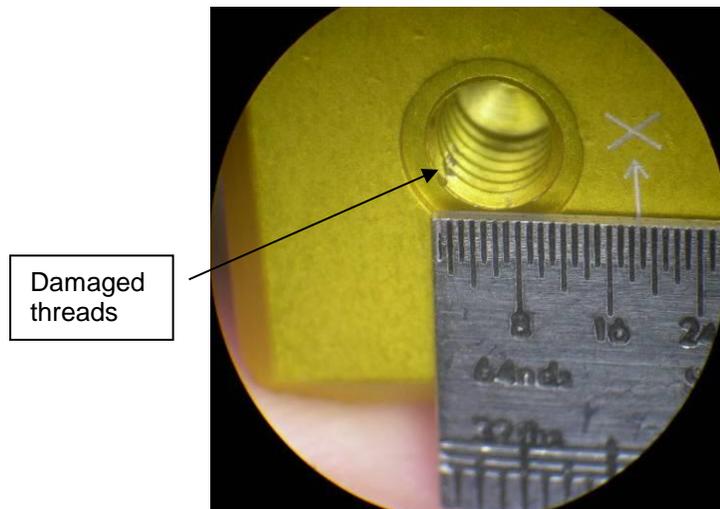


Figure 14 Unacceptable Thread Damage Example

VII. 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.
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.

User Guide: Manufacturing Guidelines

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.

VIII. 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.
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.

User Guide: Manufacturing Guidelines

IX. 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.

X. Documentation

A. Requirements

Certificates of Conformance requirements for suppliers can be found in QA1027. This document is also available on WWW.PCB.COM

XI. Definitions

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

User Guide: Manufacturing Guidelines

TABLE 1 – Material Composition Identification

Description	Type / Grade	UNS Number
Alloys/Exotics	HAYNES(R) 242(R)	UNS N10242
Alumina-Oxide	AL203 (96% Purity)	N/A
Nickel Iron Alloy	Alloy 52	UNS N14052
Nickel Ferromagnetic Alloy	Alloy 79	UNS N14080
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
Arnavar	Cobalt-base alloy	UNS R30007
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
Phosphor Bronze	544-H04	UNS C54400
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
Carbon Steel	4140	UNS G41400
Carbon Steel	4340	UNS G43400
Copper		UNS C11000
Copper		UNS C12200
Copper		UNS C18200

User Guide: Manufacturing Guidelines

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 X	UNS N06002
Nickel Alloy Brazing Matl.	BNi-2	UNS N99620
Nickel-Silver		UNS C73500
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
Stainless Steel	465	UNS S46500
Stainless Steel	660	UNS S66286
SUPREMEX	640XA	N/A

User Guide: Manufacturing Guidelines

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	M2	UNS T11302
Tool Steel	O1	UNS T31501
Tungsten	HD-17 - Class 1	N/A
Tungsten	HD-18 – Class 3	N/A
Kovar	Class 1	UNS K94610