Jabil Digital DFx Content Extract

Design For Assembly

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Design For Assembly

DFA > 3D Printing > 3D Printing
Entry ID: 1601

3D Printing General Information

Information

CID: 1	Content Owner: Jabil	Content Type: Information

Introduction

3D printing is a method of manufacturing also known as "additive manufacturing" because instead of removing material to create a part as is normally done in a machine shop, the process instead adds material in successive layers to create the desired shape. Since the components are built layer by layer, it is possible to design internal features and passages that could not be cast or otherwise machined. Complex geometries and assemblies with multiple components can be simplified to fewer parts with a more cost effective assembly.

3D printing utilizes software that slices the 3D model into layers. Each layer is traced and added on top of the previous one.

This technology is used to manufacture parts for a variety of industries including aerospace, dental, medical and other industries that have small to medium size, highly complex parts.

Advantages and Disadvantages

Layer by layer production allows for much greater flexibility and creativity in the design process. Typical manufacturing process constraints may not apply so a part can be re-designed so that it is stronger in the areas that it needs to be and lighter overall. 3D printing has constraints that may require new design considerations to take full advantage of the technology.

3D printing significantly speeds up the design and prototyping process. Parts can easily be created one at a time as well as iteratively changing the design each time it is produced. Parts can be created within hours, reducing the design cycle down to a matter of days or weeks compared to months.

The process of creating tooling etc. to produce the part is no longer necessary facilitating quicker turnaround times. Also, the price of 3D printers has decreased substantially so it is more economically feasible as an alternative manufacturing method.

Depending on the 3D printing technology, the equipment and materials can be expensive along with slow cycle times leading to expensive parts. This can make it hard to compete with mass production that uses other manufacturing methods but 3D printing is rapidly becoming more competitive.

CID: 2	Content Owner: Jabil	Content Type: Information

Fused Deposition Modeling (FDM / FFF)

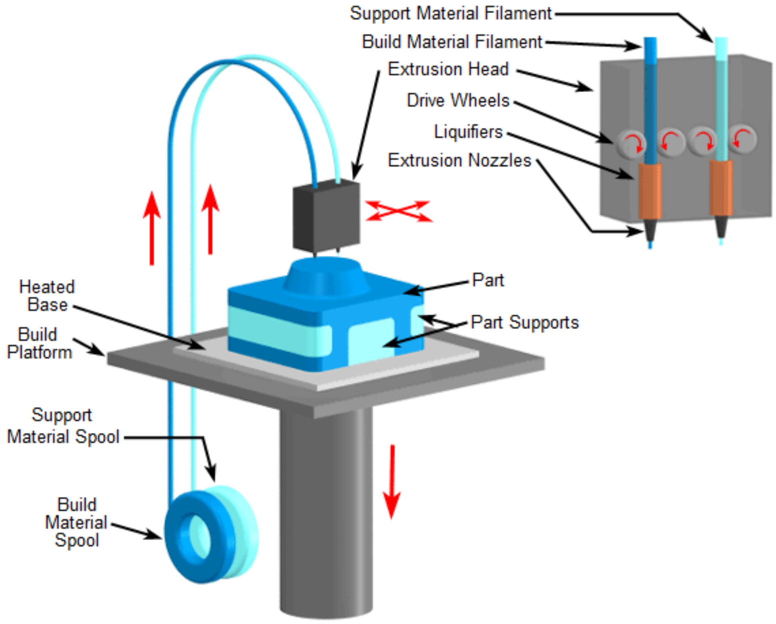
The term FDM is a trademark of Stratasys Ltd. and is also known generically as Fused Filament Fabrication (FFF). FDM works on an additive principle by laying down material in layers. A plastic filament is unwound from a coil and supplies material to an extrusion nozzle that can turn the flow on and off. The nozzle is heated to melt the material and can be moved in both horizontal and vertical directions and controlled by a Computer Aided Manufacturing (CAM) software package.

The model or part is produced by extruding small beads of thermoplastic material to form layers as the material hardens immediately after extrusion from the nozzle. There can be two extrusion nozzles, one to dispense the part material and one to dispense the support material.

Advantages and Disadvantages

Can be more economical since it uses plastic for both the part and the support material. Even low cost FDM printers have enough resolution for many applications. FDM dual extrusion nozzle equipment can use water soluble materials to eliminate supports completely.

Other types of supports leave marks that require additional steps to remove. Warping is more of an issue than some other 3D printing methods.



CID: 3	Content Owner: Jabil	Content Type: Information

Stereolithography (SLA)

SLA utilizes a vat of liquid ultraviolet curable photopolymer resin and a laser to build parts one layer at a time. For each layer, the laser beam traces a cross section of the part pattern on the surface of the liquid resin. Exposure to the laser cures and solidifies the pattern traced on the resin.

After the pattern has been traced, the elevator platform descends by a distance equal to the thickness of a single layer. Then a resin filled blade sweeps across the cross section of the part, re-coating it with fresh material. On this new liquid surface, the next layer pattern is traced fusing with the previous layer. A complete 3D part is formed by this process.

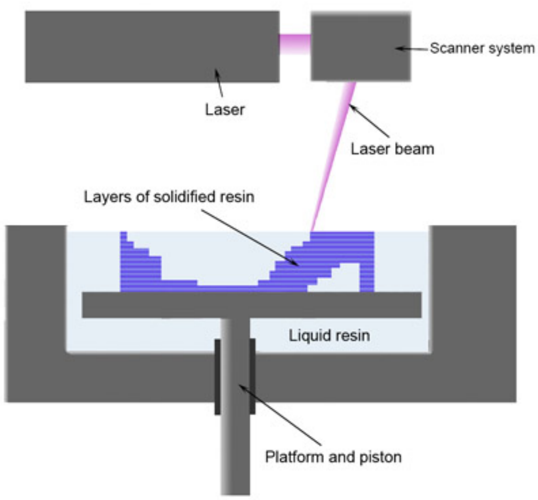
Advantages and Disadvantages

Parts can be fairly high resolution with layers typically between 0.002" (0.0500mm) and 0.006" (0.1500mm) thick.

Processing can be slow and there is a limited selection of polymers available.

Parts must go through additional processing steps including being immersed in a chemical bath to remove excess resin and curing in an ultraviolet oven.

Stereolithography requires the use of supporting structures that serve to attach the part to the elevator platform, preventing deflection due to gravity and holding the cross sections in place so that they resist lateral pressure from the re-coater blade. Supports must be removed from the finished product manually, unlike in other less costly printing types.



CID: 4	Content Owner: Jabil	Content Type: Information

Selective Laser Sintering (SLS)

A laser is used to fuse small particles of plastic, metal, ceramic or glass powders into a 3D shape. The laser selectively fuses powdered material by scanning cross sections of a 3D model of the part on the surface of a powder bed. After each cross section is scanned, the powder bed is lowered one layer thickness, a new layer of powder is applied on top, the laser fuses the next layer to the previous and the process is repeated until the part is completed. The physical process can be full melting, partial melting, or liquid phase sintering.

Some SLS machines use single component powders such as with direct metal laser sintering. In single component powders, the laser melts only the outer surface of the particles, fusing the solid non-melted cores to each other and to the previous layer. However, most SLS machines use two component powders, typically either coated powder or a powder mixture.

Advantages and Disadvantages

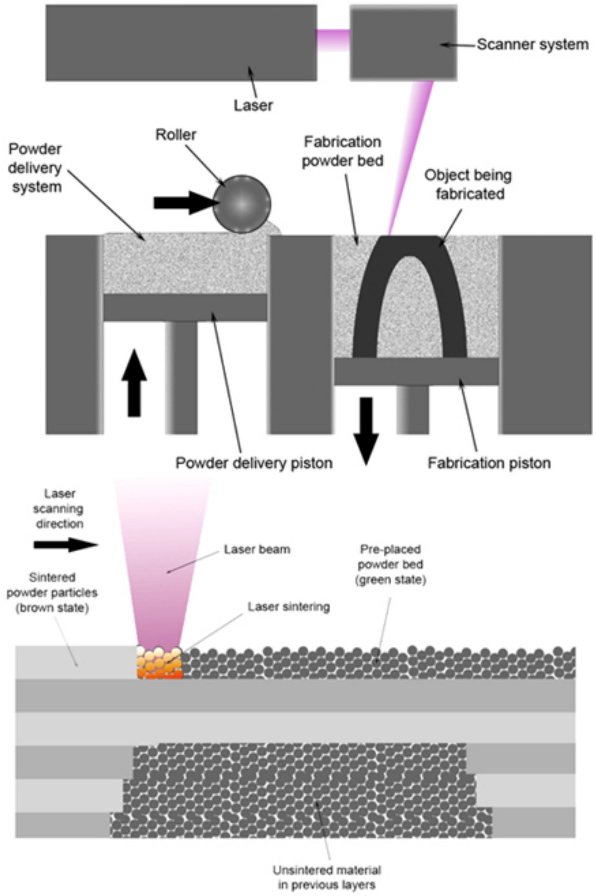
Depending on the material, 98% to 99% density can be achieved with material properties comparable to those from conventional manufacturing methods.

With an example build envelop of 9.843" (250.0000mm) x 9.843" (250.0000mm) x 7.284" (185.0000mm) and the ability to "grow" multiple parts at one time, SLS is a cost and time effective technology.

No special tooling is required and parts can be fabricated in a matter of hours. Since SLS can use common engineering materials, prototypes can now be functional hardware made out of the same material as production components.

In contrast with other additive manufacturing processes such as SLA and FDM, SLS often does not require special supports because the part being constructed is surrounded and supported by unsintered powder at all times. This allows for the construction of previously impossible geometries.

One disadvantage that SLS shares with casting is that it is impossible to fabricate a hollow but fully enclosed element. This is because the unsintered powder within the element can't be removed.



CID: 5	Content Owner: Jabil	Content Type: Information

MultiJet Printing (MJP)

An inkjet printing process that prints resin and support material layer by layer while the resin is cured with UV light. The print head and UV light are both contained within a single cross piece that moves back and forth across the work area so printing and curing occur in a single pass. The next layer is printed and cured, fusing with the previous layer.

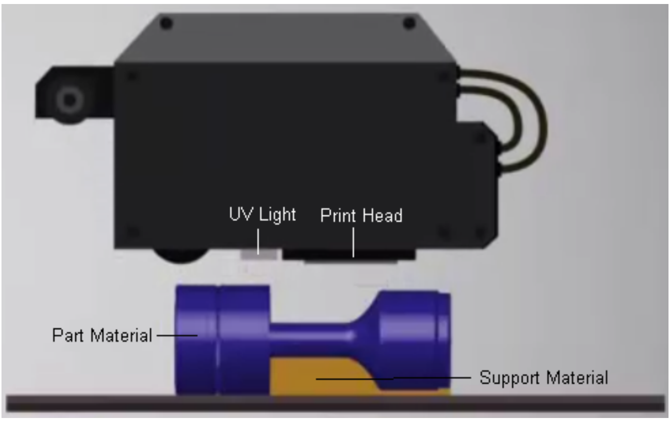
Advantages and Disadvantages

Offers a high Z direction resolution with layers as fine as 0.0006" (0.0160mm) thick so parts have a smooth finish.

Can use multiple colors and different types of materials at the same time and / or without having to change materials in the printer.

Is used to build parts, patterns and molds with fine feature detail to address a wide range of applications.

Requires an additional process step to clean the part.



Related Entries

DFA Information 1602 3D Printing > 3D Printing > 3D Printing Material Selection

DFA > 3D Printing > 3D Printing
Entry ID: 1602

3D Printing Material Selection

Information

CID: 1	Content Owner: Jabil	Content Type: Information

Introduction

Each 3D printing material has its own unique set of properties. In order to produce quality 3D printed parts, it is necessary to find materials that meet given mechanical requirements. The material selected also directly relates to the 3D printing technology used.

3D Printing Technology	Materials Available
FDM	Thermoplastics, metal and / or fiber filled plastics, rubber
MJP	Photopolymers
SLA	Photopolymers
SLS	Thermoplastics, metal powders, ceramic powders

Related Entries

DFA Information 1601 3D Printing > 3D Printing > 3D Printing General Information

DFA > Adhesive > Adhesive Requirements
Entry ID: 1182

Adhesive Types and Curing

Information

CID: 2	Content Owner: Jabil	Content Type: Information

Introduction

The adhesive process has to fit the product and assembly concept.

Adhesives are a fastening process that generally cannot be undone. The product may be damaged or impossible to repair and therefore could get scrapped.

From the material point of view, the process might be very inexpensive but introduction to the production line might require a lot of engineering effort and lead time. Therefore, an overall project review is essential.

There are several methods to cure adhesives, but not all methods fit production. The following is a very general overview.

CID: 1	Content Owner: Jabil	Content Type: Information

Photo-Initiated Curing Adhesives and Resins

After dispensing the photo-initiated curing adhesive / resin onto one part, the second part can be placed before the adhesive is cured by UV light.

Advantages	Disadvantages
Curing with UV can be very fast (depending on the light intensity)	The UV beam has to reach the adhesive for a successful curing process
With the help of light conductors, the curing process can take place in several applications	

Two Part Adhesives

The two parts (adhesive + activator) have to be stored separately and will have a limited shelf life after mixing (before application or at the dispenser).

Advantages	Disadvantages
	Normally the mixture ratio must be observed to an accuracy of 5% in order to achieve a successful curing
	During the curing time, the parts have to be well protected so they are not displaced

Heat Curing Adhesives

Heat curing adhesives contain the substance that initiates the curing reaction. The reaction does not, or only slowly, occurs at room temperature. Curing temperatures occur within a range of 100 to 200 °C.

The curing time depends on curing temperature, adhesive type and the warm up period for the mating parts. Heating can take place in ovens, with IR radiation or other suitable heat sources. The part and adhesive must reach the curing temperature.

Advantages	Disadvantages
Sub-assemblies can be assembled and cured all at the same time in an oven	All parts must be able to withstand the curing temperature
	For automated inline assembly, an inline heating process is necessary

"Hot Melt" Adhesives (Thermoplastic Adhesives)

Thermoplastics are applied hot and harden as they cool. A glue gun is one method of applying a hot adhesive. The glue gun melts the solid adhesive and applies it to the parts where it solidifies.

Advantages	Disadvantages
These adhesives are popular because of their ease of use and the wide range of materials to which they can adhere	The adhesive strength is highly variable and should only be used for non-critical fastening applications

Air Hardeners (Cyanoacrylates)

Also called "instant glue" or solvent free adhesive curing through humidity.

Advantages	Disadvantages
Curing takes place very fast, enabling parts to be attached within a few seconds	Adhesive is very aggressive, an accidental drop cannot be removed without causing cosmetic problems
	It is a "dirty" process with the high risk of contaminating the whole workstation
	Parts cannot be re-adjusted because they are glued immediately

Contact Adhesives

Contact adhesives must be applied to both surfaces and pre-cured before the two surfaces are pushed together. Some contact adhesives require a 24 hour curing time to reach final glue strength.

Advantages	Disadvantages
Once the surfaces are pushed together the bond forms quickly and with high force, so it is usually not necessary to apply pressure for a long time	Because the process requires two dispensing processes (for each part), a long curing time and high pressure this process should be avoided for automated or mass production

Related Entries

DFA	Guideline	1183	Adhesive > Adhesive Requirements > Adhesive Joint Type
DFA	Guideline	1184	Adhesive > Adhesive Requirements > Adhesive Gap Between Mating Parts
DFA	Guideline	1191	Adhesive > Adhesive Requirements > Protect Styling and Movable Parts from Adhesive

DFA > Adhesive > Adhesive Requirements
Entry ID: 1183

Adhesive Joint Type

Guideline

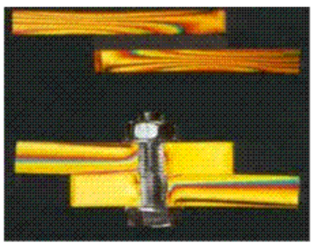
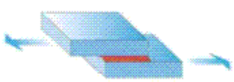
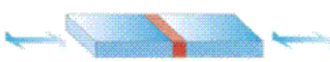
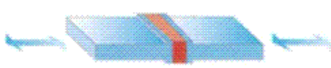
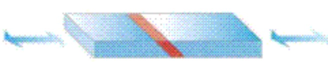
CID: 2	Content Owner: Jabil	Content Type: Requirement

Select the appropriate adhesive joint type to withstand the expected stresses.

Stress types are classified as:

- Normal strain (tensile stress / compression stress)
- Shear strain
- Torsion

The stress type should relate to the type of joint:

	To understand the static and stress model, imagine the joint as a screw / bolt connection
	The most reliable design is to transform this tensile force into a shear stress load. Normally the gluing area can be enlarged to a maximum size.
	Tensile forces which result in tensile stress should be avoided, because additional torsions might result in "peeling off".
	If tensile stress cannot be avoided, the contact surface should be as large as possible.
	An additional possibility is to increase the contact surface with a chamfer cross section.

Related Entries

DFA Information	1182	Adhesive > Adhesive Requirements > Adhesive Types and Curing
DFA Guideline	1184	Adhesive > Adhesive Requirements > Adhesive Gap Between Mating Parts
DFA Guideline	1191	Adhesive > Adhesive Requirements > Protect Styling and Movable Parts from Adhesive

DFA > Adhesive > Adhesive Requirements
Entry ID: 1184

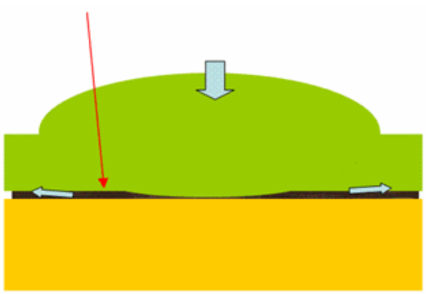
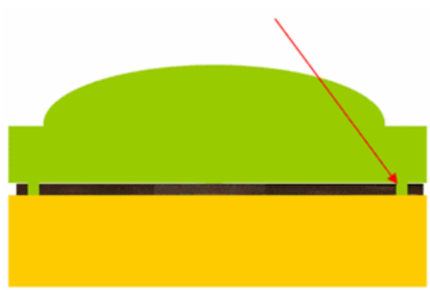
Adhesive Gap Between Mating Parts

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Thickness

To get uniform curing and reliable power transmission, the thickness of adhesive needs to be consistent. The manufacturer normally indicates the optimum thickness, typically 0.004" (0.1016mm) to 0.008" (0.2032mm) for UV curing adhesives.

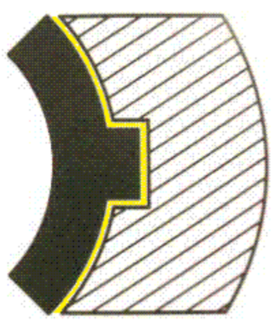
A surface that is not flat will spread the adhesive out	Two flat surfaces with standoffs will provide a uniform gap
	
☒	☑

Coplanarity

Both parts have to have coplanarity to ensure a consistent gap. Any unevenness will influence the gap and therefore the strain.

Positive Contact

Mating parts that fit together like a mold and counter-mold must be positively locked.



Related Entries

DFA	Information	1182	Adhesive > Adhesive Requirements > Adhesive Types and Curing
DFA	Guideline	1183	Adhesive > Adhesive Requirements > Adhesive Joint Type
DFA	Guideline	1191	Adhesive > Adhesive Requirements > Protect Styling and Movable Parts from Adhesive

DFA > Adhesive > Adhesive Requirements

Entry ID: 1191

Protect Styling and Movable Parts from Adhesive

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Ensure there is enough clearance between adhesive dispense areas and styling or movable parts. Clearance may include enough space so that the adhesive cannot contaminate the styling / movable parts or enough space to use protective barriers such as wings or foils during the assembly process.

Related Entries

DFA	Information	1182	Adhesive > Adhesive Requirements > Adhesive Types and Curing
DFA	Guideline	1183	Adhesive > Adhesive Requirements > Adhesive Joint Type
DFA	Guideline	1184	Adhesive > Adhesive Requirements > Adhesive Gap Between Mating Parts

DFA > GD&T > GD&T
Entry ID: 1654

GD&T General Information

Information

CID: 1	Content Owner: Jabil	Content Type: Information

Introduction:

GD&T is a scientific tool for managing manufacturing risk; more particularly GD&T is a symbolic language for specifying permissible functional limits of imperfection in real objects.

When Should GD&T be Applied:

Because GD&T was designed to position size features, the simplest answer is, locate all size features with GD&T controls.

Designers Should Tolerance Parts With GD&T When:

- Drawing delineation and interpretation need to be the same
- Features are critical to interchangeability or function
- It is necessary to reduce or eliminate scrap
- It is important to reduce drawing changes
- Automated equipment will be used
- When accurate measuring is necessary for incoming quality assurance
- It is important to increase productivity by minimizing assembly issues
- It is an effective way to define part geometry
- To communicate better and therefore produce more robust products

In Engineering:

GD&T serves as the ultimate tool for researching the functional requirements of product components, maximizing their fault tolerances and encoding part function in absolutely clear terms for manufacturing, inspection and assembly.

In Manufacturing:

GD&T provides the road map for manufacturing process planning and is essential for the scientific assessment and control of manufacturing processes.

In Inspection:

GD&T is a tool without which metrology and therefore effective quality and manufacturing process analysis is simply impossible.

In Purchasing:

GD&T is the only known tool for generating loophole free legal documents for unambiguous machine part procurement in the ever more dispersed world of corporate manufacturing and marketing.

DFA > GD&T > GD&T
Entry ID: 1655

Tolerances of Form

Guideline

CID: 2	Content Owner: Jabil	Content Type: Information

Introduction:

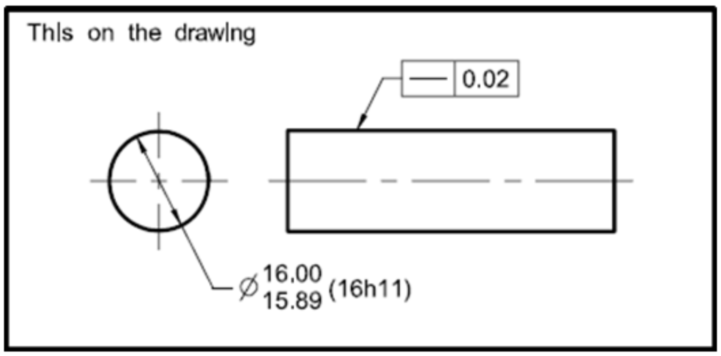
This entry establishes the GD&T principles and methods of dimensioning and tolerancing to control the form of features. Form tolerances control straightness, flatness, circularity and cylindricity. It is necessary to ensure tolerances are clearly documented to control and avoid potential issues during manual and automated assembly and so that the product functions as expected.

CID: 3	Content Owner: Jabil	Content Type: Requirement

Straightness Tolerances:

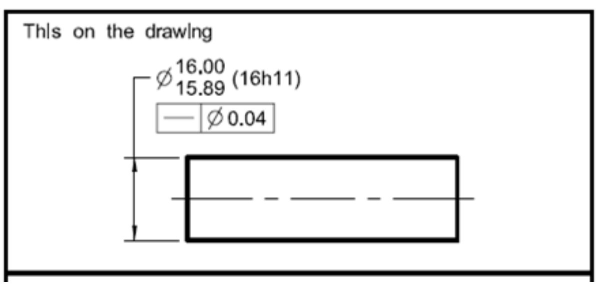
Ensure straightness tolerance is specified for all applicable exterior surfaces regardless of feature size (RFS).

- Straightness tolerances are necessary to avoid issues for a product that requires precision on features, proper sealing, cosmetics or could affect alignment of parts.



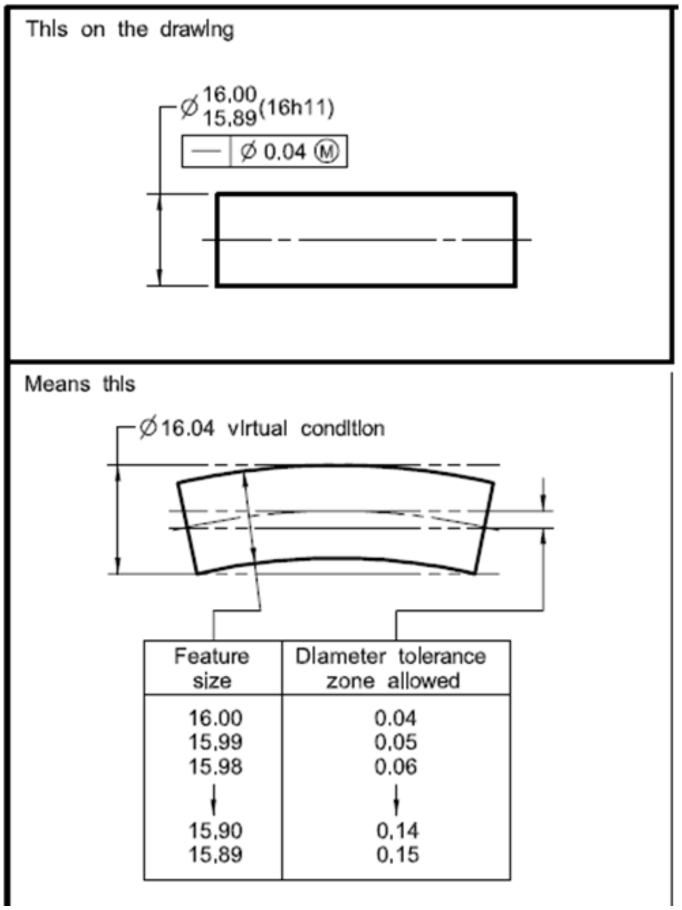
Ensure straightness tolerance zones for derived median lines (DML) (the axis) are specified for all features with two parallel surfaces or cylinders regardless of feature size.

- Straightness for derived median lines is necessary to minimize torsion that could cause issues for a manual or automated assembly process due to insertion and / or alignment of parts.



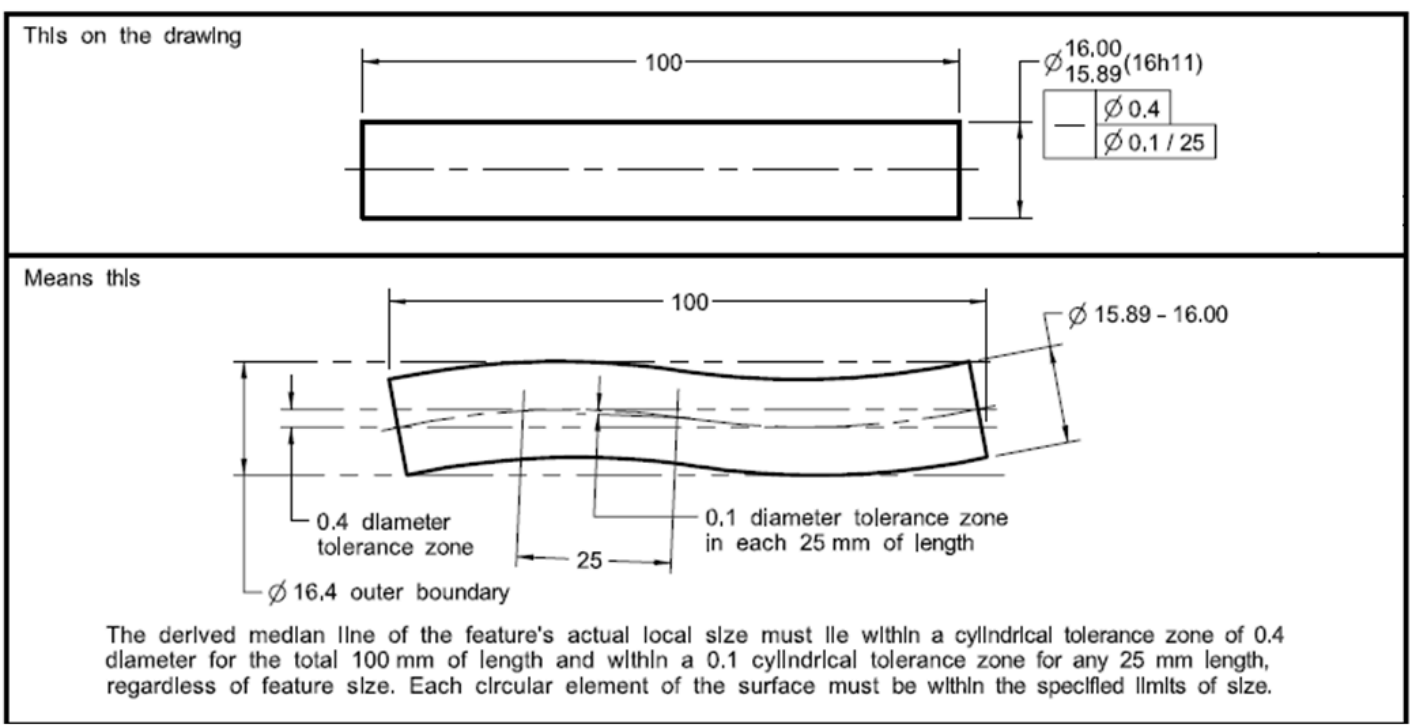
Ensure the straightness tolerances specified for all applicable exterior surfaces or derived median lines are still acceptable when max material condition (MMC) and / or least material condition (LMC) are considered.

- Straightness tolerances that consider max material condition and / or least material condition are necessary to control either virtual condition (VC) or resultant condition (RC) issues for a product that requires precision on features, proper sealing, cosmetics or could affect alignment of parts.



Ensure the straightness tolerances for unit lengths are specified for all applicable derived median lines within a tolerance zone for the total length of cylindrical features.

- Straightness tolerances for unit lengths are necessary to minimize torsion that could cause issues for a manual or automated assembly process due to insertion and / or alignment of parts.

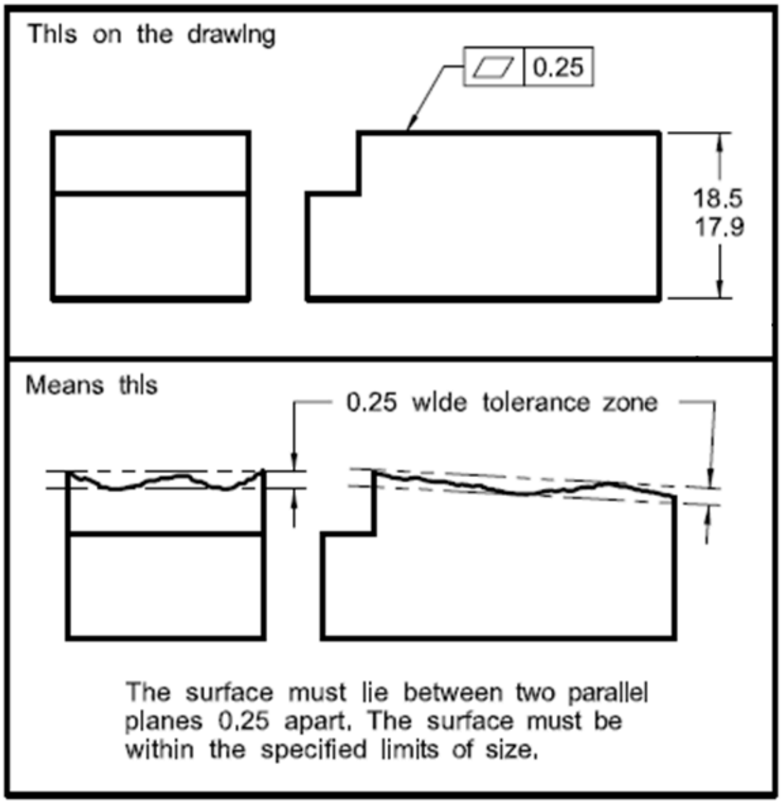


CID: 4	Content Owner: Jabil	Content Type: Requirement

Flatness Tolerances:

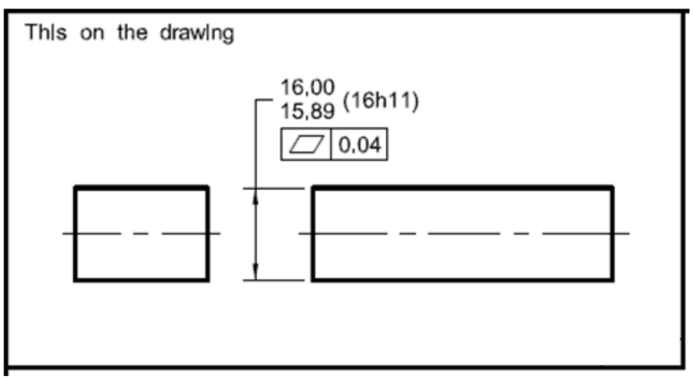
Ensure flatness tolerance is specified for all applicable features.

- Flatness tolerances are necessary to avoid issues for a product that requires precision on features, proper sealing, cosmetics or could affect alignment of parts.



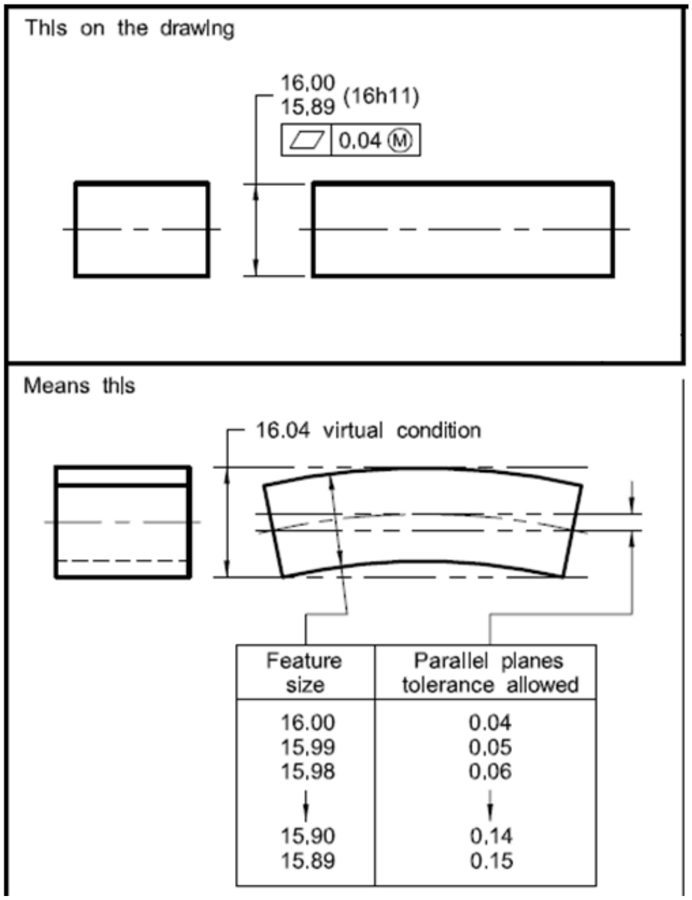
Ensure flatness tolerance zones for derived median planes (DMP) are specified for all applicable features regardless of feature size.

- Flatness for derived median planes regardless of feature size is necessary to minimize torsion that could cause issues for a manual or automated assembly process due to insertion and / or alignment of parts.



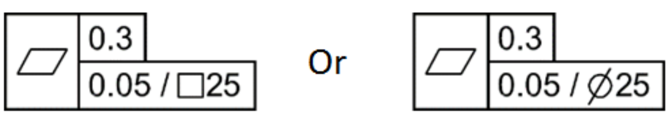
Ensure the flatness tolerances specified for all applicable exterior surfaces or derived median planes are still acceptable when max material condition and / or least material condition are considered.

- Flatness tolerances that consider max material condition are necessary to control either virtual condition or resultant condition issues for a product that requires precision on features, proper sealing, cosmetics or could affect alignment of parts.



Ensure the flatness tolerances for unit lengths are specified for all applicable derived median planes within a tolerance zone for the total length of features.

- Flatness tolerances for unit lengths are necessary to minimize deformation that could cause issues during the assembly process due to insertion and / or alignment of parts.

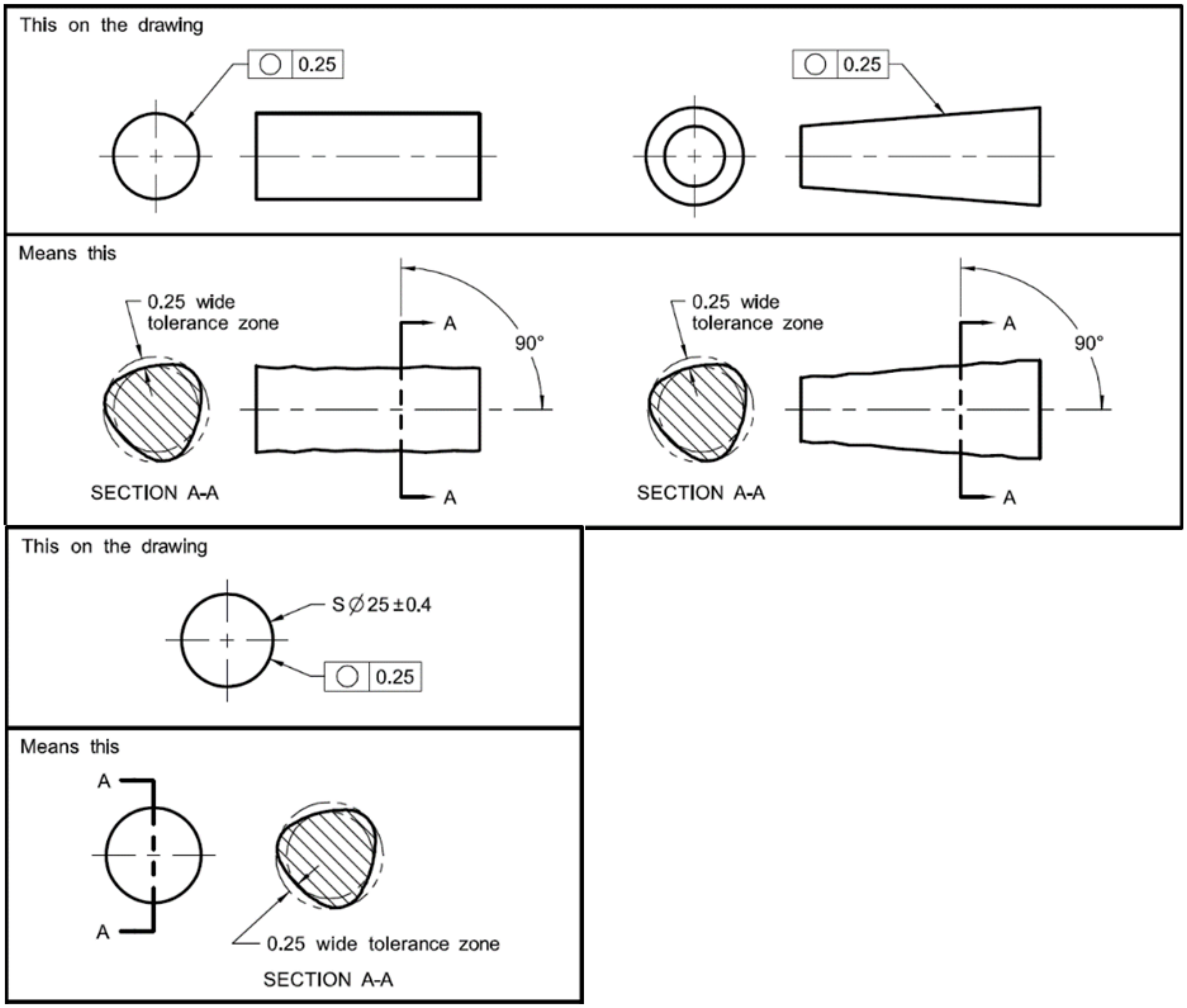


CID: 5	Content Owner: Jabil	Content Type: Requirement

Circularity Tolerances:

Ensure circularity tolerance is specified for cylinders, cones and spheres.

- Circularity tolerances are necessary to avoid issues for a product that could occur during the assembly process due to insertion and / or alignment of parts.

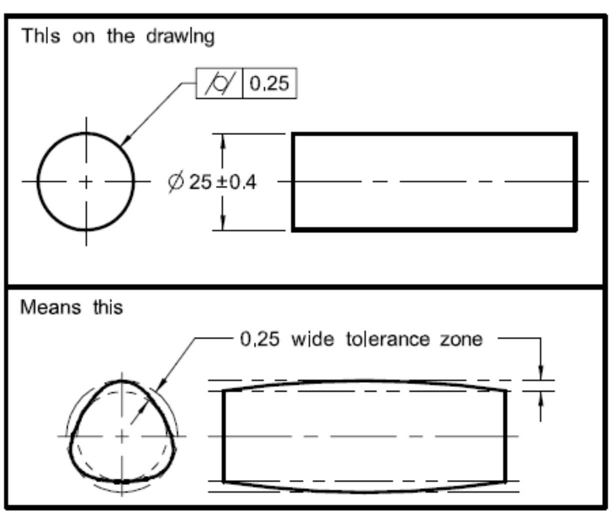


CID: 6 Content Owner: Jabil Content Type: Requirement

Cylindricity Tolerances:

Ensure cylindricity tolerance is specified for cylindrical features.

- Cylindricity tolerances are necessary to avoid issues for a product that could occur during the manual or automated assembly process due to insertion and / or alignment of parts.



DFA > GD&T > GD&T
Entry ID: 1674

Tolerances of Profile

Guideline

CID: 2	Content Owner: Jabil	Content Type: Information

Introduction:

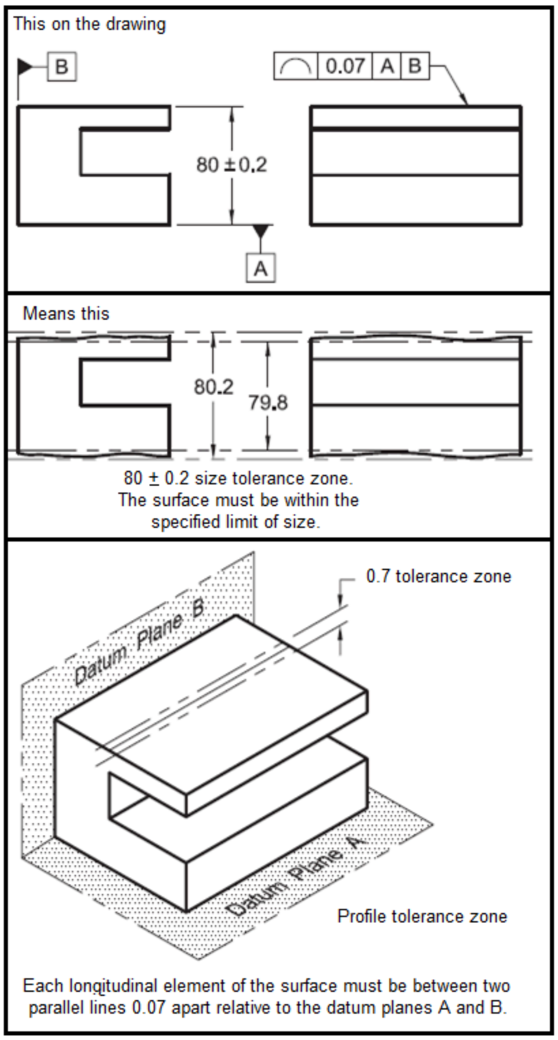
This entry establishes the GD&T principles and methods of dimensioning and tolerancing to control the profile of features. Profile tolerance zones are used to control form or combinations of size, form, orientation and location of features relative to a true profile. It is necessary to ensure profile tolerances are clearly documented to control and avoid potential issues during manual and automated assembly and so that the product functions as expected.

CID: 3	Content Owner: Jabil	Content Type: Requirement

Profile of a Line Tolerances:

Ensure the profile of a line tolerance is specified for irregular surfaces or features.

- Profile of a line tolerances are often used for aerodynamic features and are necessary to avoid issues for a product that could occur during the assembly process due to insertion and / or alignment of parts. Please ensure the profile of a line tolerance is specified for irregular surfaces or features.

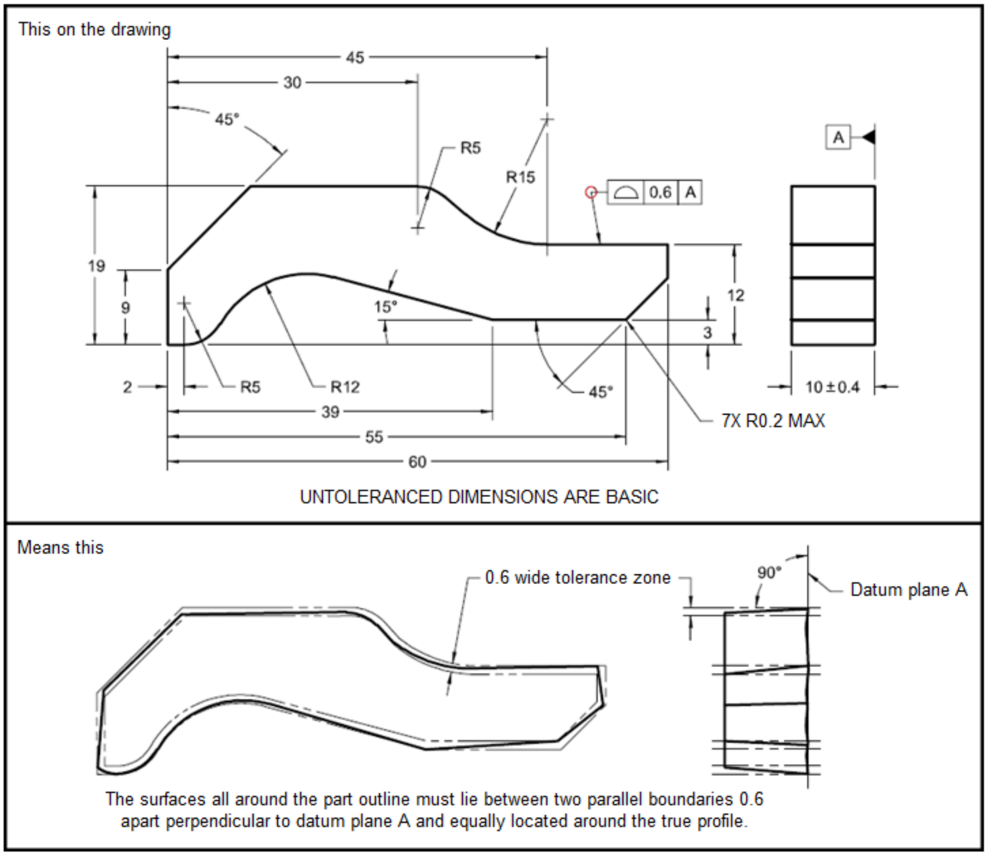


CID: 4	Content Owner: Jabil	Content Type: Requirement

Profile of a Surface Tolerances:

Ensure the profile of a surface tolerance is specified for 3 dimensional (all around or all over) surfaces or features.

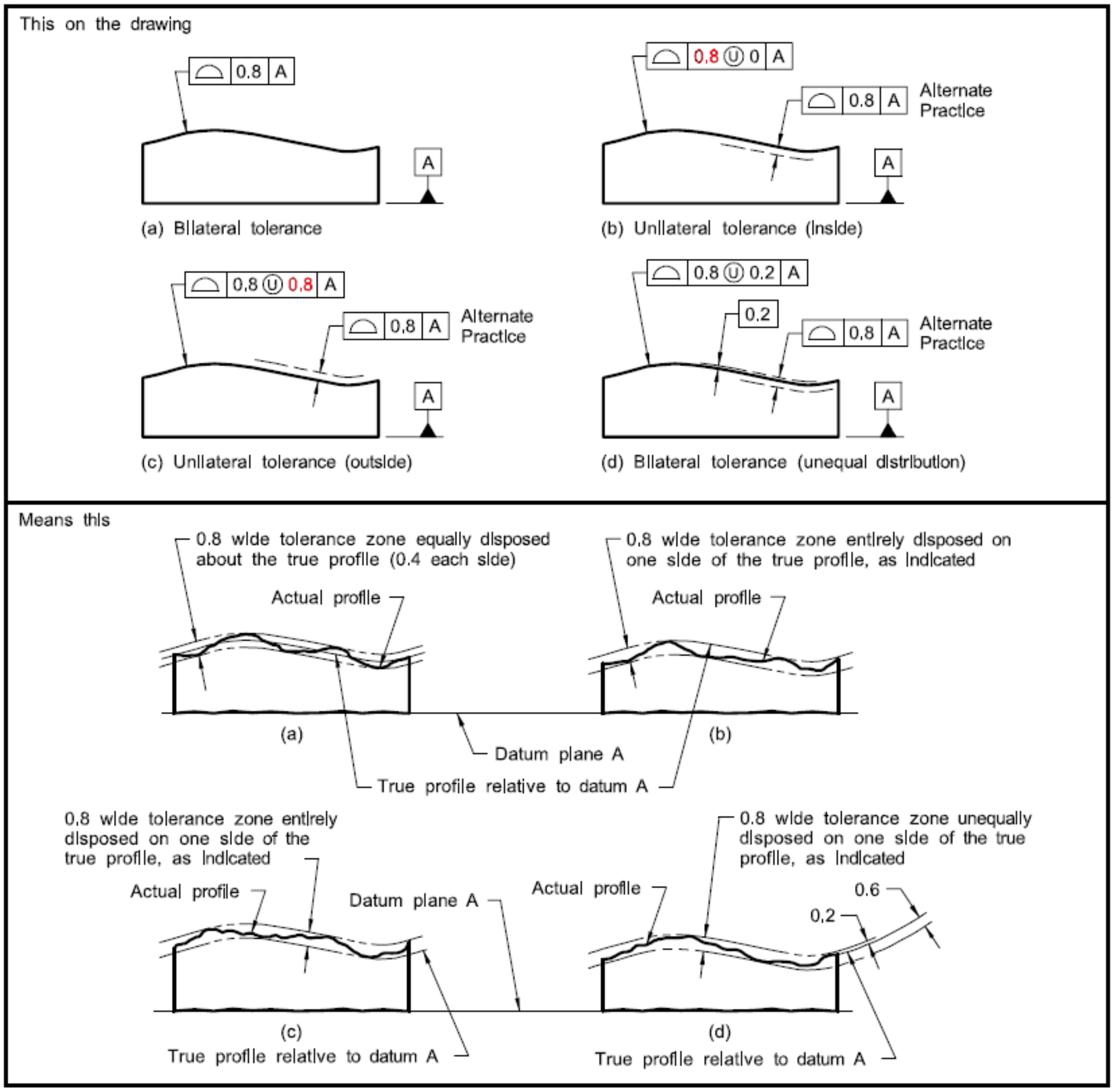
- Profile of a surface tolerances are often used for aerodynamic features and are necessary to avoid issues for a product that could occur during the assembly process due to insertion and / or alignment of parts.



Profile of a Surface Tolerances - Unilateral:

Ensure the profile of a surface unilateral tolerance is specified for 3 dimensional surfaces or features.

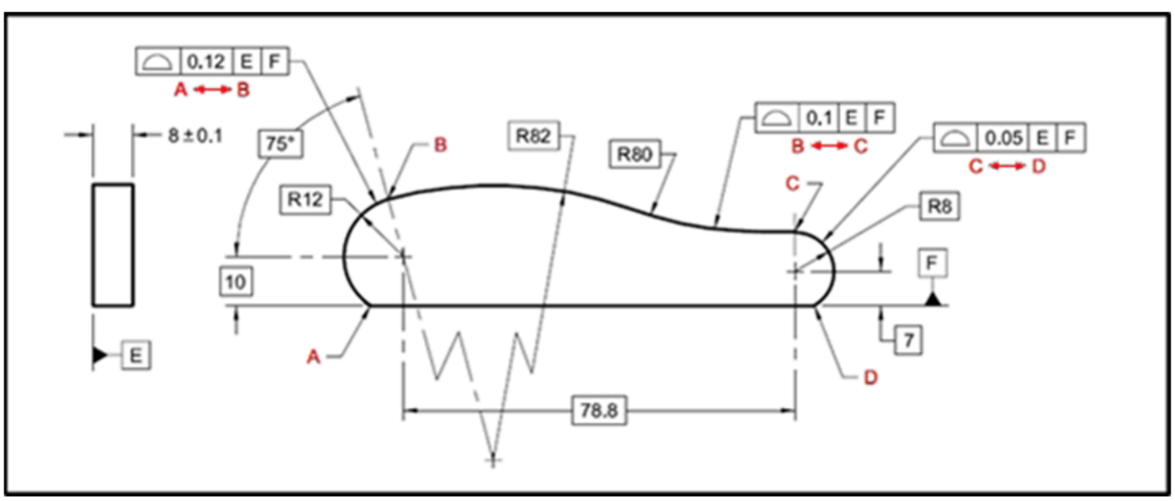
- Profile of a surface unilateral tolerances are often used for contoured surfaces that can be mathematically defined like ergonomic or aesthetic surfaces and are necessary to avoid issues for a product that could occur during the assembly process due to insertion and / or alignment of parts.



Profile of a Surface Tolerances - Segment:

Ensure the profile of a surface segment tolerance is specified for different portions of the true profile that have different tolerances for the designated areas.

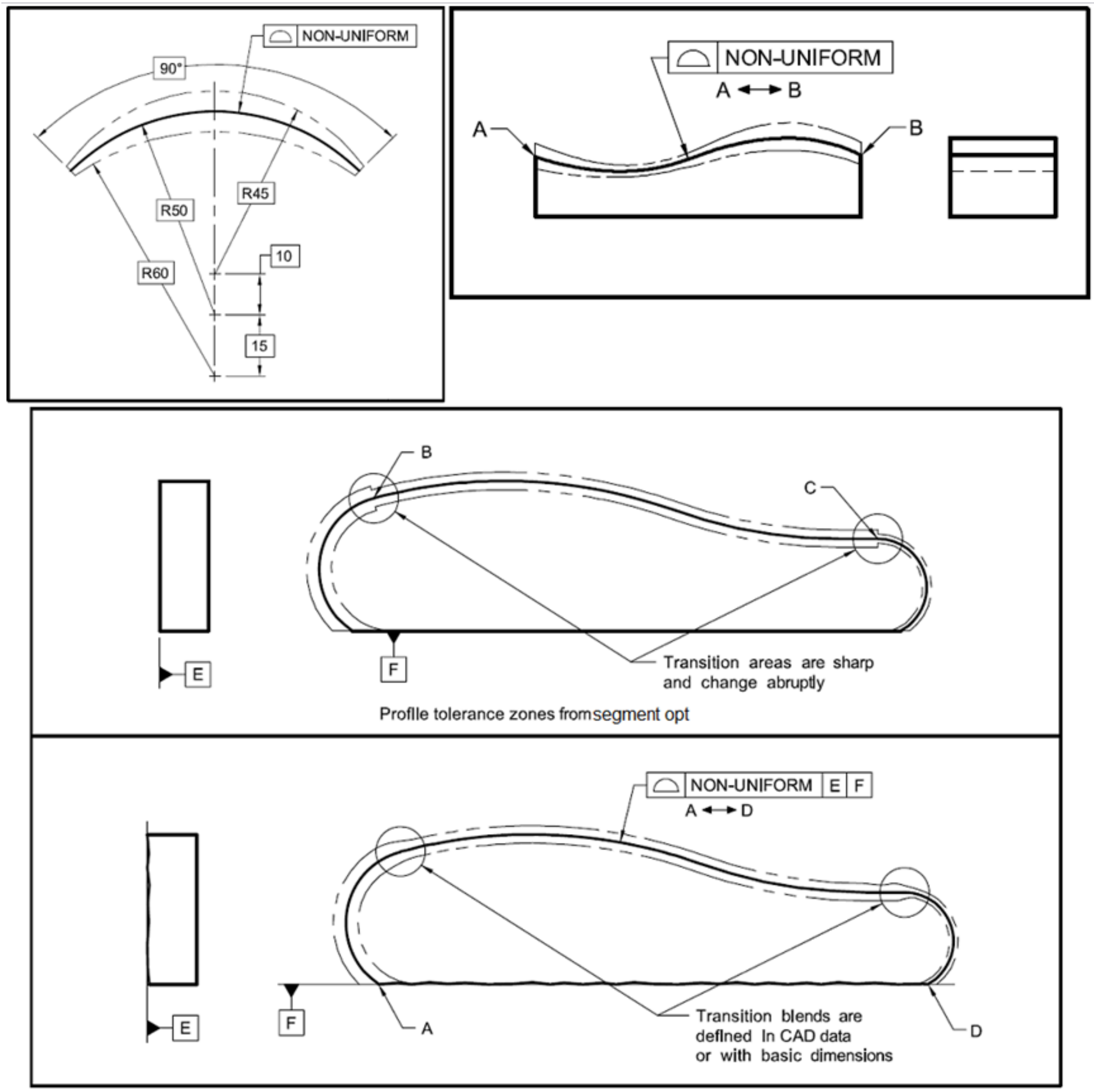
- Profile of a surface tolerances for segments are often used for aerodynamic features and are necessary to avoid issues for a product that could occur during the assembly process due to insertion and / or alignment of parts.



Profile of a Surface Tolerances - Non-Uniform Zone:

Ensure the profile of a surface non-uniform zone tolerance is specified for sophisticated surface requirements over the true profile of the designated portions of the part.

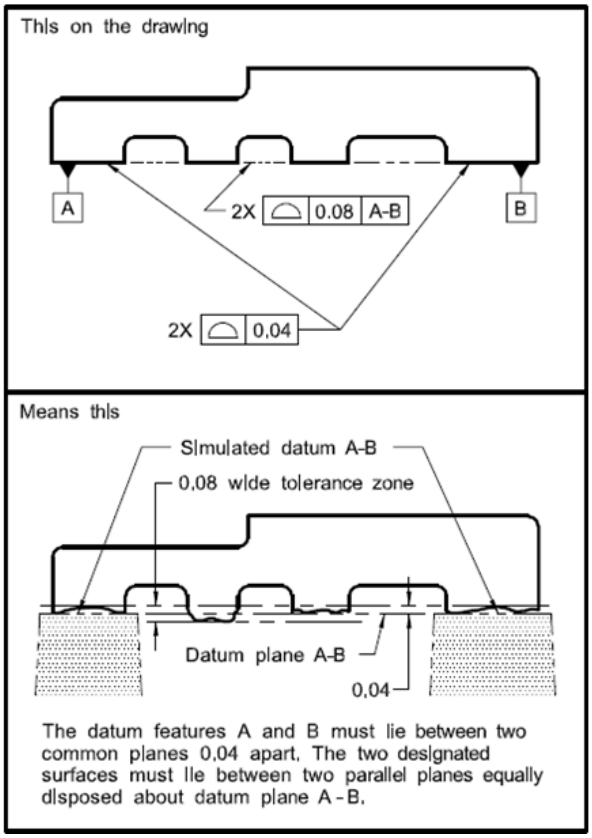
- Profile of a surface tolerances for non-uniform zones are often used for aerodynamic and complex features and are necessary to avoid issues for a product that could occur during the assembly process due to insertion and / or alignment of parts.

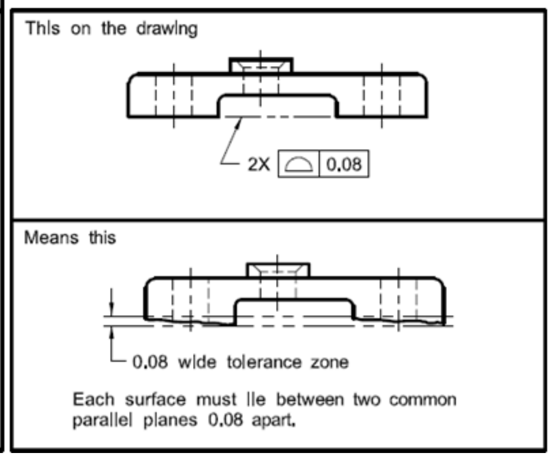


Profile of a Surface Tolerances - Coplanar Surfaces:

Ensure the profile of a surface coplanar surfaces tolerance is specified for two or more surfaces that require having all elements in one plane over the true profile of the designated features of the part.

- Tolerances on coplanar surfaces are necessary when two or more surfaces have all elements in one plane with complex features, often mating surfaces, and are necessary to avoid issues for a product that could occur during the assembly process due to insertion and / or alignment of parts.


This on the drawing
A
B
2X ⌓ 0.08 A-B
2X ⌓ 0.04
Means this
Simulated datum A-B
0.08 wide tolerance zone
Datum plane A-B
0.04
The datum features A and B must lie between two common planes 0.04 apart. The two designated surfaces must lie between two parallel planes equally disposed about datum plane A - B.


This on the drawing
2X ⌓ 0.08
Means this
0.08 wide tolerance zone
Each surface must lie between two common parallel planes 0.08 apart.

DFA > GD&T > GD&T
Entry ID: 1682

Tolerances of Runout

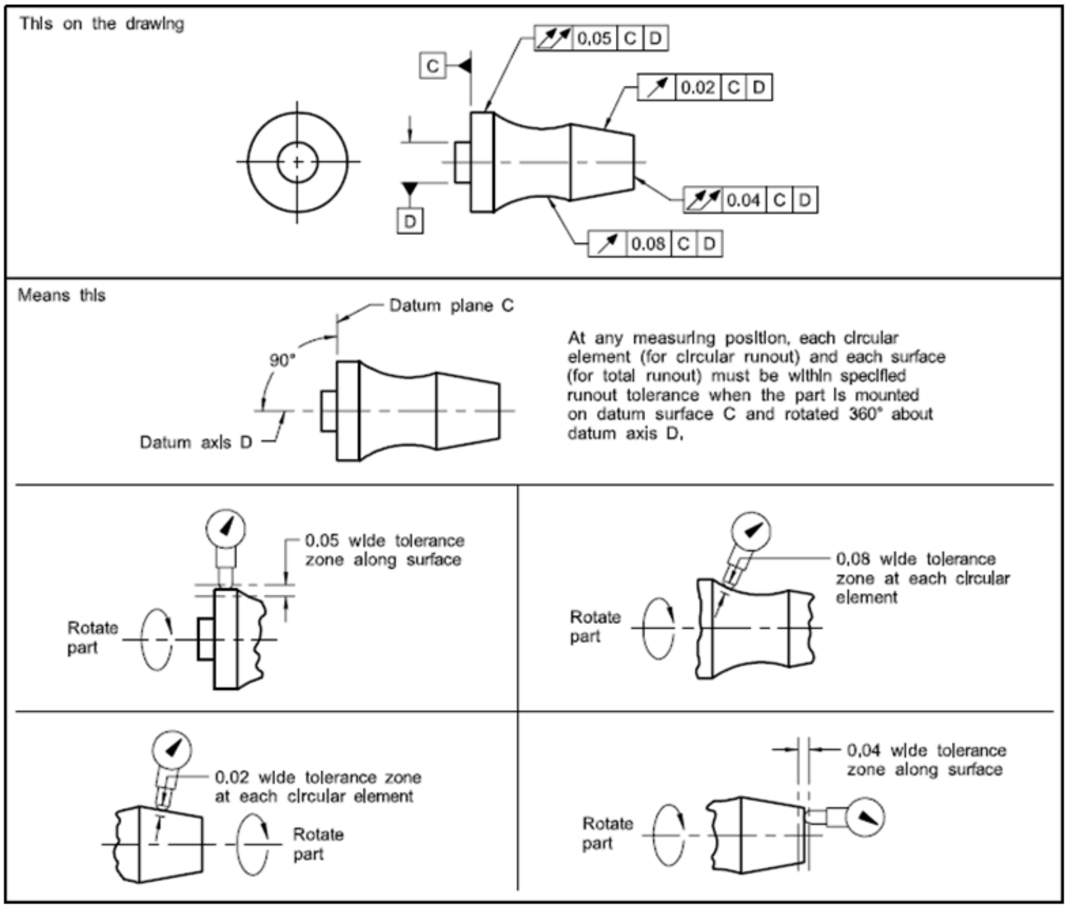
Guideline

CID: 2	Content Owner: Jabil	Content Type: Information

Introduction:

This entry establishes the GD&T principles and methods of dimensioning and tolerancing to control the runout of features. The types of features controlled by runout tolerances include cylindrical surfaces constructed around a datum axis and those constructed at right angles to a datum axis.

Runout tolerances are used to control cylindrical features and are necessary to ensure they are symmetrical relative to a datum axis and are normally utilized to control concentric tolerance zones around the true profile of a feature. Having runout tolerances clearly documented helps to control and avoid potential issues during manual and automated assembly and also so that the product functions as intended.

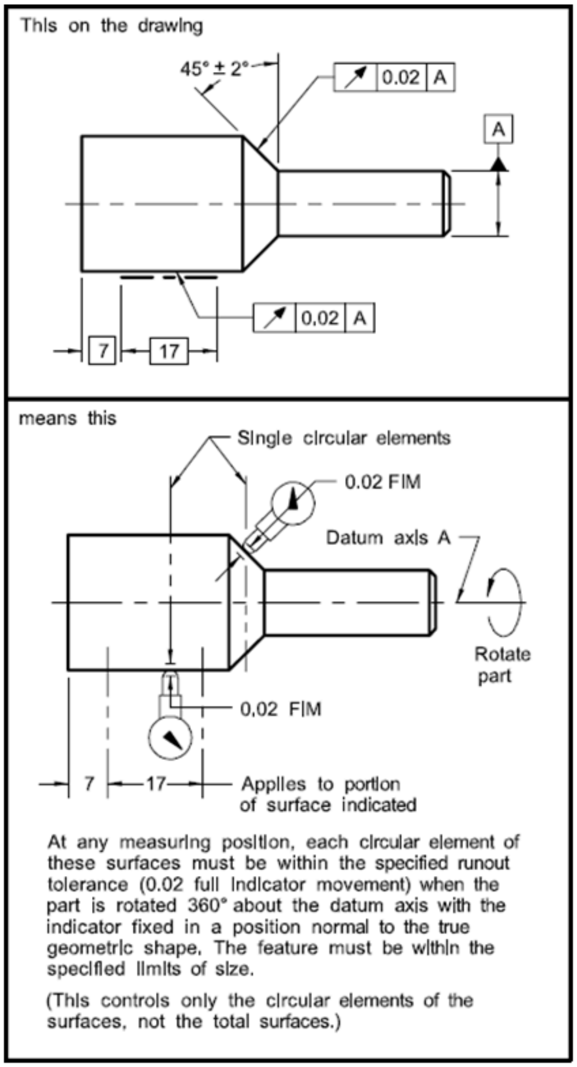


CID: 3	Content Owner: Jabil	Content Type: Requirement

Circular Runout Tolerances:

Ensure the circular runout tolerance is specified for surfaces constructed around a datum axis or at right angles to a datum axis.

- Circular runout tolerances are often used for cylindrical features that rotate and are necessary to avoid issues for a product that could occur during the assembly process due to insertion and / or alignment of parts and also the functionality of the product. Please ensure the circular runout tolerance is specified for surfaces constructed around a datum axis or at right angles to a datum axis.

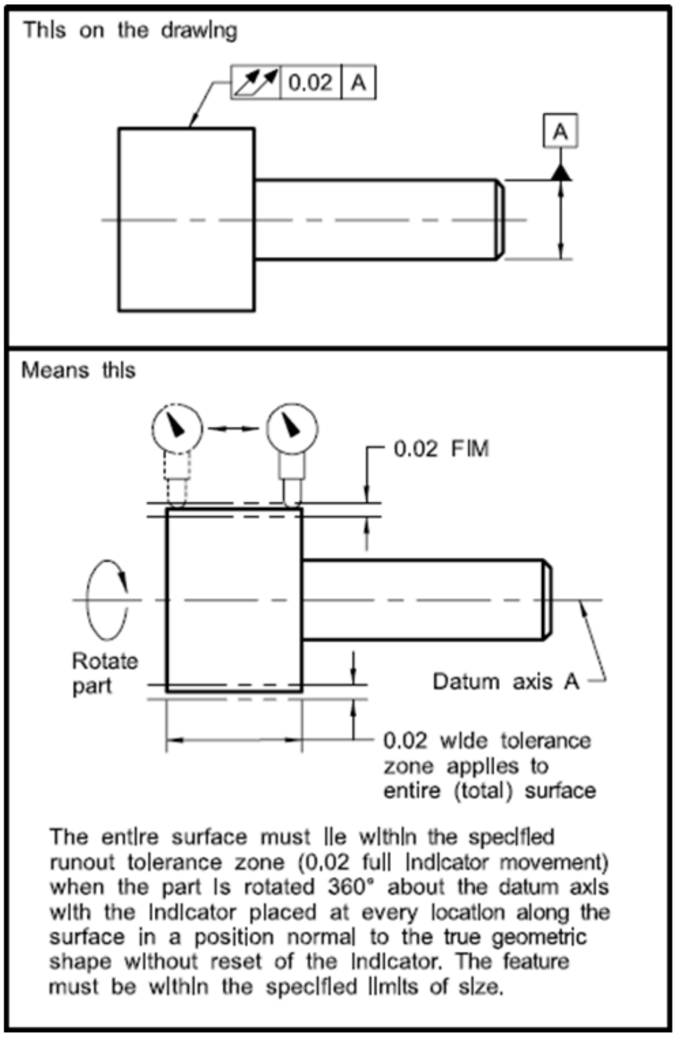


CID: 4	Content Owner: Jabil	Content Type: Requirement

Total Runout Tolerances:

Ensure the total runout tolerance is specified for circular and profile measuring positions as the part is rotated 360 degrees around the datum axis.

- Total runout tolerances are often used for cylindrical features that rotate and are necessary to avoid issues for a product that could occur during the assembly process due to insertion and / or alignment of parts and also the functionality of the product. Please ensure the total runout tolerance is specified for circular and profile measuring positions as the part is rotated 360 degrees around the datum axis.


This on the drawing
0.02
A
A
Means this
0.02 FIM
Rotate part
Datum axis A
0.02 wide tolerance zone applies to entire (total) surface
The entire surface must lie within the specified runout tolerance zone (0,02 full indicator movement) when the part is rotated 360° about the datum axis with the indicator placed at every location along the surface in a position normal to the true geometric shape without reset of the indicator. The feature must be within the specified limits of size.

DFA > GD&T > GD&T
Entry ID: 1688

Tolerances of Orientation

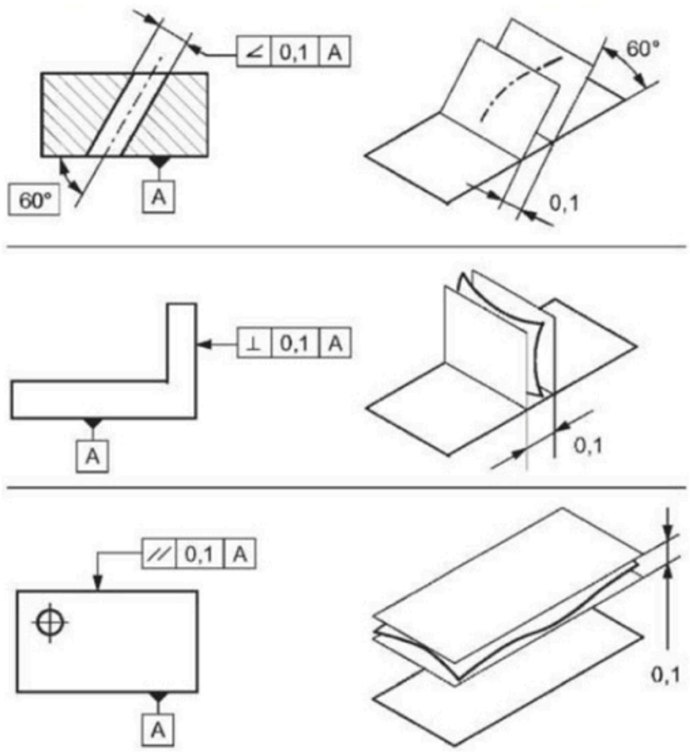
Guideline

CID: 2	Content Owner: Jabil	Content Type: Information

Introduction:

This entry establishes the GD&T principles and methods of dimensioning and tolerancing to control the orientation of features. The types of features controlled by orientation tolerances include a surface, a feature's derived median plane or a feature's derived median line.

Orientation tolerances are used to control parallel, perpendicular, and all other angular relationships, relative to a datum reference, are necessary to ensure they are properly oriented. Having orientation tolerances clearly documented helps to control and avoid potential issues during manual and automated assembly and also so that the product functions as intended.

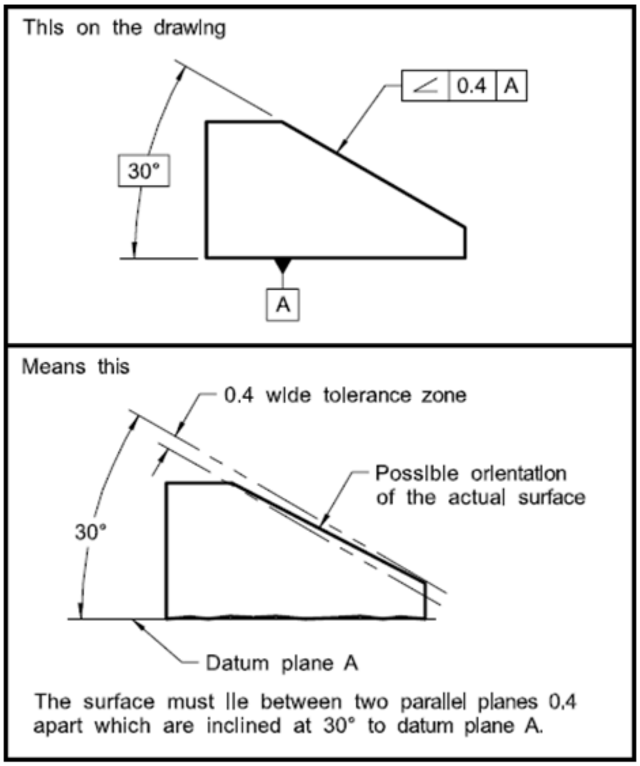


CID: 3	Content Owner: Jabil	Content Type: Requirement

Angularity Tolerance:

Ensure that angularity tolerance is specified on a surface, a feature's derived median plane or a feature's derived median line at the specified basic angle over the designated features of the part.

- Angularity tolerances are often used on surfaces, a feature's center plane or a feature's axis and are necessary to avoid issues that could occur during the assembly process due to insertion and / or alignment of parts and also the functionality of the product. Please ensure the angularity tolerance is specified on a surface, a feature's derived median plane or a feature's derived median line at the specified basic angle over the designated features of the part.

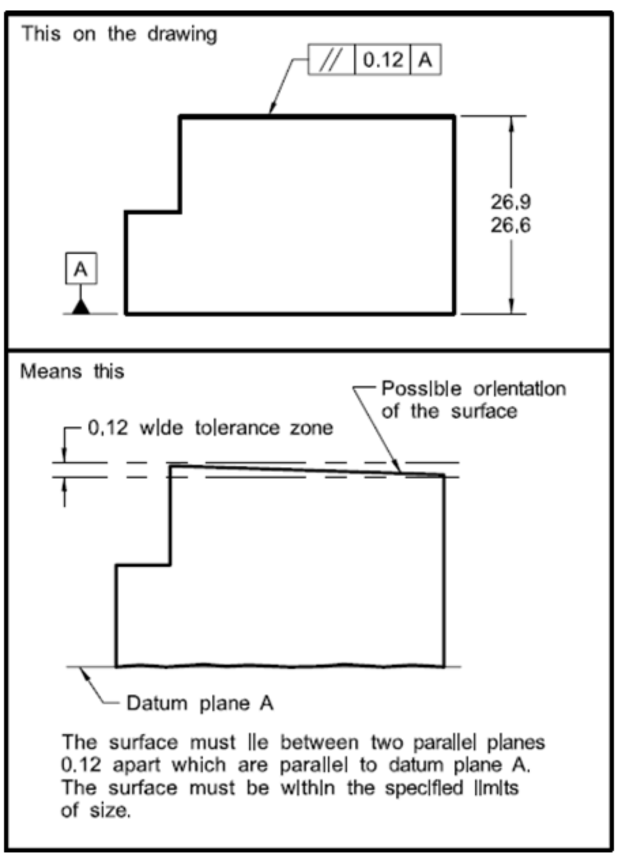


CID: 4	Content Owner: Jabil	Content Type: Requirement

Parallelism Tolerance:

Ensure that parallelism tolerance is specified on a surface or feature's derived median plane (equidistant at all points to the datum plane) or a feature's derived median line at the specified basic angle over the designated features of the part.

- Parallelism tolerances are often used on a surface or feature's center plane, equidistant at all points from a datum plane; or a feature's axis and are necessary to avoid issues that could occur during the assembly process due to insertion and / or alignment of parts and also the functionality of the product. Please ensure that parallelism tolerance is specified on a surface or feature's derived median plane (equidistant at all points to the datum plane) or a feature's derived median line at the specified basic angle over the designated features of the part.

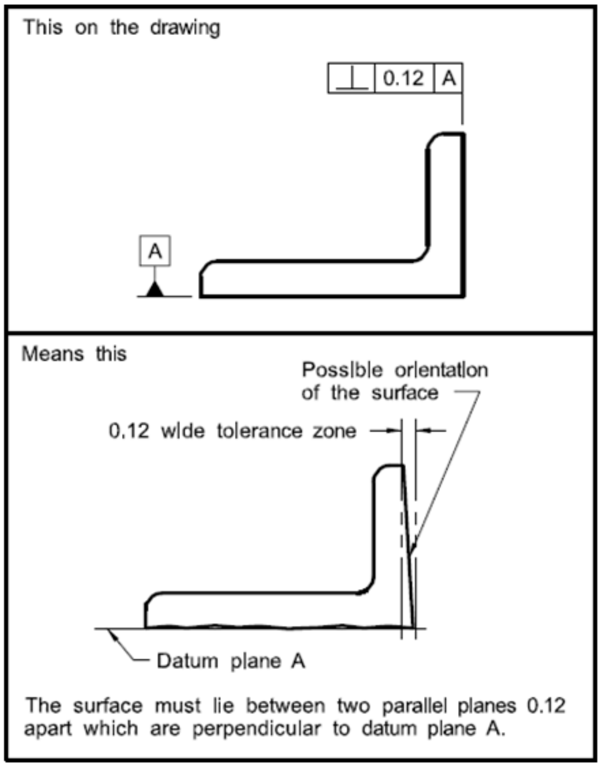


CID: 5	Content Owner: Jabil	Content Type: Requirement

Perpendicularity Tolerance:

Ensure that perpendicularity tolerance is specified on a surface, feature's derived median plane, or feature's derived median line over the designated features of the part.

- Perpendicularity tolerances are often used on a surface, feature's center plane or feature's axis and are necessary to avoid issues that could occur during the assembly process due to insertion and / or alignment of parts and also the functionality of the product. Please ensure that perpendicularity tolerance is specified on a surface, feature's derived median plane, or feature's derived median line over the designated features of the part.



DFA > GD&T > GD&T
Entry ID: 1694

Tolerances of Location

Guideline

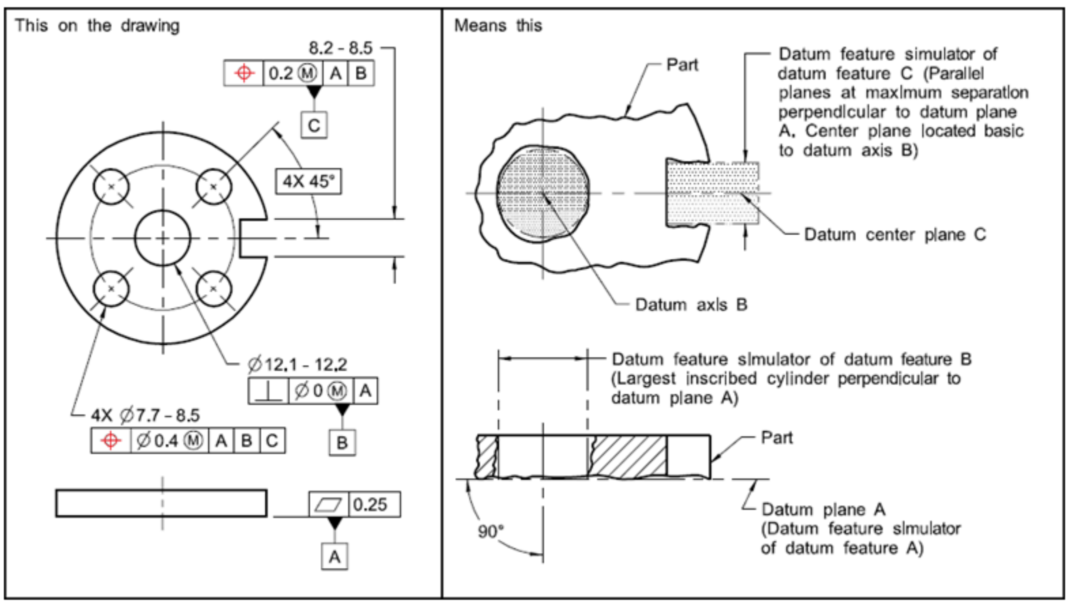
CID: 2	Content Owner: Jabil	Content Type: Information

Introduction:

This entry establishes the GD&T principles and methods of dimensioning and tolerancing to control the location of features. The types of features controlled by location tolerances include:

- The center distance between features of size (FOS) such as holes, slots, bosses, and tabs.
- The location of features of size as a group, from datum features, such as plane and cylindrical surfaces.
- The coaxiality or concentricity of features of size.
- The symmetry of features of size — center distances of correspondingly located feature elements equally disposed about a datum axis or plane.

Location tolerances are used to control position, concentricity and symmetry relative to a datum reference and are necessary to ensure they are properly located. Having location tolerances clearly documented helps to control and avoid potential issues during manual and automated assembly and also so that the product functions as intended.

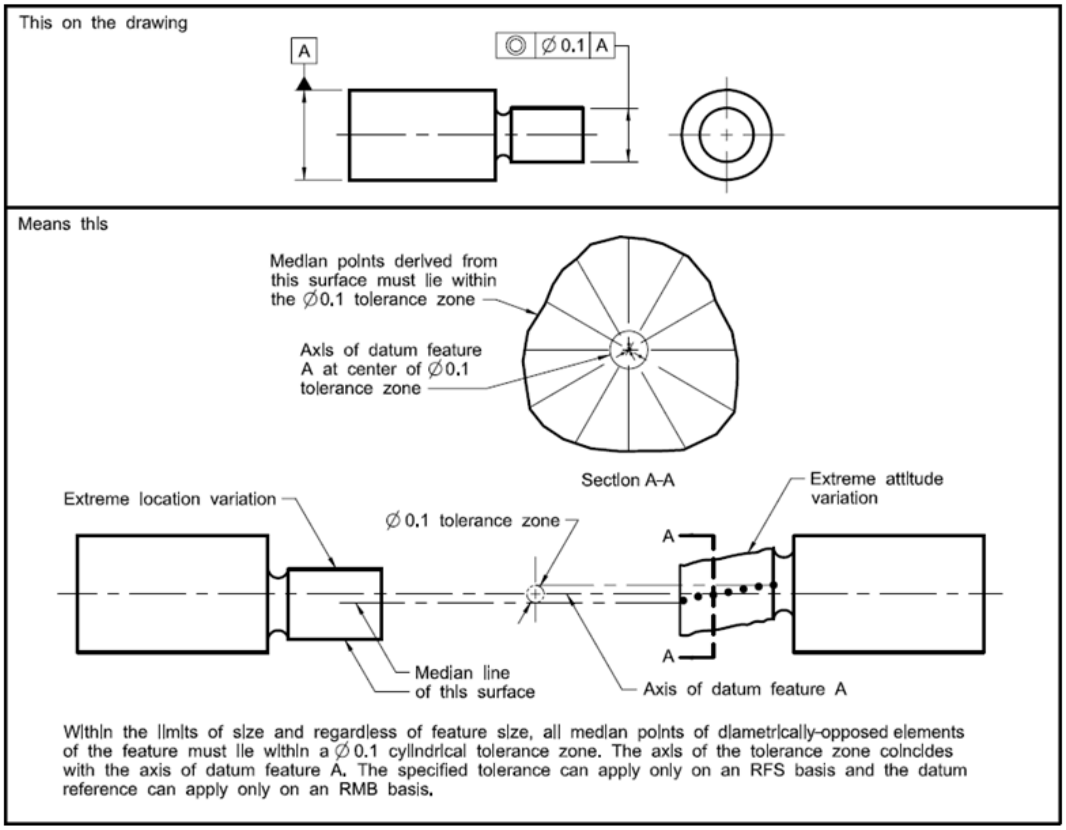


CID: 3	Content Owner: Jabil	Content Type: Requirement

Concentricity Tolerance:

Ensure that concentricity tolerance is specified as a cylindrical or spherical tolerance zone for median points or a derived median line of all diametrically opposed elements of a surface and are congruent with a datum axis.

- Concentricity tolerances are often used on cylindrical or spherical surfaces and are necessary to avoid issues that could occur during the assembly process due to insertion and / or alignment of parts and also the functionality of the product. Please ensure that concentricity tolerance is specified as a cylindrical or spherical tolerance zone for median points or a derived median line of all diametrically opposed elements of a surface and are congruent with a datum axis.

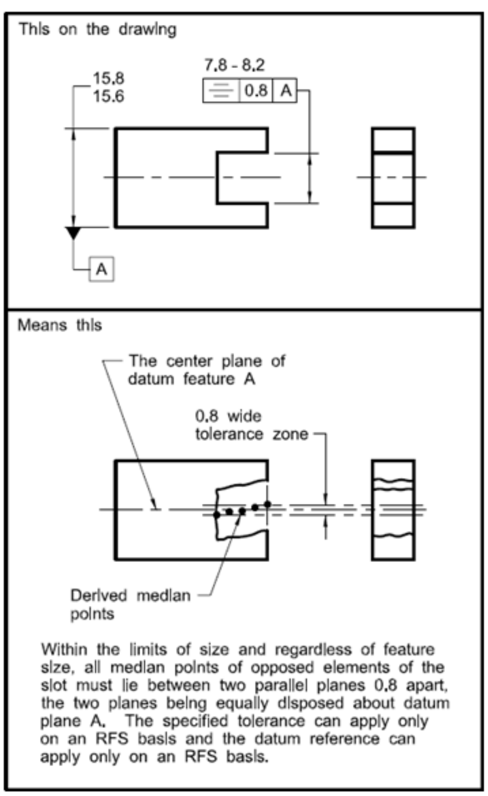


CID: 4	Content Owner: Jabil	Content Type: Requirement

Symmetry Tolerance:

Ensure that symmetry tolerance is specified on a surface, feature's derived median plane or datum axis over the designated features of the part.

- Symmetry tolerances are often used on surfaces, feature's center planes or feature's axis and are necessary to avoid issues that could occur during the assembly process due to insertion and / or alignment of parts and also the functionality of the product. Please ensure that symmetry tolerance is specified on a surface, feature's derived median plane or datum axis over the designated features of the part.

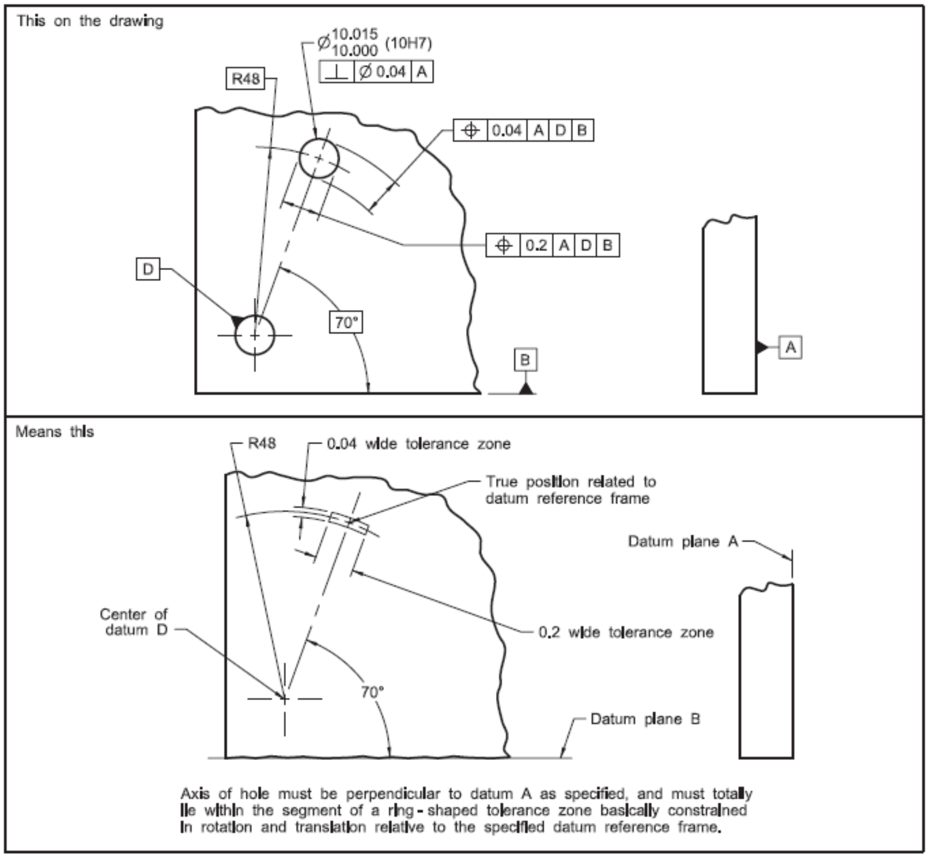


CID: 5	Content Owner: Jabil	Content Type: Requirement

Position Tolerance:

Ensure that position tolerance is specified for perpendicularity, parallelism and symmetry and is specified as a cylindrical or derived median plane tolerance zone for a derived median line over the designated features of the datum feature simulator.

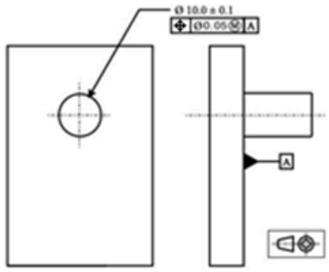
- Position tolerances to control perpendicularity, parallelism and symmetry are often used on a feature's center planes or a feature's axis and are necessary to avoid issues that could occur during insertion and / or alignment of parts during assembly and also the functionality of the product. Please ensure that position tolerance is specified for perpendicularity, parallelism and symmetry and is specified as a cylindrical or derived median plane tolerance zone for a derived median line over the designated features of the datum feature simulator.



True Position Tolerance Using Maximum Material Condition or Least Material Condition:

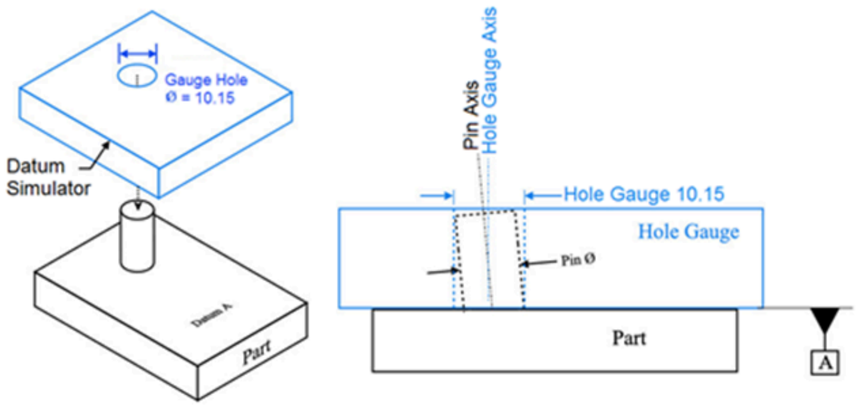
Ensure that true position using maximum material condition (MMC) or least material condition (LMC) tolerances are specified as a cylindrical or derived median plane tolerance zone for a derived median line over the designated features of the datum feature simulator at it's material boundary.

- Position at its maximum material condition (MMC) or least material condition (LMC) is often used on a feature's center planes or a feature's axis and are necessary to avoid issues that could occur during insertion and / or alignment of parts during assembly and also the functionality of the product. Please ensure that true position using MMC or LMC tolerances are specified as a cylindrical or derived median plane tolerance zone for a derived median line over the designated features of the datum feature simulator at it's material boundary.



This is on drawing

Means This



DFA > GD&T > GD&T
Entry ID: 1712

Tolerance Stackup Analysis

Information

CID: 1	Content Owner: Jabil	Content Type: Information

This Tolerance Stackup Analysis (TSA) spreadsheet was created as a global tool for all DFA engineers.

It is recommended that you pull a fresh copy of the file for each analysis because the spreadsheet may have changed during the most recent release of the KnowledgeBase.

Tolerance Stackup Analysis Spreadsheet [File is located in the "File Attachments" folder.]

Establish a team naming convention for the spreadsheets that everyone will understand. This will be helpful if the files are stored in a central location.

The Tolerance Analysis Process

1. Understand your problem. Why are you analyzing the gap, compression, alignment or overlap? What kind of gap, compression, alignment or overlap do you need? How are the parts interacting with each other? What should the results tell you when you are done?
2. Write a problem statement. Are you analyzing a maximum case or a minimum case gap, compression, alignment or overlap? Why are you analyzing this gap, compression, alignment or overlap? Answering these questions will help others to understand your loop as well as the assumptions you are making.
3. Create a CREO or SolidWorks cross-section drawing of your problem. First, this may help you identify any issues that may have been overlooked within your 3D models. Second, this will help others visualize the gap, compression, alignment or overlap you are analyzing as well as the loop you are using.
4. Enter the desired gap for the assembly based on customer requirements or specifications. If you are already seeing results in this value that you did not expect, re-evaluate your loop.
5. Enter the nominal temperature, this will represent the normal conditions to which the product will be exposed. Enter the minimum temperature and maximum temperature the product could be exposed to, this will help to determine how parts could behave at difficult temperature conditions and how gaps or alignment could be affected by temperature conditions.
6. Select the appropiate material involved on the assembly based on customer requirements or specifications. This will help to determine how temperature will affect the expansion coefficient in the result of the analysis.
7. Assign a reference letter for the figure or image (i.e. - A,B,C,etc.) and a direction vector (**+/-** 1) to each dimension in your loop. This will help others follow the flow of your loop. In addition, this will help you make a simple transition from the CREO / SolidWorks drawing to the spreadsheet. If the result is negative, please re-enter the information with a different sign; either (**+**) or (**-**) so the result will be positive (**+**)
8. Develop the loop equation (i.e. A+B-C-D-g=0) by entering the nominal dimensions in the spreadsheet. This is a good sanity check to make sure that you have the appropriate vectors applied to your dimensions.
9. Assign a tolerance to each dimension. Try to use industry standards (**+/-**) whenever possible.
10. Define PPK for each entered dimension, this will help to determine a statistical result for the analyzed gap.
11. In the analysis result, review the sum of your total tolerance.
12. Determine your worst case conditions. Verify the dimension analysis graph, how the minimum and maximum gaps behave with the worst case tolerance.
13. The PPM graph shows how the assembly will behave during production based on 127 simulated samples over a long period of time.
14. The dimensional analysis shows the gap, compression, overlap or alignment result. This is the purple vertical line located on the graph. The Z Lspec and C Uspec represents the minimum and upper tolerance entered on the target X data in the spreadsheet. With this result try to demonstrate how the purple vertical line tends to be located, if it is on the lower tolerance or at the upper tolerance.
15. Apply statistical tolerance analysis where applicable.

CID: 2	Content Owner: Jabil	Content Type: Information

Loop Diagram Best Practices

- Create a closed loop diagram using vectors from starting surface to ending surface.
  - Horizontal dimension loops: start on left of gap.
  - Vertical dimension loops: start on bottom of gap.
- Do not include gaps when selecting the path for the dimension loop.
- Each vector represents a dimension.
- Use an arrow to show the direction of each vector in the dimension loop.

- Identify each vector as positive (**+**) or negative (**-**)
    - For horizontal dimensions:
        - **+** dimensions from left to right
        - **-** dimensions from right to left
    - For vertical dimensions:
        - **+** dimensions from bottom to top
        - **-** dimensions from top to bottom
- Assign a variable name or letter to each dimension in the loop.

DFA > Seals / Gaskets > Seals / Gaskets
Entry ID: 1750

General Information for Seals / Gaskets

Information

CID: 1	Content Owner: Jabil	Content Type: Information

Introduction:

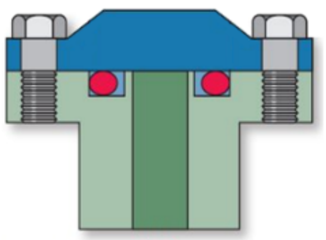
A mechanical seal is a device that joins systems or mechanisms by preventing leakage (e.g. in a plumbing system), containing pressure or excluding contamination. A seal effectiveness depends on adhesion in the case of sealants and compression in the case of gaskets.

CID: 2	Content Owner: Jabil	Content Type: Information

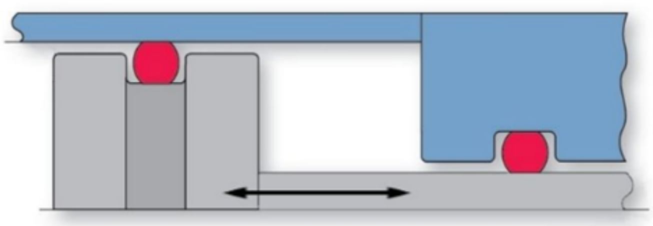
Applications:

Sealing applications are divided into three categories:

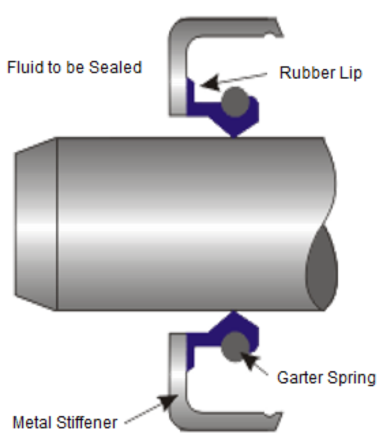
- Static seal – applications where there is no movement.



- Dynamic seal – applications where there is linear motion or slow rotation or oscillation, less than 50FPM (15 meters per minute).



- High speed rotation - applications are classified as rotary if the surface speed is greater than 50FPM (15 meters per minute).



CID: 3	Content Owner: Jabil	Content Type: Information

Adhesives / Fluid Sealants:

Sealant is utilized in domestic and industrial applications to fill unwanted gaps and openings that could allow seepage of liquids, gases or particulate matter.

For efficiency and precision in production an automatic dispenser is often used. A curing process is required and the methods (room temperature, anaerobic curing, UV curing etc.) depend on what type of sealant is used.

If the assembly of a mating part is required, compression may be required to create the seal.

O-rings / Gaskets:

An O-ring, also known as a packing or toric joint, is a mechanical gasket in the shape of a torus. It is a loop of elastomer with a round cross-section, designed to be seated in a groove and compressed during assembly between two or more parts creating a seal at the interface.

A gasket is a mechanical seal which fills the space between two or more mating surfaces, generally to prevent leakage from or into the joined objects while under compression.

Back-up Rings:

A back-up ring is a ring of hard, extrusion resistant material such as high durometer nitrile, nylon, Hytrel, or PTFE (a generic compound of teflon) or Viton. They are not seals themselves but are usually used in conjunction with o-rings in high pressure applications for support or as spacers.

Nitrile and PTFE are the most commonly used. Typically nitrile comes in a solid ring, with one side concaved to fit the o-ring. Generally, PTFE comes in single turn scarf cut, solid or a spiral of two turns.

Solid Contoured Section   Solid Flat Section   Split   Spiral

Inch sizes are produced to Aerospace Standard 568, just like o-rings and quad-rings. When selecting a back-up ring, the three most important specifications to be aware of are:

- Inner dimension of the ring, or the outer dimension of the shaft on which the back-up rings will be applied
- Radial cross-section of the seal
- Ring thickness, or the axial width of the cross section of the ring. Thickness is calculated as (ring outer diameter minus ring inner diameter) / 2

Note: if there is only 1 back up ring, it must be placed on the low pressure side of the system.

CID: 4	Content Owner: Jabil	Content Type: Information

Reasons for O-ring Failure:

Failures are usually due to a number of causes and typically include environmental issues. For example, excess friction causes heat which in return causes the o-ring to swell, therefore exposing the o-ring to a possibly harsher chemical or environment.

Some of the failure modes can include what's referred to as extrusion, nibbling, non-filled or breaking and cracking.

Successful O-ring   Extrusion & Nibbling   Non-Filled   Breaking or Cracking

Such affects may be compounded due to human error in overlooking critical elements of gland design, including but not limited to: preliminary testing, proper o-ring compound use, poor installation, lack of proper maintenance or lubrication. Some of the more common reasons for o-ring failure are as follows:

- incorrect o-ring size
- incorrect installation
- poor maintenance or lack of lubrication
- incompatibility of the elastomer and the environment, including heat or cold

These problems can be difficult to evaluate so it is strongly recommended that adequate testing be performed in the intended environmental setting.

Related Entries

DFA	Information	1751	Seals / Gaskets > Seals / Gaskets > Gasket Design and Material Selection
DFA	Guideline	1783	Seals / Gaskets > Seals / Gaskets > Seals / Gaskets

DFA > Seals / Gaskets > Seals / Gaskets

Entry ID: 1751

Gasket Design and Material Selection

Information

CID: 2	Content Owner: Jabil	Content Type: Information

Gasket Design:

Gasket design in an enclosure is as critical in forming a good seal as the gasketing material itself. Design will have a significant effect on functionality, aesthetics and overall performance.

Stripping:

Supplied in rolls of material slit to a specified width that can be cut to length by the assembler. Low scrap rate makes stripping cost effective, however, corner seams may make the system susceptible to wear and leakage if not properly designed and assembled. Examples of corner seams include:

Butt Miter Joint Dove Tail

Die-Cut:

Die-cut gaskets are most common when the complexity of the design does not allow for stripping or when the overall size does not result in large center scrap that can be minimized by designing a "foldout" gasket. Foldouts allow a die-cut to be expanded to its final form without compromising corner sealing.

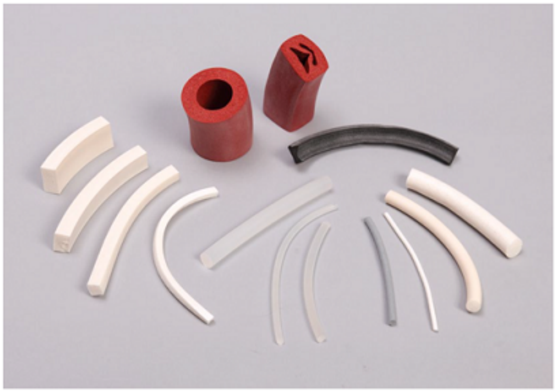
Standard Die-Cut Complex Die-Cut Fold Out Gasket

Form In Place:

Dispensing equipment can be used to automate applying an elastomer in liquid form directly into a device or enclosure. This liquid then foams and cures at room temperature. Form in place is most beneficial when the gasket design is very complex or would result in significant yield loss with a die-cut. Available foam chemistries are very limited, mainly polyurethane, and the initial cost of the dispensing system is high.

Bulb Extrusions:

Extrusions can be tailored for abrasion and / or environmental resistance by using very durable elastomers. The hollow center allows for compressibility as the material may be naturally firm. The skinned surface on all sides combined with a high density minimizes any liquid ingress. Extrusions are commonly found in automotive and appliance doors. For perimeter seals, these hollow profiles can be made from foam or solid elastomers and can offer a wide range of chemistries and configurations.



Design Considerations:

- Channeling a gasket in a specified position can prevent sliding or moving over time.
- Flat, blade and angled flanges offer specific performance advantages and can affect sealing surface area and compression force.
- Shields and flanges can be designed to protect a gasket from physical damage, UV and chemical exposure.
- Bolts or hinges can be designed to eliminate surface bowing.
- Maximizing gasket wall width helps reduce ingress.
- Avoid stretching a gasket as it can lead to displacement over time.
- Consider material thickness, grade and gap tolerance.
- When mechanical gasket retention features are not available, the gasket must be adhesively bonded to the parts. Adhesives can be messy and awkward to use, adding gasket material with a coating of pressure sensitive adhesive (PSA) is an option.

CID: 1	Content Owner: Jabil	Content Type: Information

Gasket Material Selection:

It's impossible to determine an appropriate material without knowing the temperature, environment, media and pressure the gasket will experience. It's also important to determine the actual range of every parameter and every operating condition. Cleaning with caustic agents, for example, creates very different gasket challenges than handling a benign fluid like milk.

Temperature:

This refers to the temperature of the media. Many elastomers harden when cold, making them less able to resist pressure and reducing their ability to flex as the joint changes size. Neoprene, for example, has a lower limit of -40 ℃ while high performance fluoroelastomer (FKM) can only withstand -23 ℃.

Environment:

Temperature is one factor, sunlight another. A gasket used outdoors in a midwestern winter could see low temperatures while one exposed to the desert sun will get extremely hot. In addition, UV light damages some common gasket materials. NBR, for example, has poor UV resistance while EPDM is more durable.

Media:

Some gasket materials will swell when exposed to oils and others will oxidize rapidly. Brake fluid is incompatible with nitrile rubber and FKM while silicone and EPDM are a poor match for gasoline.

Pressure:

The pressure inside a pipe or enclosure can force gasket material to extrude out sideways. Harder materials generally hold up better but require higher clamping forces. In extreme cases it may be necessary to consider PTFE, spiral-wound or metal gaskets.

RTV Silicone:

If a pressure sensitive adhesive is not capable of wetting out or penetrating a surface, or if the surface is not flat, then liquid adhesive systems that cure at room temperature (RTVs) can be used. When fully cured, these systems bond well to most surfaces but can be messy and labor intensive.

CID: 3	Content Owner: Jabil	Content Type: Information

Material Selection Profiles:

Properties	EPDM	TPE	Silicone
UV Resistance	Very good for black, good for lighter colors	Very good for all colors	Very good for all colors
Welding work	No	Yes	No
Corner molding	Yes	No	Yes
Application temperature range	-40 to 150℃	-40 to 80℃	-60 to 200℃
Colors	Black, sliver gray, light gray, white	Any	Any
Minimum wall thickness	0.8000mm	0.5000mm	0.5000mm
Resistance to chemicals	Good	Good	Very good

Properties	EPDM	TPE	Silicone
Paint compatibility (wood)	Depends on compound used	Very good	Very good
Cyanoacrylate adhesion	Very good	Restricted	Poor
Application with adhesive tape	Good	Limited	Good
Deformation due to packaging	Minor problems	Only certain packaging possible	Minor problems
Co-extrusion	3 components possible	4 components possible	Very difficult

Related Entries

DFA	Information	1750	Seals / Gaskets > Seals / Gaskets > General Information for Seals / Gaskets
DFA	Guideline	1783	Seals / Gaskets > Seals / Gaskets > Seals / Gaskets

DFA > Seals / Gaskets > Seals / Gaskets
Entry ID: 1783

Seals / Gaskets

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Ensure the enclosure standard and regulation codes for sealing methods are documented in the product specifications.

- Not specifying the applicable standards and regulations, such as Ingress Protection could result in safety and / or product reliability issues.

For vapor barriers, ensure closed cell materials are selected for seals / gaskets.

For structural reinforcement, ensure closed cell materials are selected for seals / gaskets.

For sound dampening, ensure open cell materials are selected for seals / gaskets.

If dust or moisture protection is required, ensure open cell materials are selected for seals / gaskets.

- Choosing the wrong cell structure could result in safety and / or product reliability issues.

Ensure the Compression Set Resistance (C-SET) is documented in the product specifications.

- Not specifying the necessary C-SET could result in a poor seal and product reliability issues.

For outside diameter O-rings, maximum stretch = 3%

For inside diameter O-rings, maximum stretch = 5%

- A higher stretch percentage could allow dust or moisture penetration.

Ensure the squeeze percent for O-ring face seals is between 20% and 30%

Ensure the squeeze percent for O-ring static male / female seals is between 18% and 25%

Ensure the squeeze percent for O-ring reciprocating seals is between 10% and 20%

Ensure the squeeze percent for O-ring rotary seals is between 0% and 10%

- An incorrect squeeze percent can result in a shorter life and leaking.

Ensure O-rings fill less than 85% of the seal groove.

- Filling too much of the O-ring groove can result in a shorter life and leaking.

Related Entries

DFA	Information	1750	Seals / Gaskets > Seals / Gaskets > General Information for Seals / Gaskets
DFA	Information	1751	Seals / Gaskets > Seals / Gaskets > Gasket Design and Material Selection

Entry ID: 1149

Overview of Adhesive Tape Technologies

Information

CID: 1	Content Owner: Jabil	Content Type: Information

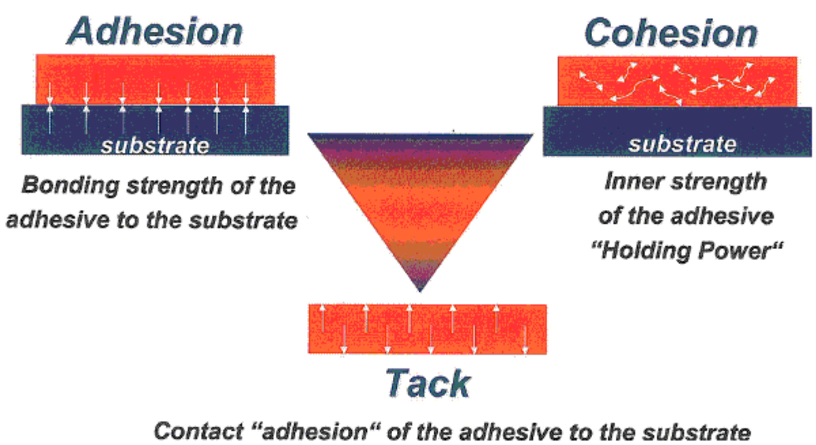
	PSA	HAF
Process	Easy process, no jigs. Just remove protective tape and apply to part	More complex process and dedicated tool needed: Normally 3sec to 10 sec for the application of heat (180-200°C) and pressure (2-5 bar) required. Only applicable in combination with at least one metal part!
Peel Adhesion Bonding Strength	Maximum 15 N/cm² peel adhesion to steel after 14 days	Reachable bonding strength is between 350 and 850 N/cm² (about 5 times higher bonding strength than any PSA tape).
Reliability	The maximum peel adhesion will be reached after some time (days/weeks) and there is a small risk of weakness due to environmental conditions during lifetime.	After HAF bonding the strength will be reached immediately and the film will stay stable regardless of time and environmental influences.

Definition:

Adhesion: Peel adhesion bonding strength of the adhesive to the substrate. There is a difference between initial adhesion and final adhesion.

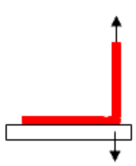
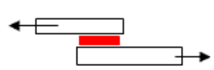
Cohesion: Shear resistance inner strength of the adhesive "holding power".

Tack: Initial bonding without pressure contact of the adhesive to the substrate is the first customer perception of tape performance influences the repositionability.



Adhesive tapes with maximum adhesion AND maximum shear AND maximum tack are not possible! While raising one parameter the other parameters will decrease or remain the same.

Distinction between peel adhesion and bonding strength is the influence of adhesion / cohesion and the test method:

Peel Adhesion	Bonding Strength
 Influenced mainly by adhesion here 90° adhesion but also values for 180° available.	 Resistance to this shearing tension is influenced by adhesion and cohesion.

Further product requirements and environmental conditions which influence the right choice of tape type

- Electrical conductivity required?
- Special tack properties required to allow repositioning?
- High tensile strength during application required (e.g. automated high speed application)?
- Will the product be exposed to extraordinary low / high temperature?
- Is the bonding on curved (3D) surfaces?
- What is the required adhesion?

DFA > Adhesive Tape > Adhesive Tape Requirements
Entry ID: 1153

Pressure Sensitive Adhesive

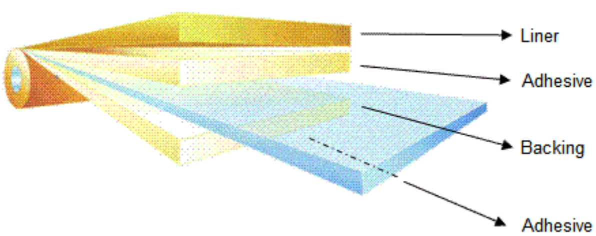
Information

CID: 1	Content Owner: Jabil	Content Type: Information

1) PSA Tape Thickness

Total material thickness, available from 30µm to about 200µm, is the sum of the dimensions of the layers (adhesive + backing + adhesive).

- Liner - to protect and carry the adhesive.
- Adhesive - typically acrylic or rubber.
- Backing - typically 12µm thick and normally made of PET. Available in a range of colors.



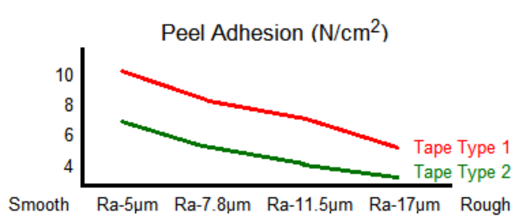
2) Substrate and Peel Adhesion

The type of substrate, especially the surface tension of the substrate, influences the peel adhesion. A decrease in the surface tension reduces the peel adhesion.

	Material	Abbreviation	[dyne or Nm/m]
	Polycarbonate	PC	44-48
	Steel	Steel	42-46
	Polyethylenterephthalate	PET	42-46
	ABS	ABS	40-44
	Polyvinylchloride	PVC	37-41
	Polystyrene	PS	36-40
	Aluminum	Alum	32-36
	Polyethylene	PE	30-34
	Polypropylene	PP	30-34

3) Surface Texture

An increase in surface texture roughness reduces the peel adhesion. A smooth surface is optimal.



4) Time Related Properties

There is a difference between immediate adhesion and ultimate peel adhesion over time. Peel adhesion usually increases over time by improved wetting. Within the first 72 hours an increase of up to 100% is possible, depending on the tape product and substrate. For critical assemblies it is helpful to wait 72 hours before further processing.

The application pressure and time have only a minor influence on the initial peel adhesion as well as the adhesion over time. The peel adhesion after 24 hours can only improve from 3% to 20% compared to the peel adhesion in the first few minutes.

5) Type of Adhesive

For industrial applications, mainly acrylic adhesives are used. The following overview shows the pros and cons of acrylic and rubber adhesives.

Acrylic	Rubber
+ Sticks well to many substrates (PET, PC, glass, metals)	+ Cheaper

Acrylic	Rubber
+ Temperature resistance	- Poor resistance against elevated temperatures
+ Aging stability	- Low aging resistance
+ Environmental resistance	- Poor humidity resistance
+ Higher shear resistance at elevated temperatures	- Poor chemical resistance

Related Entries

DFA Information 1158 Adhesive Tape > Adhesive Tape Requirements > Heat Activated Film Adhesive

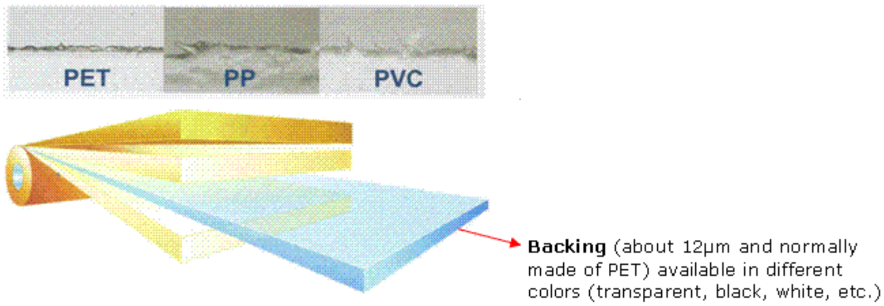
Entry ID: 1154

Adhesive Tape Backing Material for Automated Application

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Use 12µm PET backing material for automated application. It has the best properties in comparison with PP and PVC.



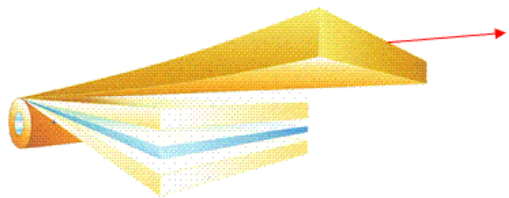
DFA > Adhesive Tape > Adhesive Tape Requirements
Entry ID: 1155

Adhesive Tape Liner Material for Automated Application

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Observe liner material requirements for automated application.



The major task of the liner is to protect and to carry the adhesive until application.

The type of the liner will be determined by the process (conditioner* / automated application / manual application)

* The conditioner is a preceding company which takes the raw material (adhesive), applies dedicated actions like punching, cutting, etc. and provides then the prepared tape to the factory for further processing.

The selection should be aligned with the conditioner's needs.

Cost	Type of Liner	Thickness/Color	Advantages/Disadvantages
$ Least	Glassine Paper Liner	70 µm 80 g/m^2 brown	+ low electrostatic discharge + low compression + easy hand tearable - limited humidity resistance in large surface applications
$$	PE Coated Paper Liner	120 µm 120 g/m^2 white, blue logo	+ good tensile strength + excellent humidity resistance + good kiss cut ability (important for conditioner) - higher thickness tolerances
$$$	PP Film Liner	80 µm 72 g/m^2 red, translucent	+ transparency for visual inspection + high humidity resistance + dust free convertibility - low elongation
$$$$ Greatest	PET Film Liner	50 µm 70 g/m^2 white	+ excellent tear strength + good thickness tolerance + dust free convertibility - higher costs

DFA > Adhesive Tape > Adhesive Tape Requirements
Entry ID: 1158

Heat Activated Film Adhesive

Information

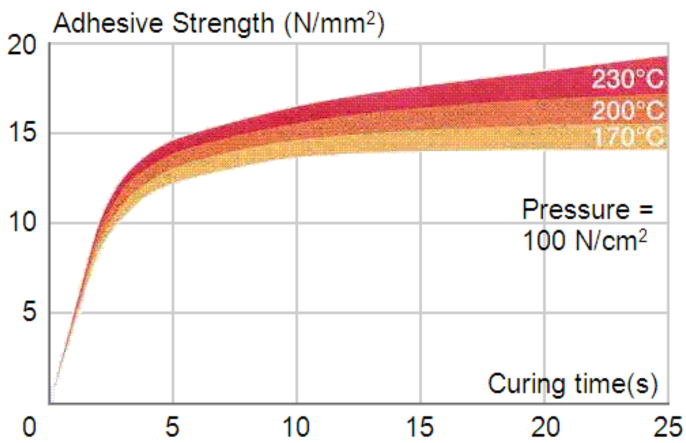
CID: 1	Content Owner: Jabil	Content Type: Information

1) HAF Versus PSA

HAF should only be used if the peel adhesion of PSA is too low. The use of HAF is only applicable in combination with at least one metal part. Peeling off the liner and the thermo-bonding requires more complex tools and preparation for manual or automated assembly.

2) Peel Adhesion

The customer has to define the desired peel adhesion. Pressure normally starts at 2bar (=20N/cm²) up to 10 bar (=100N/cm²) - an increase in bonding strength by 15% is possible by using high pressure instead of low pressure. The following diagram shows the relationship between curing time, temperature and adhesive strength.



Related Entries

DFA Information 1153 Adhesive Tape > Adhesive Tape Requirements > Pressure Sensitive Adhesive

Entry ID: 1160

Adhesive Tape Liner Selection for the Press-Cut Process

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

The most susceptible process step at automated application is stripping the adhesive tape from the liner. Select an appropriate liner material that is compatible with the intended factory press-cut process.

DFA > Assembling > Assembling Requirements
Entry ID: 1161

Assembly Sequence and Sub-Assembly Utilization

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Ensure the design has a logical assembly sequence.

Minimize the number of levels of assembly.

Minimize assembly time through design choices.

- This can increase assembly / dis-assembly time.

Avoid turning or flipping the assembly and sub-assemblies.

Minimize re-orientation of the entire assembly during the assembly process.

Ensure the assembly process is from the inside to the outside and / or from the bottom to the top.

Ensure all parts and sub-assemblies are added from one side (preferably the Z axis).

Ensure the insertion points for components are easy to see and reach.

Ensure part handling and manipulation are considered in design choices.

- These could cause ergonomic issues and / or increase assembly time and complexity.

Ensure all parts that can be, are combined into sub-assemblies.

Ensure assemblies / sub-assemblies are modular and / or interchangeable.

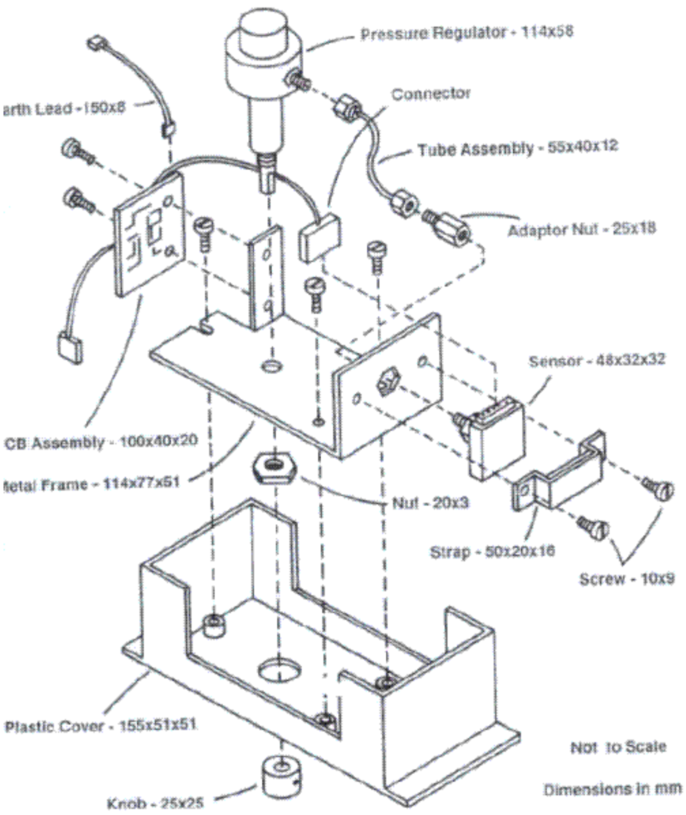
- This will generally result in a lower BOM cost, fewer ergonomic issues and less assembly work.
- A frame or chassis can act as an interface which supports collecting and merging all single parts and sub-assemblies into a set that results in an accurate stackup.

A logical structure supports the assembling but also the dis-assembling for repair or analysis actions. The breakdown into sub-assemblies allows pre-assembly and pre-testing at other places or vendors, makes production more flexible and uncouples production cells.

Example:

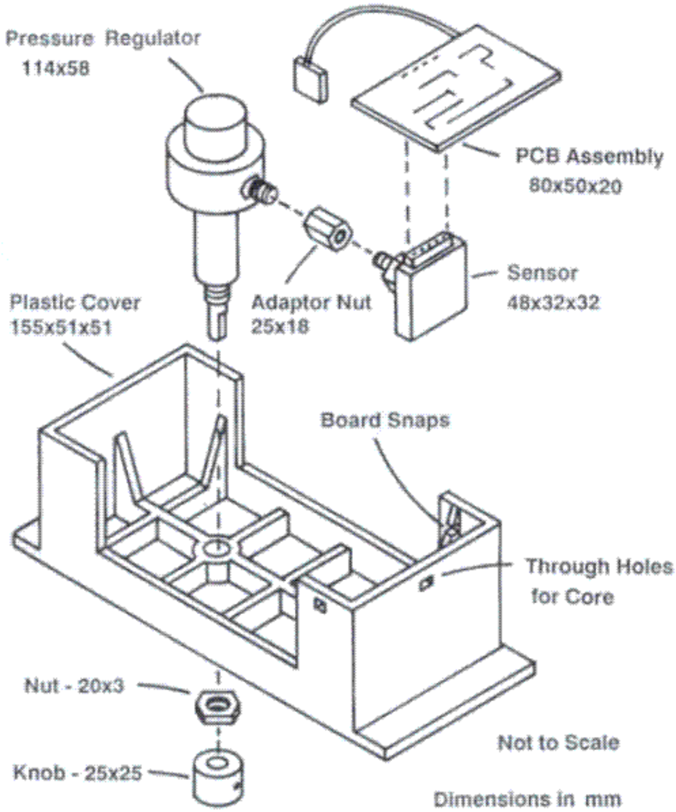
Previous design:	Improved design:
• Many parts and sub-assemblies • Screws from all sides • No logical assembly sequence	• Parts integrated into sub-assemblies • Eliminated all screws • Logical assembly sequence - set grows from the bottom to the top

Previous Design Example:



Controller assembly.

Improved Design:



Conceptual redesign of the controller assembly.

Entry ID: 1162

Secure Individual Parts in a Sub-Assembly

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Design proper securing for each individual part in the sub-assembly.

Ensure parts are self-locating and secured immediately upon insertion.

- Already assembled parts can be displaced from their position when the assembled module is transported between assembly cells.
- Parts could be lost, displaced, or fall off at the customer potentially causing a safety issue.

DFA > Assembling > Assembling Requirements

Entry ID: 1163

Customization of Assemblies Within a Product Family

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Within a product family the parts which are assembled first have to be standard components that are used for all sub-products within the family. The customization has to take place at the end of the assembly process.

Design the process flow so that custom parts (parts with alternative colors, printing, labeling, etc.) are the last parts assembled providing shorter turn-time of finished goods and smaller inventories and planning expenses (work in process, finished sub-assemblies, etc.)

DFA > Assembling > Assembling Requirements
Entry ID: 1165

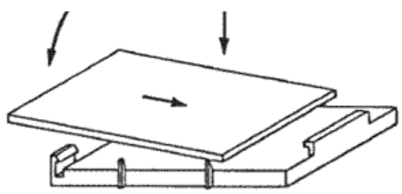
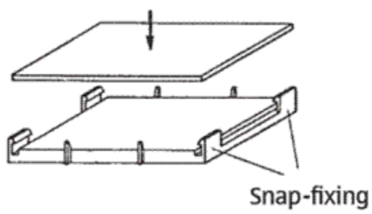
Placement Movements of Parts / Sub-assemblies

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Minimize placement movements of parts / sub-assemblies whenever possible.

- Multiple placement movements could cause ergonomic issues and / or increase assembly time, difficulty and make assembly difficult to automate.

(Not Preferred)	(Preferred)
• Assembly requires three different movements • Potential ergonomic issues • Extended assembly times, higher assembly risks • Difficult to automate	• Only one assembly movement • Reduced risk of ergonomic issues • Shorter assembly times, lower assembly risks • Easier to automate
	
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DFA > Assembling > Assembling Requirements
Entry ID: 1166

Assembly Tools, Fixtures and Equipment

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Decrease the need for specialized tooling and fixtures by utilizing existing tooling and fixtures.

- The manual or automated assembly process should be optimized and simplified so that there is no need for new custom assembly tools and fixtures.
- Designing a custom fixture or tooling can be difficult, adds cost and may impact product reliability.

Make design choices that utilize existing assembly equipment, preferably from a single equipment manufacturer.

- This can reduce tooling cost, makes maintenance easier and reduces the need for equipment spare parts.
- Common equipment can be easier for assemblers to operate.

DFA > Assembling > Assembling Requirements
Entry ID: 1167

Packaging and Re-orientation of Parts / Sub-assemblies

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Select packaging to avoid operator re-orientation of parts / sub-assemblies during placement.

If trays are needed (for quality reasons), all parts / sub-assemblies should be oriented in a way that the operator does not have to change the orientation of the part after gripping.

Related Entries

DFM Information 1339 Component Selection > General > Supplemental Component Selection Information

DFA > Assembling > Assembling Requirements
Entry ID: 1168

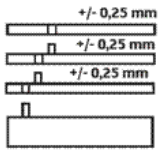
Alignment Features

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

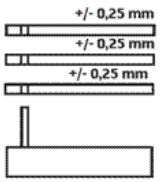
Ensure the number of alignment features for multi-part assemblies is minimized.

- This can cause tolerance stackup issues requiring tight tolerances at the individual part level.
- By designing a single location / alignment feature, we can achieve +/- 0.2500mm tolerance between base part and upper part with bigger tolerances at individual parts.



Location tolerance between base part and upper part is +/- 0.7500mm due to the tolerance chain.

If we want +/- 0.2500mm location tolerance between base part and upper part, we have to tighten the tolerance in individual parts down to +/- 0.0800mm.



Ensure parts are designed so they can only be installed in one orientation.

- If parts do not have orientation / alignment features they could be assembled incorrectly.

DFA > Assembling > Assembling Requirements
Entry ID: 1169

Consolidation and Part Count Reduction

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Ensure part count is reduced by consolidating features whenever possible.

Minimize part counts and types.

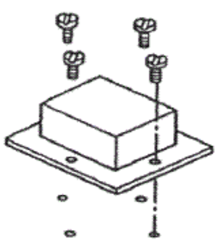
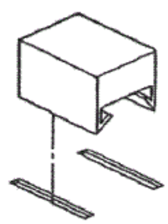
- A high part count results in more manual or automated assembly, increasing complexity and cycle time.

Sometimes it is possible to combine and merge functions of several parts into one part by redesigning a small detail or by changing the material or the production process of the part (e.g. injection molding instead of turning).

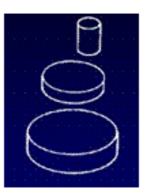
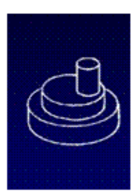
Analyze the need of separation or existence of single parts according to these questions:

- Are these parts required to move relative to each other?
- Must these parts be made from different materials?
- Do other assembly steps prevent these parts from being combined?
- Will servicing require disassembly of these parts?
- Is there a part that keeps variation under control?
- Could these parts be consolidated at the supplier in order to reduce assembly time?

Fewer attachment features can simplify manual or automated assembly and reduce part count.

 Multiple attachments	 Single attachment
✗	✓

Each part requires resources for designing, ordering, releasing and assembling. Every reduction in the number of parts can reduce the BOM price and the manual or automated assembly process.

 Multiple pieces	 Single piece
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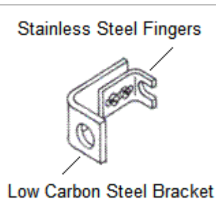
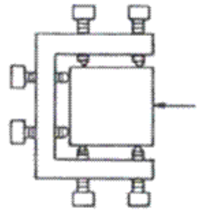
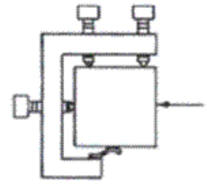
 Adjustment required	 No adjustment
✗	✓

 Over determined	 Kinematically sound
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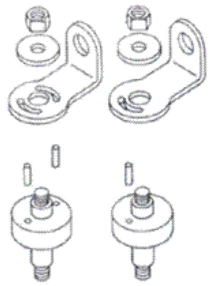
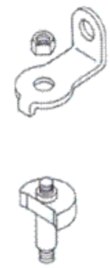
 Over determined	 Kinematically sound
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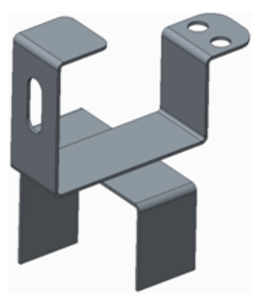
When reducing the part count by integrating parts, take into account the total costs. Only one part could create much higher tooling costs and material costs due to wasted metal. Two simple metal strips cut and bent from a single strip and assembled with resistance welding could be cheaper, therefore calculate both possibilities.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As long as it is cost effective, have the vendor assemble complex pieces before delivering them to save time and difficulty during the manual or automated assembly process.

	
☒	☑

Related Entries

DFA Guideline 1171 Assembling > Assembling Requirements > Alignment Referencing Systems

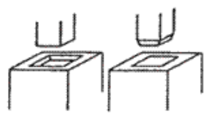
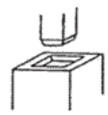
Entry ID: 1170

Guided Assembly

Guideline

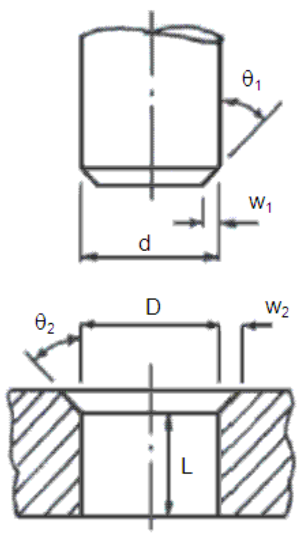
CID: 2	Content Owner: Jabil	Content Type: Requirement

Design parts with self-aligning features. This will speed up the assembly because no fine-adjustment of manual movements will be necessary and possible damage to the parts is minimized.

		
Difficult to assemble, no self-aligning parts.	Better, half of the pair has alignment features.	Easiest to assemble, both parts are self-aligning.
Minimal changes in part design but big influence on assembly time and ease of assembly.		

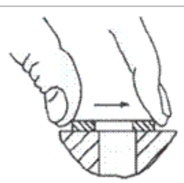
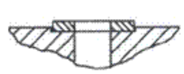
Features for insertion assistance like chamfers facilitate sensitive assembly operations. The standard for joining pegs and holes is to provide a chamfer which is 10% of the diameter (w1 = 0.05 x d, w2 = 0.05 x D) on both parts.

(a) Geometry of Peg



(b) Geometry of Hole

Parts such as washers should be self-locating with a slot or counterbore.

	
Holding down and alignment required for subsequent operation	Self-locating
	

DFA > Assembling > Assembling Requirements
Entry ID: 1171

Alignment Referencing Systems

Guideline

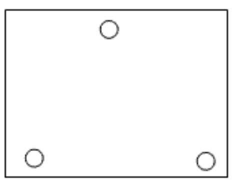
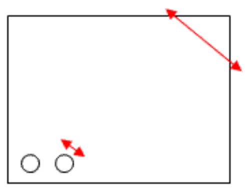
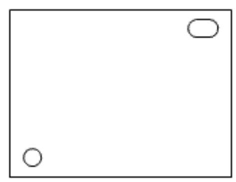
CID: 2	Content Owner: Jabil	Content Type: Requirement

Design components and sub-assemblies with mechanical alignment reference features such as leads, lips, tapers, chamfers, etc. so they are self-aligning.

- Without these features, inaccurate alignment and / or increased assembly time may occur.

Efficient reference systems align parts to a clear position but over referenced parts can complicate the assembly process.

Referencing systems should be placed in an effective way.

 Over-referenced (3 holes)	 Referencing holes too close could lead to a big offset in the opposite corner	 Good design, accurate alignment without too many reference features
		

When mechanical alignment is not possible, provide visual reference features to align parts that require free positioning.

- No features to show the operator how to place the part could result in poor alignment or increased assembly time.
- Markings, embossing or guided edges to align parts are recommended.
- Flimsy components like labels or foils which require free positioning can be mounted more accurately if referencing features are provided.

Related Entries

DFA Guideline 1169 Assembling > Assembling Requirements > Consolidation and Part Count Reduction

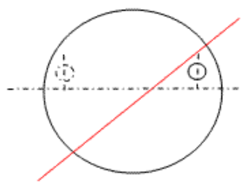
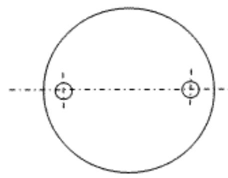
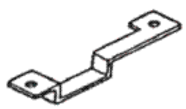
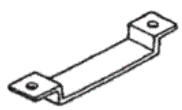
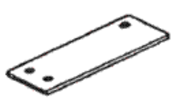
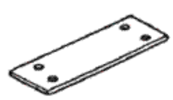
DFA > Assembling > Assembling Requirements
Entry ID: 1172

Symmetrical Part Designs

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

If orientation is not an issue, symmetrical part designs are preferred because they are easier to manufacture and assemble.

 Asymmetrical	 Symmetrical
☒	☑
 Asymmetrical	 Symmetrical
☒	☑
 Asymmetrical	 Symmetrical
☒	☑
 Asymmetrical	 Symmetrical
☒	☑

Related Entries

DFA Guideline 1173 Assembling > Assembling Requirements > Asymmetrical Part Designs

DFA > Assembling > Assembling Requirements
Entry ID: 1173

Asymmetrical Part Designs

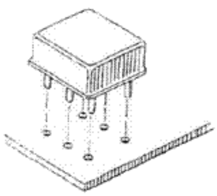
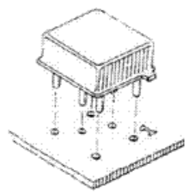
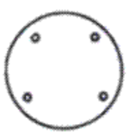
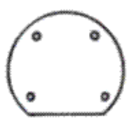
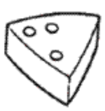
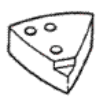
Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

If orientation is required, ensure part designs include orientation features.

Decrease ambiguity in part / sub-assembly orientation through the use of rotational symmetry.

- This could allow parts to be placed incorrectly and potentially fall off at the customer causing a safety issue.
- Part designs that are clearly asymmetrical are easier and quicker to assemble.

 Wrong insertion possible	 Only correct insertion possible and clear indication
	
 Slightly asymmetrical	 Clearly asymmetrical
	
 Slightly asymmetrical	 Clearly asymmetrical
	

Related Entries

DFA Guideline 1172 Assembling > Assembling Requirements > Symmetrical Part Designs

DFA > Assembling > Assembling Requirements
Entry ID: 1174

Similar Looking Parts

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Similar looking parts should clearly indicated (e.g. by color) to avoid any mis-placement. Wrong or mis-inserted parts can lead to malfunction of the assembly and impair quality.

This applies to both mechanical and electrical components.

Example: Do not use bolts, screws, springs, etc. with similar diameters/lengths/force (the wrong bigger screw could damage the small hole or the wrong longer bolt could not be pressed to the desired level).

Recomendation: In order to reduce the risk to the assembly, the design of a tool as a mask to place parts separtely will reduce the risk of mistakes.

The pictures show connectors with different colors which shows the operator, which cable has to be plugged here.

DFA > Assembling > Assembling Requirements
Entry ID: 1175

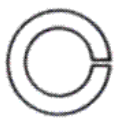
Prevent Tangling / Jamming of Parts

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Select parts that will not tangle, nest or jam in bulk packaging and / or inventory storage.

- This could damage the parts or cause assembly process issues.
- Bulk packaging is the cheapest storage method and therefore always preferred.
- If parts can jam together or become tangled, avoid this by using design features.

 Will jam	 Cannot jam
☒	☑
 Will tangle	 Cannot tangle
☒	☑

DFA > Assembling > Assembling Requirements
Entry ID: 1176

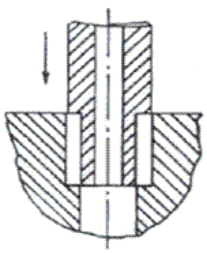
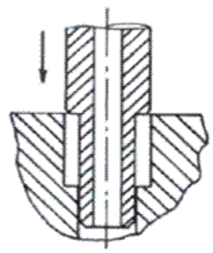
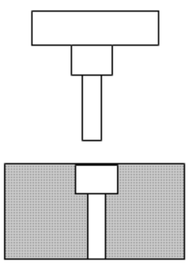
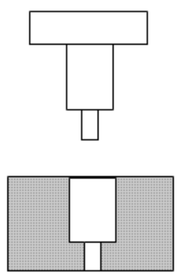
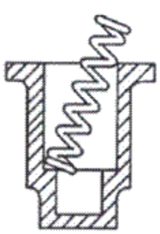
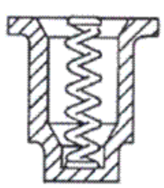
Two Alignment Steps During Insertion

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Select / design parts to avoid two alignment steps for a single insertion and / or add chamfers.

- This could increase assembly time and difficulty. Parts could also be assembled incorrectly or fall off at the customer, potentially causing a safety issue.

 Difficult to insert	 Easy to insert
☒	☑
 The pin might collide twice	 If the pin is positioned the first time, there is no need for a second alignment
☒	☑
 Part can hang up	 Part falls into place
☒	☑

DFA > Assembling > Assembling Requirements
Entry ID: 1177

Part Insertion Force

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Avoid high insertion forces during assembly.

Maximum part insertion force is 5 Newton.

- Higher insertion force can cause operator repetitive strain injuries / ergonomic issues.
- This could also result in part damage during insertion, increased assembly time and part location issues.
- The process may have to be automated to accommodate the higher insertion force.

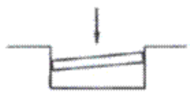
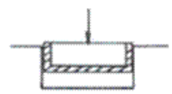
DFA > Assembling > Assembling Requirements
Entry ID: 1178

Part Geometries and Jamming During Insertion

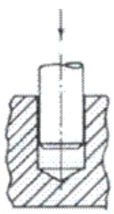
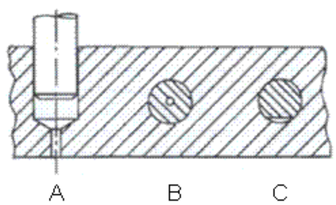
Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Incorrect geometries (e.g. relationship between diameter/length and part height) might result in jamming during insertion. Jamming can interrupt the workflow extensively and output could be decreased.

 Part jams across corners	 Part cannot jam
	

Air cushions may increase the insertion force. To avoid this, provide air relief passages at blind holes.

 Air cushion - difficult to insert	 (A) Hole in work (B) Hole in pin (C) Flat on pin
	

DFA > Assembling > Assembling Requirements
Entry ID: 1180

Finger and Tool Access for Gripping Parts

Guideline

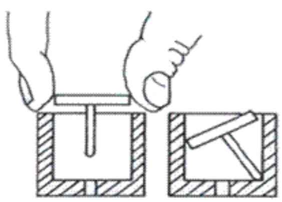
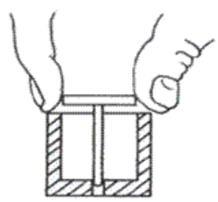
CID: 3	Content Owner: Jabil	Content Type: Requirement

Select parts that are easy to pick up with the fingers and avoid costly tools.

- This is normally the fastest and easiest handling method and should not slow down the operators.
- Parts that are too small can cause an ergonomic issue.

 Thickness too small, finger grasp is difficult	 Vision is obstructed and pre-positioning is difficult because of small size
	

The fingers need free access to the place of insertion to guide the part into position. As a general rule, clearance for each finger is at least 10x10 mm but should be evaluated for each insertion.

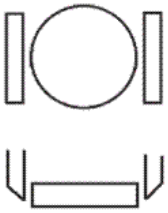
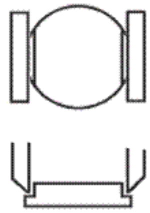
 Part must be released before it is located	 Part located before release
	

CID: 2	Content Owner: Jabil	Content Type: Requirement

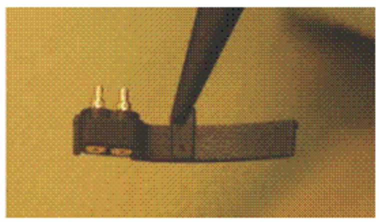
If it is not possible to use parts that can be picked up with bare fingers, select parts that can be easily handled with tools.

When constructing gripping areas, the following details should be considered:

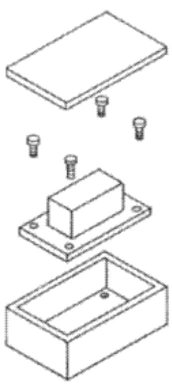
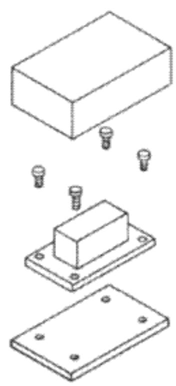
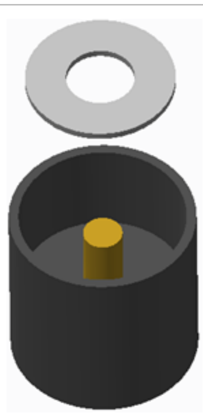
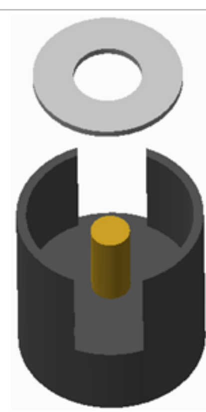
- The gripping area should support steady and reliable gripping of the part
- Gripping is supporting possible pressing of the part into its place
- Assembly of the whole part is possible using the original grip without a need to alter the grip during the part assembly operation
- Risk of damaging the part and / or its sensitive areas (like contact springs etc.) should be avoided during gripping and possible pressing

 Cylindrical part gripped by tweezers • Unreliable grip causing risk that part is dropped from grip before assembled in its place • Grip is not enabling pressing part into its nest without changing grip	 Cylindrical part with proper gripping areas • More reliable grip; lower risk that part is slipping away from tweezers • Grip is enabling pressing part into its nest without changing grip
☒	☑

Example of optimized construction:

• Gripping rib enabling faster and more reliable handling of part during assembly • Gripping rib also prevents wrong way assembly of part (poka-yoke)	 ☑

Tool access should also be considered.

 Restricted access for assembly screws	 Easy access after redesign
☒	☑
	

Tools cannot access desired location	Cutouts permit the use of a tool for easier insertion of the part
☒	☑

DFA > Assembling > Assembling Requirements
Entry ID: 1726

Optical Fiber Routing

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Optical fiber routing requirements:

Keep optical fibers away from heat generating components such as large caps and DC/DC converters.

- The heat could damage the fibers and affect performance.

Do not route fibers over components if it can be avoided.

- This will help ensure that soldering and desoldering tools do not come into contact with the fibers if a component must be repaired.

Ensure fibers do not cover barcodes or labels.

- Labels and barcodes must be accessible without having to move the fiber loops, potentially damaging them.

Ensure fibers are clear of the top and bottom guide rails in the rack.

- The fibers could get pinched, damaging them and affecting performance.

Ensure fibers are clear of tooling areas, test points, fasteners and screw locations.

- The fibers could get damaged and affect performance.

Roll fibers from vertical to horizontal over as long a distance as possible.

- The fibers could get damaged and affect performance.

Ensure jacketed fibers cannot come into contact with sharp edges and burrs.

- The fiber coating could get damaged and affect performance.

Ensure the lid of the product does not compress the fibers and splice protectors.

- Compression could affect the performance of the fibers.

Ensure sticky tape is not used to hold down fibers.

- It could stick to the fibers and cause breakage if it needs to be removed.

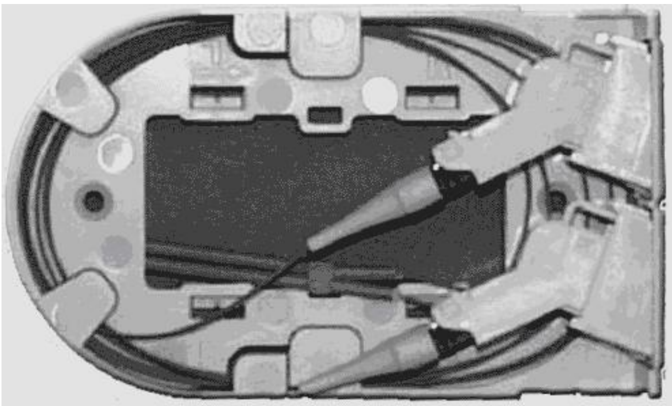
Ensure fibers are not routed near unprotected wire bond loops.

- Optical fibers are stiffer than wire bond loops and could easily damage them.

CID: 3	Content Owner: Jabil	Content Type: Requirement

Do not route optical fiber loops around the outer edges of the circuit pack unless they are captivated.

- Unsecured loops may fall out of the circuit pack during shipment or insertion into a rack and get damaged. They may also get pinched by the guide rails.



Related Entries

DFM	Rule	1107	Component Selection > General > Optical Fiber Connectors
DFM	Guideline	1108	Component Selection > General > Optical Fiber Pigtails
DFM	Guideline	1124	Data and Deliverables > General > Optical Requirements in Design Drawings
DFM	Guideline	1345	Component Selection > General > Self-Adhesive Pads and Optical Fibers
DFM	Guideline	1636	PCB Design > General > Optical Design Considerations
DFA	Rule	1728	Assembling > Assembling Requirements > Optical Fiber Bend Radius
DFA	Guideline	1729	Assembling > Assembling Requirements > Optical Fiber Clips

DFA > Assembling > Assembling Requirements
Entry ID: 1728

Optical Fiber Bend Radius

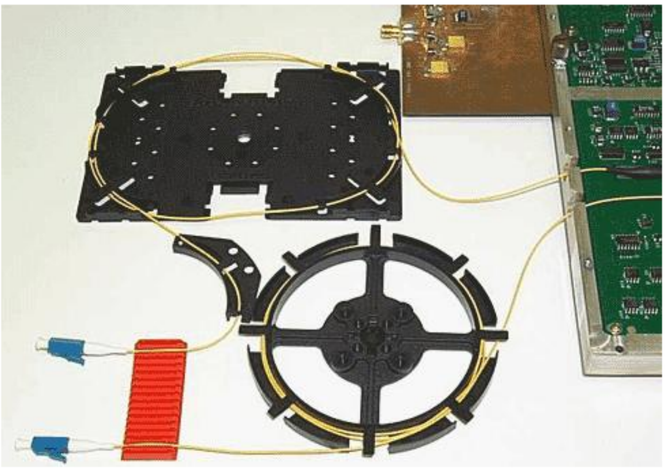
Rule

CID: 2	Content Owner: Jabil	Content Type: Requirement

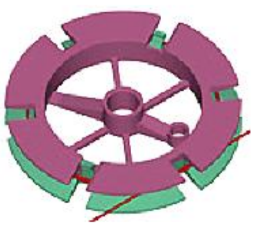
Maintain a minimum optical fiber bend radius of 38.1000mm.

- A radius that is too tight may cause power loss and / or damage the fiber.

Clips or spools can be used to accomplish this. They protect the fibers from other components and aid in rework. Clips allow for variations in the fiber loops, spools maintain radii and add extra protection but at an added cost.



Two part construction makes the spool easy to disassemble.



Related Entries

DFM	Rule	1107	Component Selection > General > Optical Fiber Connectors
DFM	Guideline	1108	Component Selection > General > Optical Fiber Pigtails
DFM	Guideline	1124	Data and Deliverables > General > Optical Requirements in Design Drawings
DFM	Guideline	1345	Component Selection > General > Self-Adhesive Pads and Optical Fibers
DFM	Guideline	1636	PCB Design > General > Optical Design Considerations
DFA	Guideline	1726	Assembling > Assembling Requirements > Optical Fiber Routing
DFA	Guideline	1729	Assembling > Assembling Requirements > Optical Fiber Clips

DFA > Assembling > Assembling Requirements
Entry ID: 1729

Optical Fiber Clips

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Observe optical fiber clip requirements:

Use clips to route optical fibers around the outside perimeter of the PCB creating a keep-out zone.

- A keep-out zone may prevent damage to the fibers during handling and installation.

Minimize the number of fibers inserted into each clip and ensure that the fibers are loose and not binding.

- Fibers that are not loose may get damaged due to binding.

Ensure fiber clips can be completely opened prior to removing the fibers.

- A partially closed clip could damage the fibers during removal.

Ensure there are extra fiber clip holes for improved routing versatility.

- No extra clip holes will limit routing.

Select snap-in, fire retardant optical fiber clips.

- Snap-in clips improve production efficiency and fire retardant clips may prevent long term reliability issues.

For ribbon fibers, select compatible clips.

- Incompatible clips may damage the fibers.

Related Entries

DFM	Rule	1107	Component Selection > General > Optical Fiber Connectors
DFM	Guideline	1108	Component Selection > General > Optical Fiber Pigtails
DFM	Guideline	1124	Data and Deliverables > General > Optical Requirements in Design Drawings
DFM	Guideline	1345	Component Selection > General > Self-Adhesive Pads and Optical Fibers
DFM	Guideline	1636	PCB Design > General > Optical Design Considerations
DFA	Guideline	1726	Assembling > Assembling Requirements > Optical Fiber Routing
DFA	Rule	1728	Assembling > Assembling Requirements > Optical Fiber Bend Radius

DFA > Assembling > Assembling Requirements
Entry ID: 1767

Adjustable Parts

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Select parts and components that don't require adjustments.

- This can increase cycle time and quality issues.
- Unnecessary adjustments can reduce the possibility of automation.

DFA > Assembling > Assembling Requirements
Entry ID: 1768

Product Adjustments

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Make design choices that avoid adjustments commonly used to bring the product to proper specifications.

- Adjustments can increase cycle time and quality issues.
- Specialized equipment might be required.

DFA > Assembling > Assembling Requirements
Entry ID: 1769

Heat Sinks

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Ensure heat sink mating surfaces provide adequate tension / compression and maximum thermal transfer / conductivity.

- Heat sinks are usually higher in mass and can dislodge, causing damage to the assembly.
- Thermal conductivity can be impaired if the heat sink is not properly designed.

Include design feature(s) so the heat sink can only be assembled in one direction.

- Incorrect assembly could affect the functionality and / or cause assembly issues.

DFA > Assembling > Assembling Requirements
Entry ID: 1770

EMI Suppression

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Ensure EMI suppression media has full conductivity with all metal mating surfaces.

- Poor conductivity would negatively effect EMI suppression test results.

DFA > Assembling > Assembling Requirements
Entry ID: 1771

Labels

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Ensure the label size selected will fit in the intended location and is accessible / visible.

- Wrong sizes can cause contact / mechanical interference issues for assembly and test.
- Wrong sizes may increase cycle times and cause quality, functional and aesthetic issues.
- If the label is not clearly visible, it can't be scanned automatically, manually or viewed by operators.

DFA > Assembling > Assembling Requirements
Entry ID: 1772

Sharp Edges

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Ensure there are no sharp edges.

- Sharp edges can be a hazard for assemblers and could damage other parts of the product.

DFA > Assembling > Assembling Requirements
Entry ID: 1773

Part Damage

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Avoid parts that can be easily damaged or broken.

- Parts that are fragile require special packaging, handling and can increase quality issues.

DFA > Assembling > Assembling Requirements
Entry ID: 1774

Serviceable / Replaceable Part Access

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Ensure easy access for serviceable or replaceable parts.

- Parts that require service or regular maintenance should be easily accessible.
- Removal of other components to get access should be avoided.
- The product could be damaged if access is restricted.

DFA > Assembling > Assembling Requirements
Entry ID: 1775

End Use Environment

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Ensure the product has adequate protection for the end use environment.

- The product must be able to withstand the end use environment.
- Latent field failures could occur.

DFA > Assembling > Assembling Requirements
Entry ID: 1776

Design Functionality

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Ensure design functionality is adequate for the application without unnecessary design features or materials.

- Unnecessary design features and materials can increase cost without any benefits.

DFA > Assembling > Automated Assembly
Entry ID: 1848

Automated Assembly

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Robotic Assembly:

For robotic assembly: design parts that can all be gripped and inserted using a single robot gripper.

- Each change to a special gripper and then back to a standard gripper is approximately equal to two assembly operations and increases assembly time.

For robotic assembly: avoid the need for reorienting the partial assembly and / or manipulating previously assembled parts.

- These operations increase assembly cycle time without adding value to the assembly. If the partial assembly has to be turned to a different orientation during the assembly process, this may result in increased fixture cost and the need for a more expensive robotic arm.

For robotic assembly: avoid selecting parts that have thin or tapered edges.

- These types of parts can overlap as they move along a conveyor or feed track and jam.

For robotic assembly: avoid selecting parts that are fragile.

- Part handling systems could damage the part, often during recirculation in a feeder.

For robotic assembly: avoid selecting parts that are sticky or magnetic.

- If the force required for separation is comparable to the weight of the part, it may be difficult to prevent issues during part feeding and assembly.

For robotic assembly: avoid selecting parts that are abrasive.

- This type of part will create extra wear on the surfaces of automated handling systems.

For robotic assembly: select parts that can be oriented using simple tooling.

- Complex parts could require longer assembly time, expensive tooling, and / or a more expensive robot to assemble.

For robotic assembly: select parts that can be delivered in an orientation from which they can be gripped and inserted without manipulation.

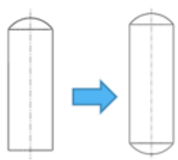
- Parts that must be re-oriented prior to placement could require longer assembly time and / or a more expensive robot to assemble.

For robotic assembly of parts in magazines or trays: ensure they are reliably located while resting in their packaging so they can be gripped and inserted without any manipulation by the robot.

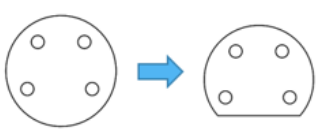
- Parts that are not reliably located could get out of position and the robot may not be able to pick it up.

For robotic assembly: select parts that are symmetrical or obviously asymmetrical.

- Parts that are obviously asymmetrical are easier for the feed system to orient. Symmetrical parts are less likely to jam the feed system and are easier for the robot pick up.



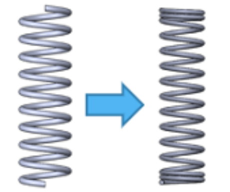
Symmetrical



Obviously Assymetrical

For robotic assembly: select springs with closed ends.

- Closed-ended springs will only tangle under pressure.

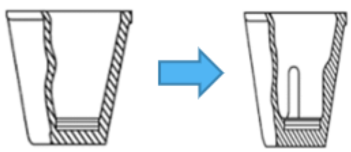


For robotic assembly: avoid parts that can shingle.

- Parts that shingle may jam the feed system.

For robotic assembly: avoid selecting parts that can nest.

- Parts that nest may jam the feed system. Nesting can be avoided using ribs or asymmetrical exterior to interior part shapes.



For robotic assembly: avoid selecting parts that can tangle.

- Parts that tangle may jam the feed system. Instead of a straight slot, a crank slot is less likely to tangle.
- Instead of an open spring-lock washer, a closed spring-lock washer is less likely to tangle.

CID: 3	Content Owner: Jabil	Content Type: Requirement

Automated Labeling:

For automated labeling: avoid placing labels on curved surfaces.

- It can be difficult to get the label to adhere to the surface and it can be more expensive to have curved tooling on the end-effector of the robot.

For automated labeling: select labels that are easy to separate from the backing paper.

- If the label is hard to separate from the backing paper, this could cause equipment downtime.

For standard automated labeling machines: minimum label size = 4.0000mm X 4.0000mm

For standard automated labeling machines: maximum label size including backing paper = 100.0000mm X 100.0000mm

- Other sizes may exceed the equipment capability.

For Zebra label printers: maximum print width = 104.0000mm

For Zebra label printers: maximum paper loading width = 115.0000mm

- Other sizes may exceed the equipment capability.

CID: 4	Content Owner: Jabil	Content Type: Requirement

Automated Screw Fastening:

For automated screw fastening to a specific torque: select machine screws going into tapped holes.

- There is no reaction torque until the screw is fully seated, so assembly will be more reliable.

For automated screw fastening: if slotted head screws are required for field repair considerations, select screws that combine Phillips and slotted screw heads.

- A Phillips screw type can be reliably automated while retaining the ability to use a flat head screw driver for field failures.

Combined Phillips & Slot

For automated screw fastening: do not select TORX screws smaller than M4.

- The TORX screw recess and bit have straight walls. With very small screws, if the screw and bit are not perfectly in alignment, the TORX bit can have trouble consistently engaging the screw.

For automated screw fastening: for high torque applications, select TORX screws.

- Hex drive screws can sometimes wedge in the socket or bit. When the drive head lifts upwards, it can take the part with it, or the cylinder could stall, stopping the machine.

For automated screw fastening into plastic: avoid selecting self-tapping screws.

- Self-tapping must be done at a slow speed, less than 800RPM, to achieve proper fastening. Self-tapping in plastic can require significantly higher torque and can make assembly more difficult for automated equipment.

For automated screw fastening using blow feeding: maximum recommended screw length = 76.2000mm

- Shorter screws will pass through bends in the hose more easily. As screw length increases, screws are more likely to jam in the blow tube.

For automated screw fastening using blow feeding: minimum screw length to head diameter ratio = 1.2 to 1

- A screw must be longer than the head diameter so it does not tumble or get caught in the feed hose or end tooling.

For automated screw fastening: minimum clearance from the center of a screw location to adjacent features = 2 X diameter of the screw head.

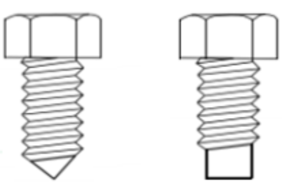
- Less clearance may make it difficult or impossible to assemble the product.

For automated screw fastening: if a screw is located at a recess location, provide a lead-in to the screw hole.

- A recess can make it more difficult to position the screw properly for installation and a lead-in can mitigate this issue.

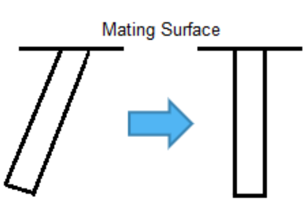
For automated screw fastening: select screws that have a lead-in chamfer, cone point, or dog point.

- These screw types reduce engagement time and minimize initial thread mating issues like cross threading and jamming.



For automated screw fastening: avoid drill holes that are not perpendicular to the mating surface.

- If the angle is not 90 degrees to the seating surface, the screw may not install properly or fully seat.



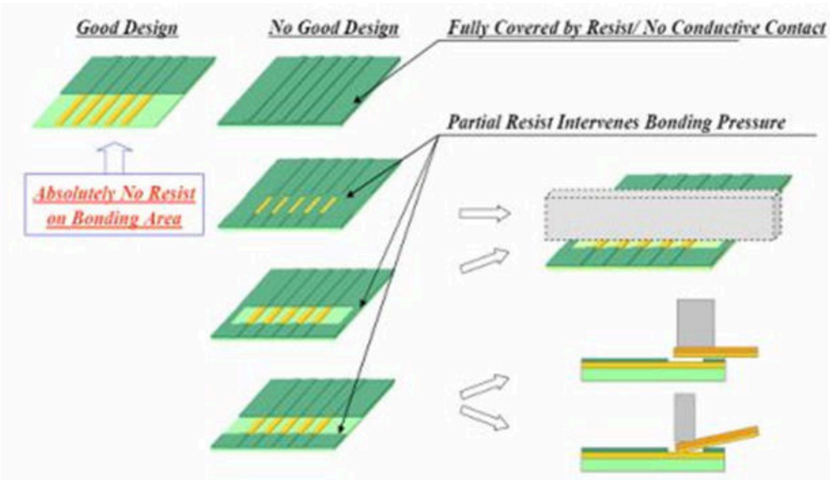
Entry ID: 1400

ACF Cover Layer Openings Around Conductive Contacts

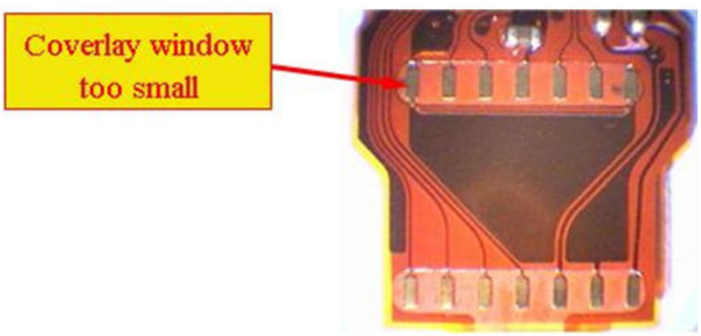
Rule

CID: 2	Content Owner: Jabil	Content Type: Requirement

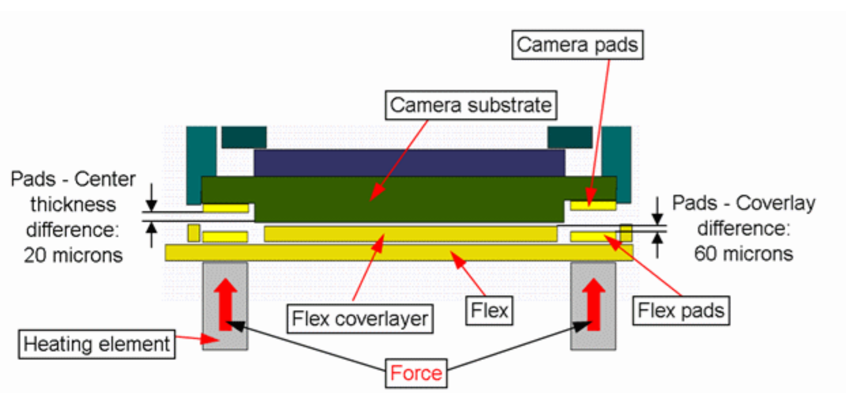
ACF cover layer and / or copper areas may be the reason for problems with the bonding process. Make sure the conductive contacts on the bonding area are not (partially) covered by a cover layer which is hampering a good connection. For illustration of the problem see also explanation below.



Make sure that there is no (partial) cover layer near the conductive contacts on the bonding area which is the reason for the requirement of a higher bonding pressure during the bonding process.



As you can see in the picture below the distance between the camera pads and the flex pads is at least 80 microns (0.0031"). Deducting the ACF material (25 microns / 0.0009") we still have a gap of 55 microns (0.0022"). Therefore too much force is transmitted to the center of the camera substrate, deforming it and changing the focus.



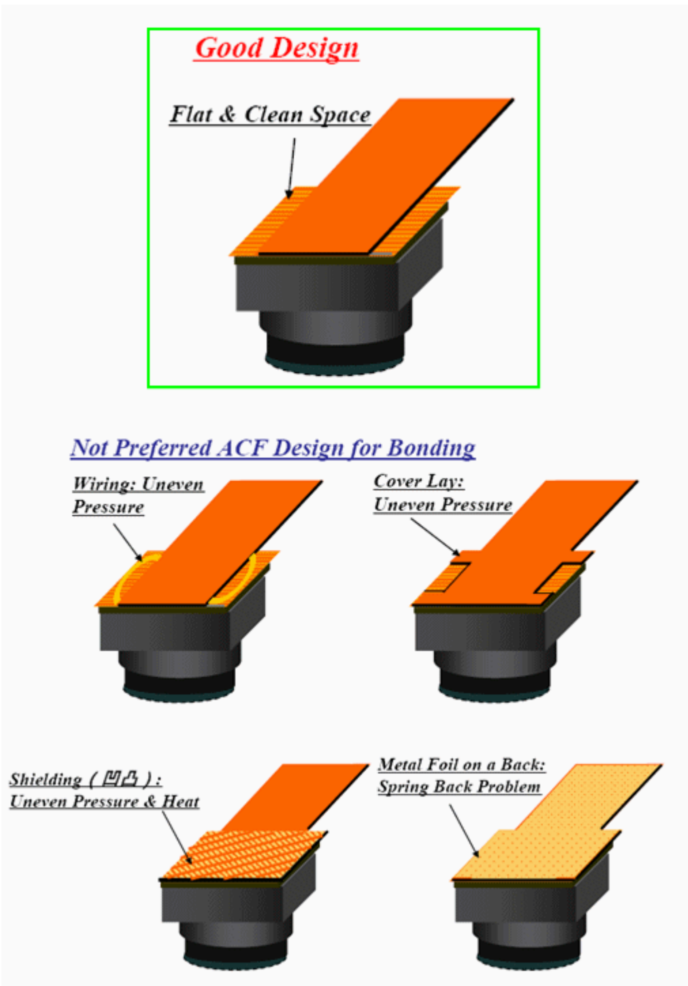
Entry ID: 1401

Back Side of ACF Pads

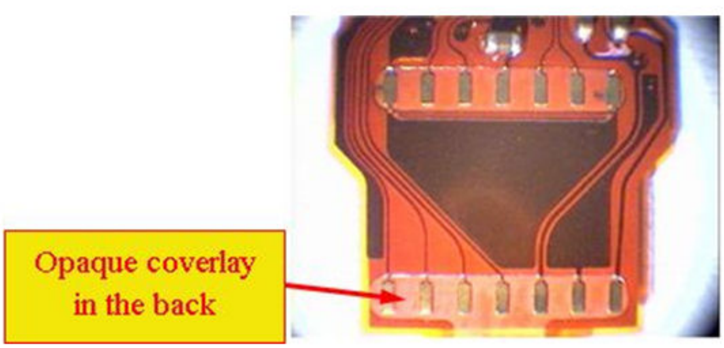
Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

If possible, always try to have a flat and clean ACF surface (pad area) and no shielding or mesh layer, etc.



Copper or opaque cover layer located on the back of the pads area covers the area and there is no possibility to check the pad alignment during / after bonding.



Also, the peel strength could drop if any of these additional layers are present. Therefore the temperature and / or the pressure have to be increased to get the same peeling results as without any additional layers.

DFA > Flex / ACF Bonding > Flex / ACF Bonding Requirements

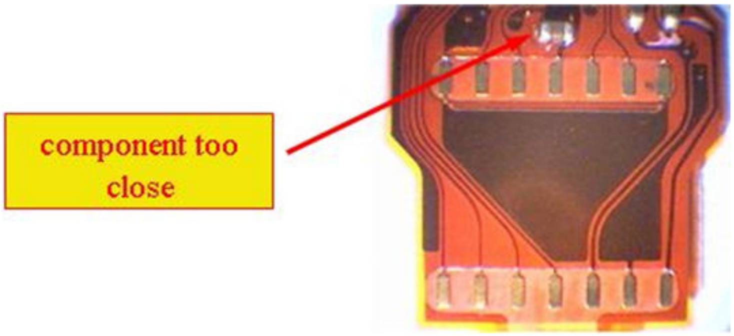
Entry ID: 1402

Component Keep-out Around ACF Bonding Area

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Minimum distance from ACF bonding area to components = 0.040" (1.0160mm). Components located too close to the ACF bonding area can interfere mechanically as well as act as heat sinks and locally reduce the temperature.



DFA > Flex / ACF Bonding > Flex / ACF Bonding Requirements

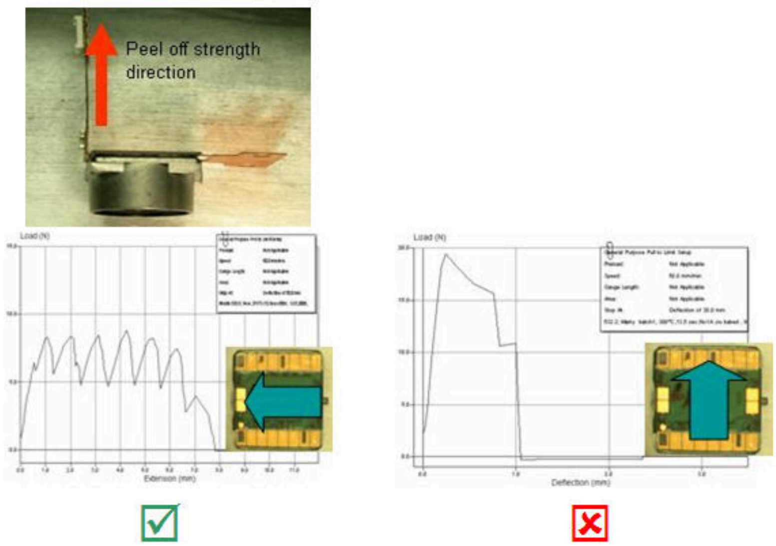
Entry ID: 1403

ACF / FPC Orientation

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

For ACF bonding, the FPC orientation should be parallel to the pad rows to maximize peel strength.



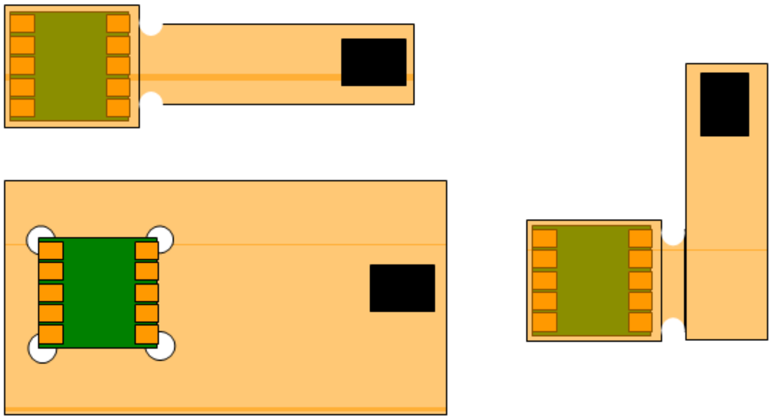
DFA > Flex / ACF Bonding > Flex / ACF Bonding Requirements
Entry ID: 1404

ACF / FPC Stress Relief

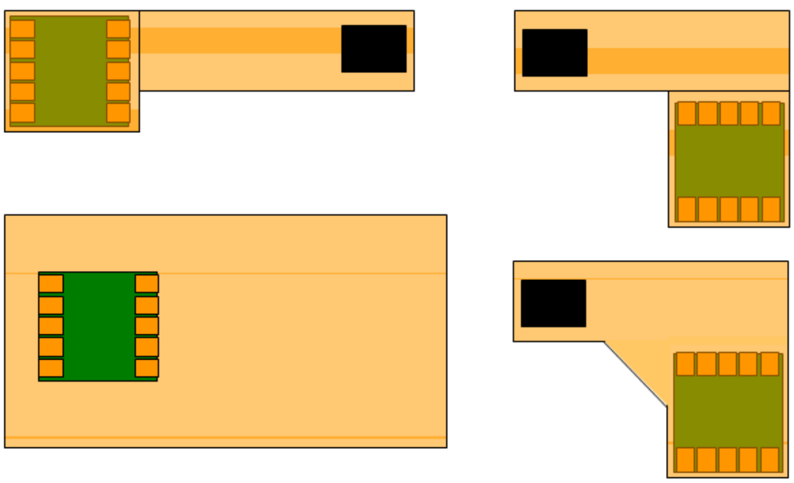
Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

A flexible relative movement between the ACF area and the rest of the FPC is required to avoid any transmission of stress applied during handling and assembly. To achieve this, provide stress relief:



The following pictures show poor designs that don't have stress relief. The forces generated during handling and assembly can be transmitted to the weakest points of the design which are the corner (anchor) pads.



The force can be transmitted to the joints in a perpendicular way. These radii and distance from the edge avoid stress applied to the weakest point and reduce or avoid forces that will create cracks starting at the corner pads, cracks on the bond, or induce complete breaks.

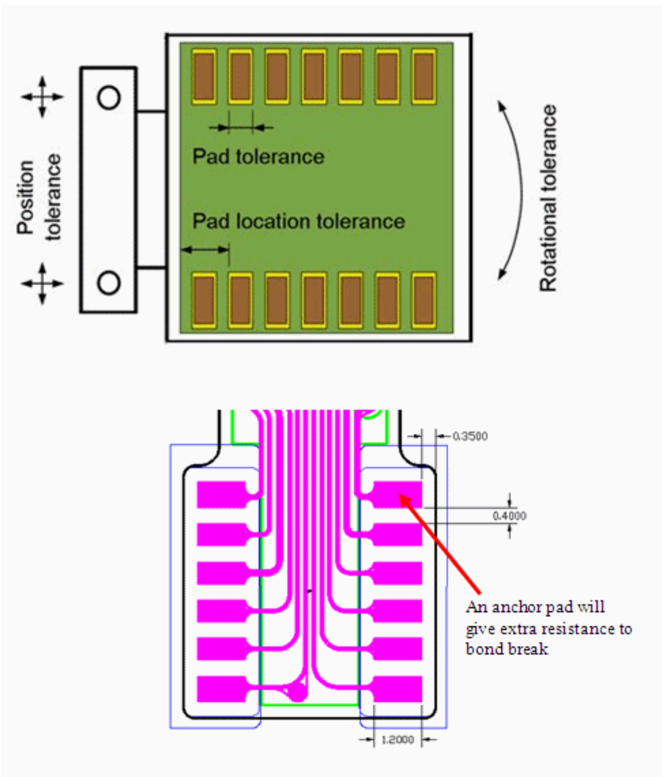
DFA > Flex / ACF Bonding > Flex / ACF Bonding Requirements
Entry ID: 1405

ACF Pad Size

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Use the maximum possible ACF pad size. For SMIA (industry standard for camera modules) the maximum pad size is the one that allows a gap of 0.6000mm (0.024") between pad edges. If proper alignment features are used (alignment pins close to the pads area) the gap can go down to 0.4000mm (0.016") but not smaller. The pad length should be as long as possible. If not all pads can be increased for any reason (e.g. tolerances, layout), make the corner (anchor) pads as big as possible.



Correct pad size is necessary and can be calculated as follows: take the camera pad dimensions and deduct the tolerances of the FPC alignment holes, alignment pins, rotation caused by the alignment pins, camera pads and camera pad location. Then deduct some safety margin to determine the pad size. Larger pads maximize peel strength.

DFA > Flex / ACF Bonding > Flex / ACF Bonding Requirements
Entry ID: 1406

FPC Alignment Holes

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Make sure the alignment holes on the FPC needed during the bonding process are the right distance to the bonding pads.

	Advantages	Disadvantages
	Closer distance to the camera, less variation	Need to remove alignment tab
	No need of tab removal	Need three holes to reduce position variation

If the distance to the alignment pins is optimized, the risk of tape misalignment during the lamination process is very low.

- If the distance is too large, there is a high risk of misalignment due to the degree of rotation.
- If the distance is too small, the positioning pins may interfere with the ACF tape and this can cause scratches on the ACF material (if pins are on the left side of bonding area and only if pins are in the same line as pads).

DFA > Flex / ACF Bonding > Flex / ACF Bonding Requirements

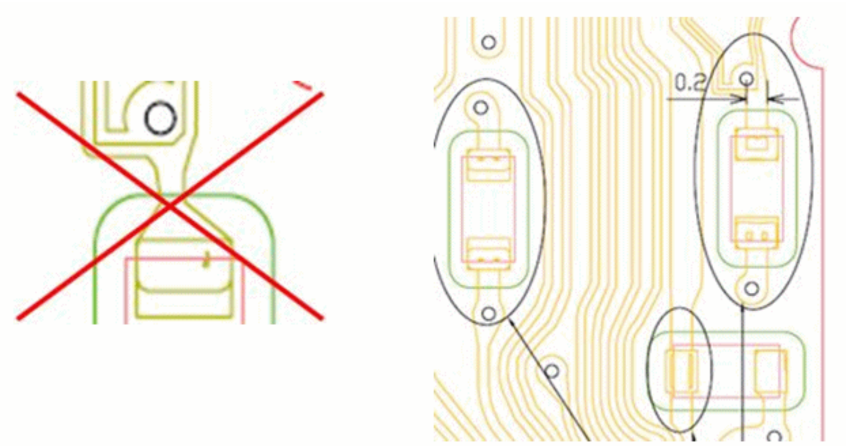
Entry ID: 1407

FPC Trace to Pad Connection

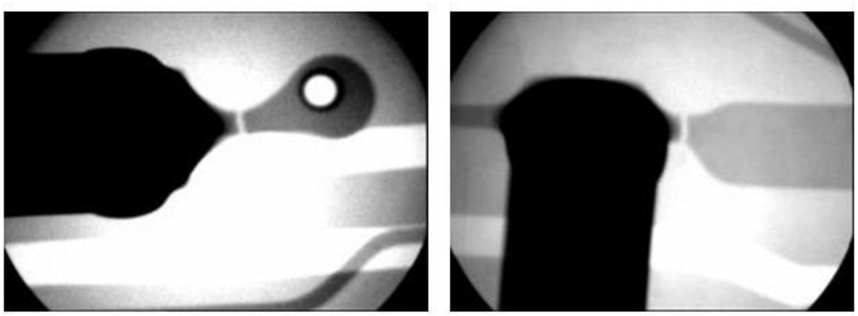
Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Maintain the same FPC trace width leading up to the pad of the component.



If the trace width is varied, the trace is more prone to damage during assembly.



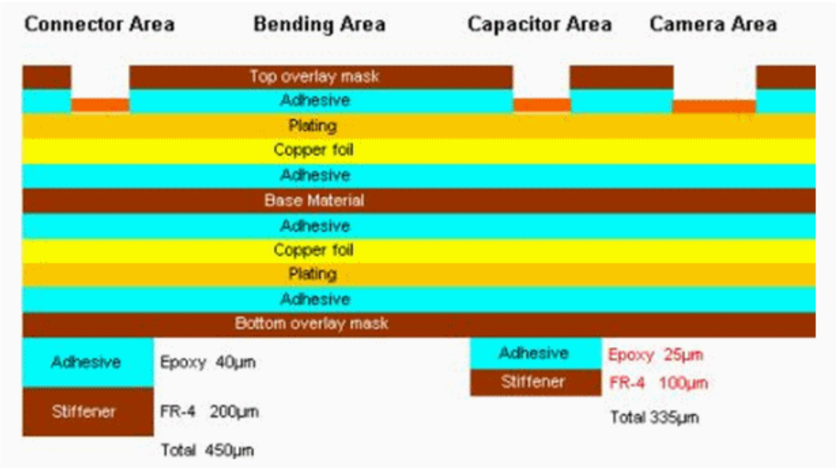
Entry ID: 1408

FPC Stiffeners

Rule

CID: 2	Content Owner: Jabil	Content Type: Requirement

Stiffeners have to be located at the back side of connectors and components (capacitors). Below is an example of the construction of a FPC with stiffeners.



Stiffeners have to be designed as a part of the FPC to ensure that no flexure related stress is exerted on the solder joints.

Related Entries

DFA Guideline 1410 Flex / ACF Bonding > Flex / ACF Bonding Requirements > For stiffener requirements on the side opposite test points.

DFA > Flex / ACF Bonding > Flex / ACF Bonding Requirements
Entry ID: 1409

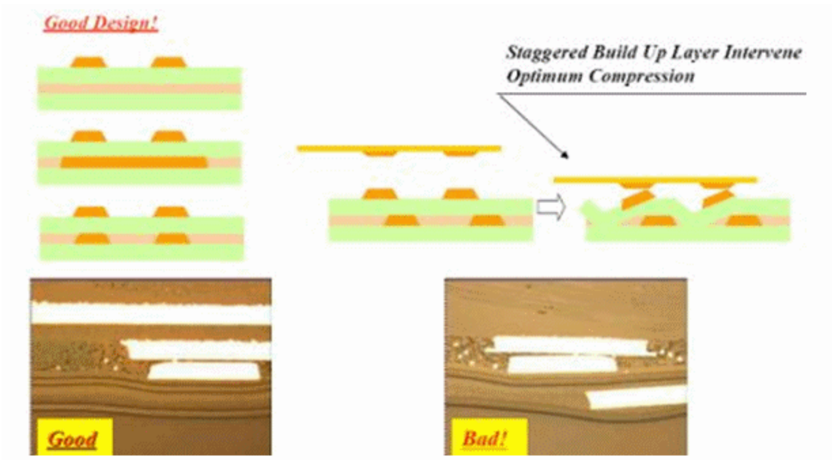
FPC Layer Stackup

Guideline

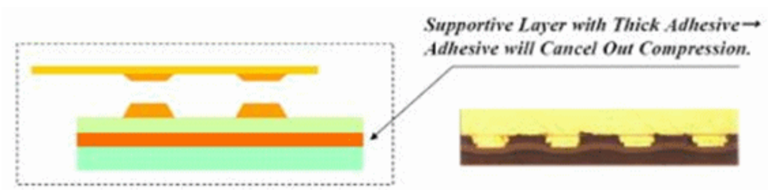
CID: 2	Content Owner: Jabil	Content Type: Requirement

1. Make sure the layer build up of the FPC has no staggered layers.
2. Make sure no thick adhesive layer is used in the flex layer build up.
3. If possible no shield layers should be in the build up.

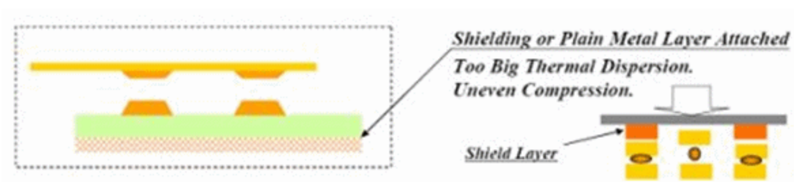
a) If the build up has staggered layers there will be a high risk of open bonding joints and the peel strength can be low.



b) If a thick adhesive layer is used in the FPC this may cancel out the compression during the bonding process resulting in poor peel strength.



c) If the FPC build up uses shielding layers this can cause an uneven compression and / or too big of a thermal dispersion resulting in poor peel strength and / or low curing rate values.



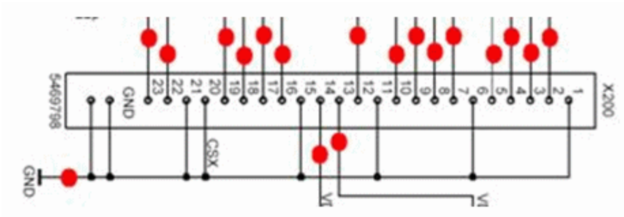
DFA > Flex / ACF Bonding > Flex / ACF Bonding Requirements
Entry ID: 1410

FPC Testability

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

a) If not utilizing the connector in the FPC for test, the circuit must have enough test points for each contact on the connector.

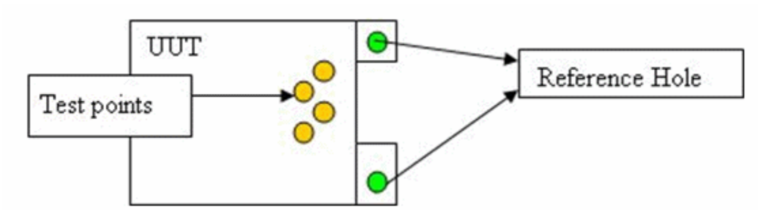


CID: 3	Content Owner: Jabil	Content Type: Information

b) See Entry 1034 for test point size and test point center to test point center spacing.

CID: 4	Content Owner: Jabil	Content Type: Requirement

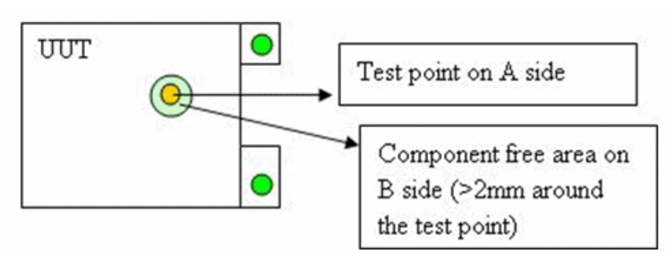
c) The alignment holes should be located as near as possible to the test points.



CID: 5	Content Owner: Jabil	Content Type: Requirement

d) The test area must have a stiffener at the back side and no components.

e) Minimum distance from test points to components on the opposite side of the FPC = 0.079" (2.0000mm).



Related Entries

DFM Rule 1034 PCB Design > Test Points > Test Points
DFA Rule 1408 Flex / ACF Bonding > Flex / ACF Bonding Requirements > FPC Stiffeners

DFA > Flex / ACF Bonding > Flex / ACF Bonding Requirements
Entry ID: 1412

FPC Clearance for Bonding Equipment

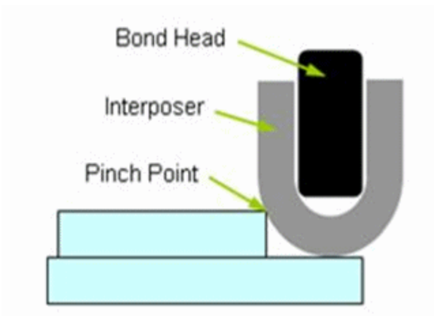
Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

For ACF bonding, ensure there is enough clearance for the FPC bonding equipment.

You typically have a limited FPC area on which to bond. Make sure you don't use too much of that space that you miss other process relevant things (interposer material, head placement).

If the space (bond line to next component or other items) is not sufficient, components may break or the interposer may get damaged. Also, the bonding pressure can change causing low peel strength.



Entry ID: 1413

ACF / Camera Thermal and Pressure Requirements

Rule

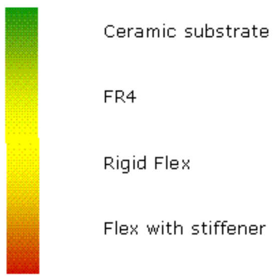
CID: 2	Content Owner: Jabil	Content Type: Requirement

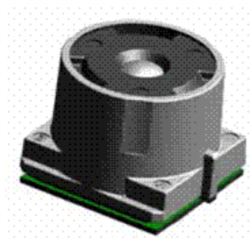
Observe the thermal and pressure requirements of cameras for ACF bonding.

a) The camera body material has to withstand a temperature according to the specification of the ACF tape. This can be between 50°C to 120°C.

b) The camera body material has to withstand a force according to the specification of the ACF tape. This can be between 20N to 30N (1MPa to 1.5MPa).

c) The mechanical properties of the substrate have to match with the conditions (pressure & heat) of the process.





Failure mode:

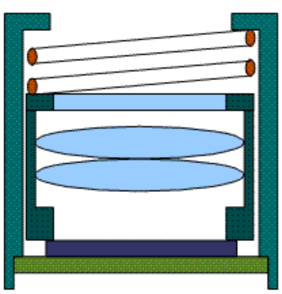
a) If the temperature of the camera body is too high it can be deformed and the performance (focus) will change.

b) If the force applied to the body is too high the material can also be deformed and the performance (focus) will change.

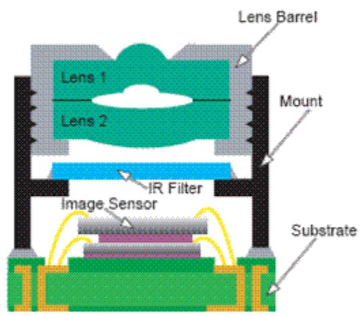
c) Since both parameters (pressure and heat) are applied directly to the substrate during the process, the mechanical properties must match the conditions, the parameters should be adjusted to them or the bonding performance will vary.

d) If this adhesive between camera substrate and body gets weak again (to much heat or pressure), the performance (focus values) will change. The substrate with the sensor is attached to the body using dispensed adhesive. Using PSA tape instead of dispensed adhesive may be a better alternative. PSA reacts better to pressure and has a controlled thickness in the complete perimeter of the substrate.

e) If the distance from camera sensor to lens is changed (up to 4µm/0,00016") the focus will degrade.



In this method the lens is always at the same distance by effect of the spring.



In this method the distance changes with temperature and pressure.

Entry ID: 1414

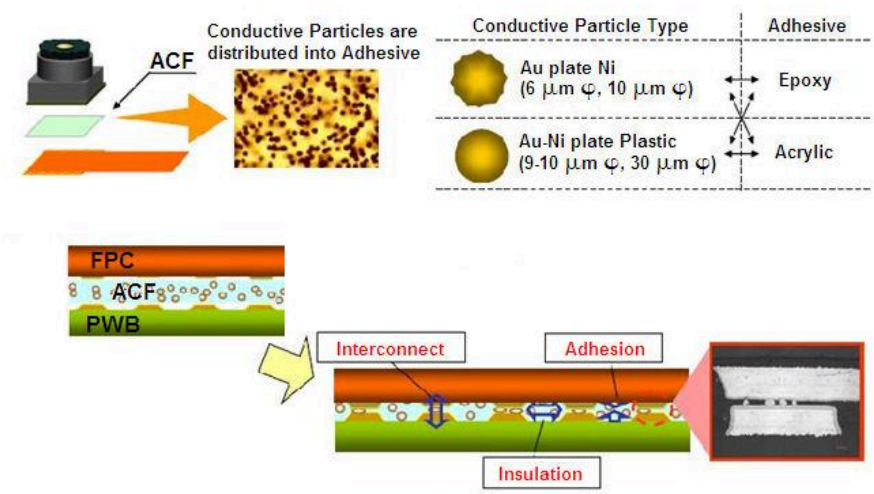
Flex / ACF Bonding General Information

Information

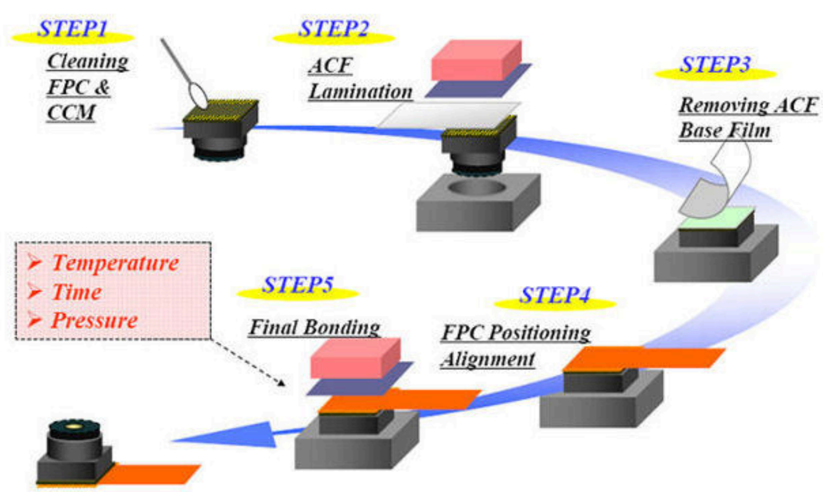
CID: 1	Content Owner: Jabil	Content Type: Information

ACF bonding technology can replace soldering technology in case sockets or reflow capable cameras are not economical or the design requires the low profile provided by ACF.

ACF bonding is an interconnection technique used for connecting cameras or displays to PCBs. If basic constraints are followed, ACF bonding is a simple and reliable process for manual or automated assembly that can be done in any factory.



Process Steps:



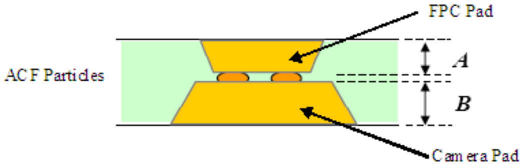
DFA > Flex / ACF Bonding > Flex / ACF Bonding Requirements
Entry ID: 1415

ACF Tape Thickness

Information

CID: 1	Content Owner: Jabil	Content Type: Information

Calculation:



ACF thickness = (A+B)/2 + ~10µm (0,0004")

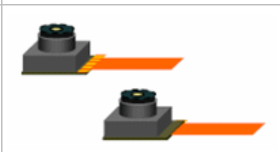
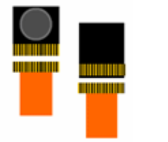
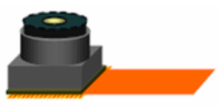
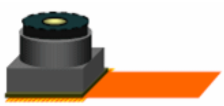
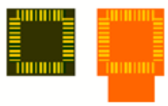
DFA > Flex / ACF Bonding > Flex / ACF Bonding Requirements
Entry ID: 1416

Various ACF Interconnect Designs for CCM

Information

CID: 1	Content Owner: Jabil	Content Type: Information

Various ACF interconnect designs for CCM (CMOS Camera Modules).

	Application	PWB & FPC Design	ACF Particle Diameter	Ranking	JABIL
1 Row ACF Bonding			6-10µm (0,0024-0,0004")	Best Case	Not in use, but possible
2 Row ACF Bonding			6-10µm (0,0024-0,0004")	2nd Best Case	Used within Jabil
4 Row ACF Bonding			30µm (0,0012")	3rd Best Case	Not preferred

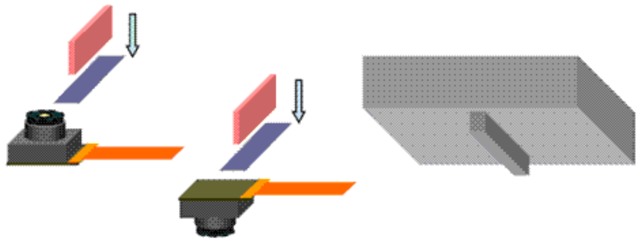
DFA > Flex / ACF Bonding > Flex / ACF Bonding Requirements
Entry ID: 1417

ACF Bonding Head Structure Configurations

Information

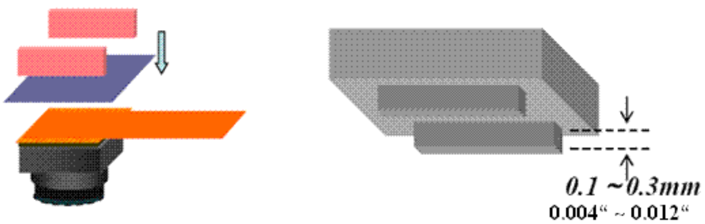
CID: 1	Content Owner: Jabil	Content Type: Information

Single line bonding



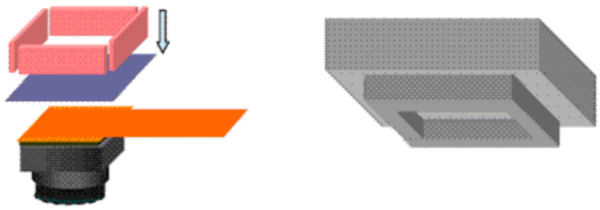
- Stable Heating Distribution resulting in good curing rate results (better ramping up in temperature profile).
- Stable Co-Planarity resulting in more reliable peel strength values.
- Simple ACF Bonding Technique

Double line bonding



Co-Planarity adjustment important and could be an impact on peel strength values.

Four line bonding



Very difficult regarding co-planarity and heat distribution resulting in poor peel strength values. Also the target for curing rate could be hard to achieve.

DFA > Heat Staking > Heat Staking Requirements
Entry ID: 1194

Heat Staking General Information

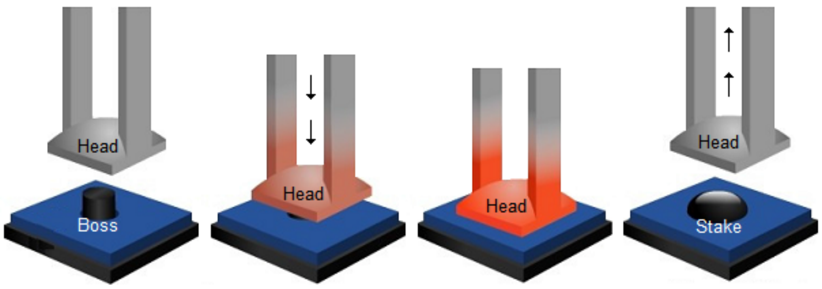
Information

CID: 1	Content Owner: Jabil	Content Type: Information

Introduction

Heat staking joins two or more parts where at least one is made out of plastic. Often the other part is made from a different material. The plastic part has bosses that protrude through holes in the other part. The bosses are then compressed using heat and force to form a stake that mechanically locks the two parts together.

The quality of the joint depends on control of the critical process parameters: temperature, pressure and time. A typical cycle time is between 1 and 5 seconds.



Advantages

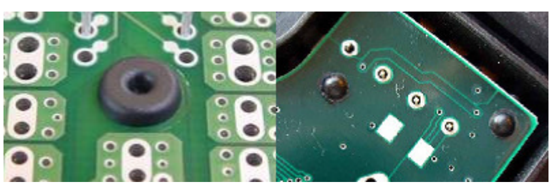
Physically and visually the heat staked assembly appears to be an extension of the molding or fabricating process.

Heat staking is an easy to operate, low maintenance, cost effective, repeatable and easily automated process for mechanically attaching products. It has the advantage that no consumables such as rivets and screws are required.

Disadvantages

Heat staking parts cannot be dis-assembled without damaging at least one of the parts.

Examples



Related Entries

DFA	Information	1195	Heat Staking > Heat Staking Requirements > Heat Stake Types
DFA	Guideline	1197	Heat Staking > Heat Staking Requirements > Heat Stake Size
DFA	Guideline	1200	Heat Staking > Heat Staking Requirements > Heat Stake Clearance

DFA > Heat Staking > Heat Staking Requirements
Entry ID: 1195

Heat Stake Types

Information

CID: 1	Content Owner: Jabil	Content Type: Information

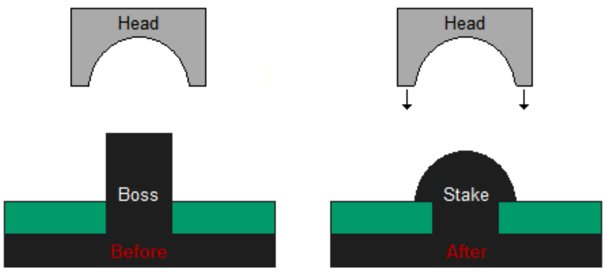
Introduction

There are a number of different heat stake types. The appropriate stake type depends on the size of the boss and what material will be used to connect the parts. Use the following pros and cons to help determine which stake type will best fit the application.

Dome Stake

The dome stake is the most commonly used. It is recommended for materials such as rigid crystalline / semi-crystalline / nylon with tightly controlled melting temperatures, abrasive fillers, glass filled and for materials that degrade easily.

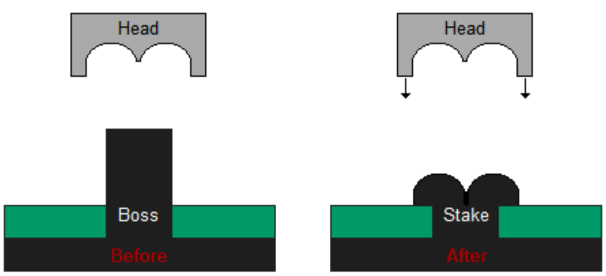
Pros	Cons
Generally used with bosses that have an outer diameter of <= 0.250" (6.3500mm)	A post assembly cooling process may be necessary
Produces a tight stake	
Comes in high and low profile	
Works well with counterbored holes	
Cosmetically pleasing	
Works well with a handheld heating tool	
Looser tolerances make it easier to align	
A wide variety of heads allows for many different dome shapes	



Rosette (Flared) Stake

The rosette stake satisfies the requirements of most applications. This stake is ideally suited for low density, nonabrasive amorphous plastics.

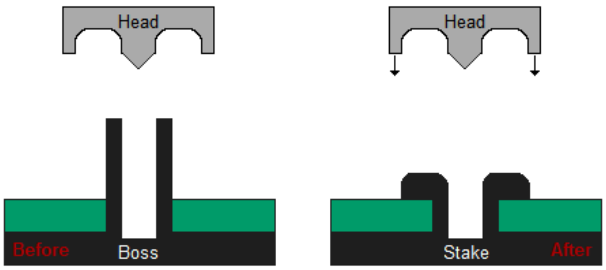
Pros	Cons
Generally used with bosses that have an outer diameter of 0.063" (1.6002mm)	Not recommended for parts with multiple heat staking locations
Flares out material giving 360° of even holding strength	Requires very accurate positioning so that the center of the head hits the center of the boss
Less staking force required	
Comes in high and low profile	
Less cycle time than a dome stake for large bosses	
Cosmetically pleasing (looks like a rivet)	
Easy to repair because there is a pilot hole for a screw	



Hollow Stake

Hollow stakes produce a large, strong stake without having to melt a lot of material resulting in less time and force required.

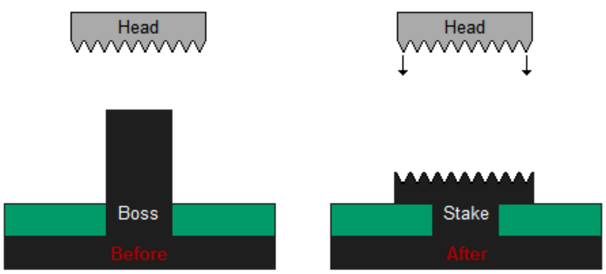
Pros	Cons
Works well with bosses that have an outer diameter of >= 0.080" (2.0320mm)	Requires very accurate positioning so that the center of the head hits the center of the boss
Avoids sink marks on the opposite side of the part	
Cosmetically pleasing, it looks like it is part of the finished molded product	
Parts can be repaired with self tapping screws	



Knurled Stake

The knurled stake is used in applications where appearance and strength are not critical. Generally, the pitch and texture of the knurl is related to the diameter of the stake.

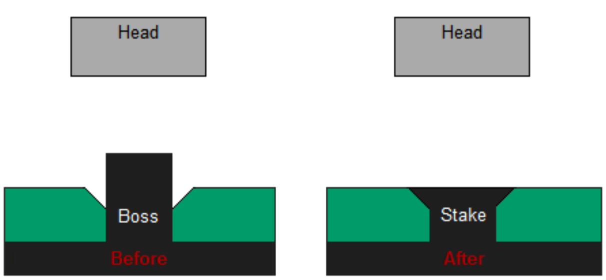
Pros	Cons
Alignment is not an important factor	
Ideally suited for automated assembly	
A single head can be used for many different stakes without alignment issues	
Flexible enough that it is also recommended for use with a handheld heating tool	
Available in a fine, medium and coarse knurl	
Ideal if thermal expansion is an issue	
Works well when the mating component has a countersink	
Significantly reduces cycle time	



Flush Stake

The flush stake is used for applications requiring a flush surface.

Pros	Cons
Produces a tight stake	The mating part has to have sufficient thickness for a countersink
Cosmetically pleasing	The volume of the boss is crucial to fill the countersink properly
Loose tolerances make it easy to align	



Related Entries

DFA Information	1194	Heat Staking > Heat Staking Requirements > Heat Staking General Information
DFA Guideline	1197	Heat Staking > Heat Staking Requirements > Heat Stake Size
DFA Guideline	1200	Heat Staking > Heat Staking Requirements > Heat Stake Clearance

DFA > Heat Staking > Heat Staking Requirements
Entry ID: 1197

Heat Stake Size

Guideline

CID: 7	Content Owner: Jabil	Content Type: Information

Introduction

The boss material is redistributed during heating but the original volume will not change. The finished height and diameter of the heat stake will be directly proportional to the original volume of the boss.

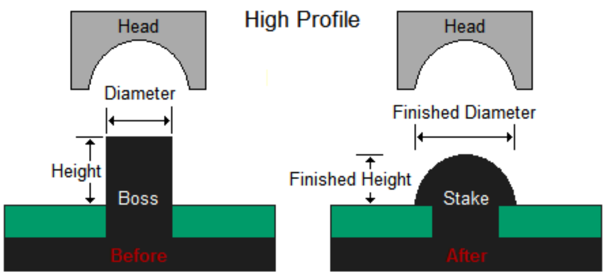
Note: The boss height is measured from the top surface of the captured material to the top of the boss.

CID: 2	Content Owner: Jabil	Content Type: Requirement

Dome Stake

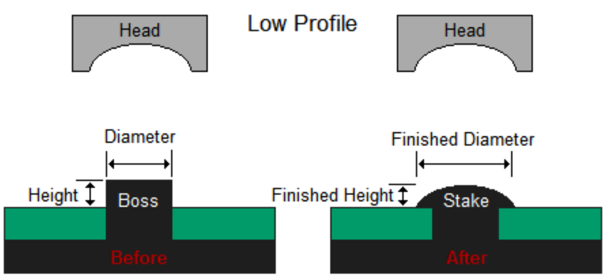
High Profile: boss height = 1.75 X boss diameter

- Finished stake height = 0.75 X boss diameter
- Finished stake diameter = 2 X boss diameter



Low Profile: boss height = 0.45 X boss diameter

- Finished stake height = 0.375 X boss diameter
- Finished stake diameter = 1.5 X boss diameter



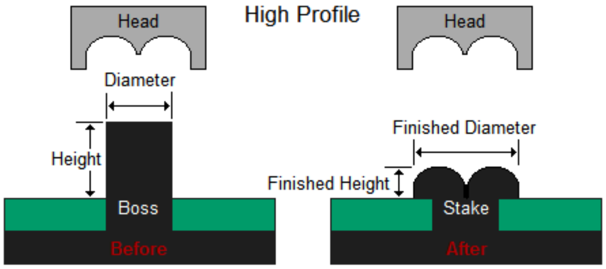
Other heights can cause issues with the size, shape and strength of the finished stake, potentially causing a safety issue if the part falls off.

CID: 3	Content Owner: Jabil	Content Type: Requirement

Rosette Stake

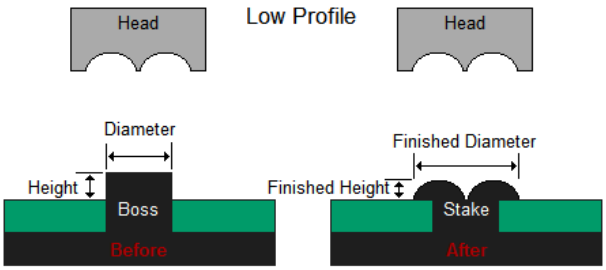
High Profile: boss height = 1.5 X boss diameter

- Finished stake height = 0.5 X boss diameter
- Finished stake diameter = 2 X boss diameter



Low Profile: boss height = 0.41 X boss diameter

- Finished stake height = 0.25 X boss diameter
- Finished stake diameter = 2 X boss diameter



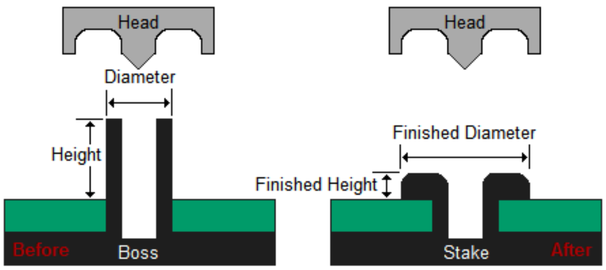
Other heights can cause issues with the size, shape and strength of the finished stake, potentially causing a safety issue if the part falls off.

CID: 4	Content Owner: Jabil	Content Type: Requirement

Hollow Stake

Boss height = 1.5 X boss outer diameter
Boss inner diameter = 0.5 X boss outer diameter

- Finished stake height = 0.375 X boss outer diameter
- Finished stake diameter = 2 X boss outer diameter



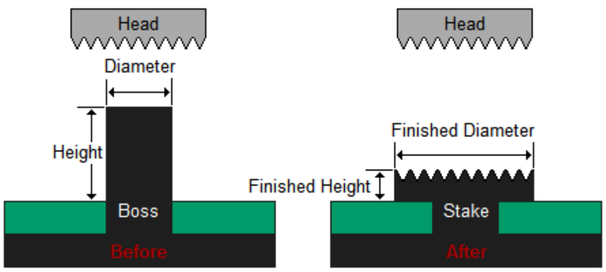
Other heights or internal diameters can cause issues with the size, shape and strength of the finished stake, potentially causing a safety issue if the part falls off.

CID: 5	Content Owner: Jabil	Content Type: Requirement

Knurled Stake

Boss height = 1.38 X boss diameter

- Finished stake height = 0.375 X boss diameter
- Finished stake diameter = 2 X boss diameter



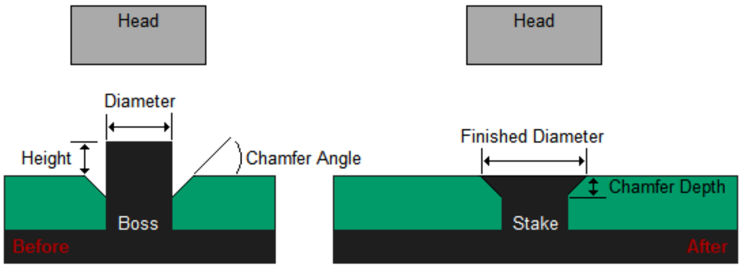
Other heights can cause issues with the size, shape and strength of the finished stake, potentially causing a safety issue if the part falls off.

CID: 6	Content Owner: Jabil	Content Type: Requirement

Flush Stake

Boss height = 0.5 X boss diameter
Chamfer angle = 45°
Chamfer depth = 0.38 X boss diameter

- Finished stake height = flush
- Finished stake diameter = 1.9 X boss diameter



Other heights, angles or depths can cause issues with the size, shape and strength of the finished stake, potentially causing a safety issue if the part falls off.

Related Entries

DFA	Information	1194	Heat Staking > Heat Staking Requirements > Heat Staking General Information
DFA	Information	1195	Heat Staking > Heat Staking Requirements > Heat Stake Types
DFA	Guideline	1200	Heat Staking > Heat Staking Requirements > Heat Stake Clearance

DFA > Heat Staking > Heat Staking Requirements
Entry ID: 1200

Heat Stake Clearance

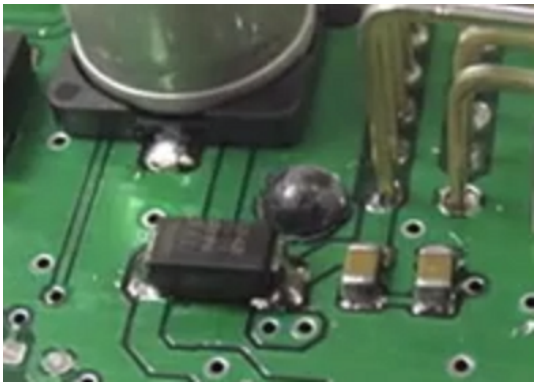
Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

There is no single clearance for the heat stake process. The distance will vary depending on the product characteristics.

Things to consider when establishing clearance:

- There must be enough space around the head that it does not make physical contact with adjacent product features
- Features too close to the heated area may melt; this is especially critical if they are visible from the outside
- Parts sensitive to heat may not melt but could still be damaged
- SMT components too close to the heating area may have their solder joints experience secondary reflow and make them susceptible to being blown off the board if air is used to cool the stake
- If secondary reflow occurs, this could also result in a disturbed solder joint



Related Entries

DFA	Information	1194	Heat Staking > Heat Staking Requirements > Heat Staking General Information
DFA	Information	1195	Heat Staking > Heat Staking Requirements > Heat Stake Types
DFA	Guideline	1197	Heat Staking > Heat Staking Requirements > Heat Stake Size

DFA > Injection Molding > Injection Molding Requirements
Entry ID: 1528

Injection Molding General Information

Information

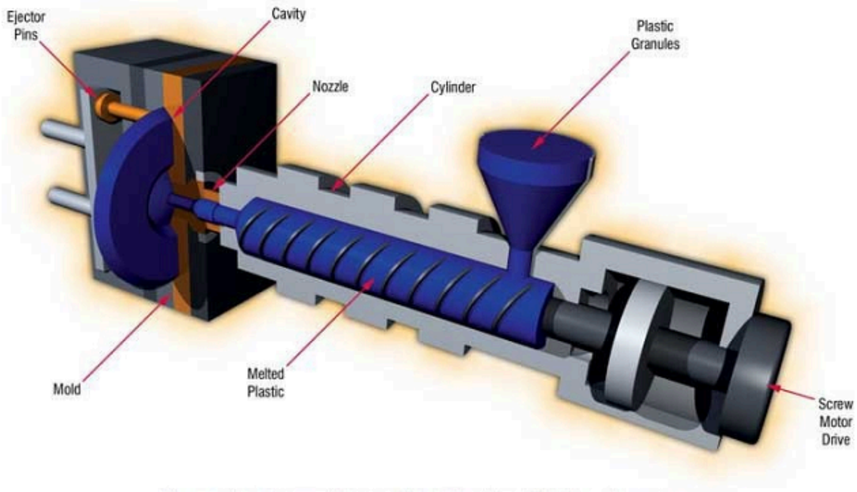
CID: 1	Content Owner: Jabil	Content Type: Information

Introduction

Injection molding is the most common manufacturing process for producing economical and automated plastic parts. Once a part is designed, a mold is made and a precision machined process is used to form the features of the desired part. The injection molding takes place when a thermoplastic, thermoset or elastomer material is fed into a heated barrel, mixed and forced into the metal mold cavity where it cools and hardens to the configuration of the cavity before being ejected.

Process

The injection molding process uses a granular plastic that is gravity fed from a hopper. A screw type plunger forces the material into a heated chamber, called a barrel, where it is melted. The plunger continues to advance, pushing the polymer through a nozzle at the end of the barrel that is pressed against the mold. The plastic enters the mold cavity through a gate and runner system. After the cavity is filled, a holding pressure is maintained to compensate for material shrinkage as it cools. At this same time, the screw turns so that the next shot is moved into a ready position, and the barrel retracts as the next shot is heated. Because the mold is temperature controlled, the plastic solidifies soon after the mold is filled. Once the part inside the mold cools completely, the mold opens, and the part is ejected. The next injection molding cycle starts the moment the mold closes and the polymer is injected into the mold cavity.



Stress

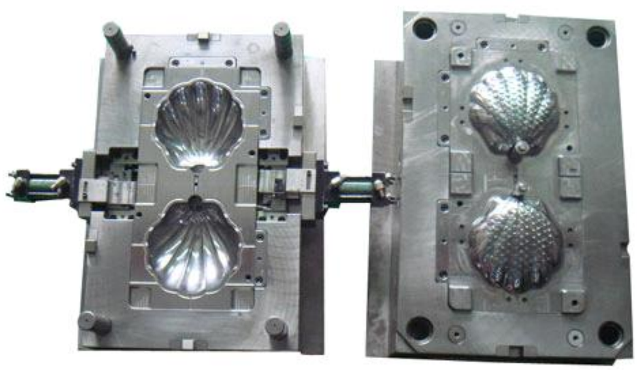
The main enemy of any injection molded plastic part is stress. When a plastic resin (which contains long strains of molecules) is melted in preparation for molding, the molecular bonds are temporarily broken due to the heat and shear force of the extruder and gate, allowing the molecules to flow into the mold. As the molecules are pushed through each feature, they are forced to bend, turn and distort to form the shape of the part. Turning hard or sharp corners exerts more stress on the molecule than taking gentle turns with generous radii. Abrupt transitions from one feature to another are also difficult for the molecules to fill and form.

As the material cools and the molecular bonds re-link into its rigid form, these stresses are in effect locked into the part. Part stresses can cause warpage, sink marks, cracking, premature failure and other problems.

Tooling

The terms mold and die are used interchangeably to describe the tooling applied to produce plastic parts. They are typically constructed from steel, hardened steel and aluminum. Of these materials, hardened steel molds are the most expensive to make, but offer the user a longer lifespan that offsets the cost per part by spreading it over a larger quantity. For low volumes, steel or aluminum molds provide a less wear resistant, less expensive and quick turn option.

The most economical molds for mass production are produced out of hardened steel. When designed and built using CNC machines or EDM processes, these molds can economically produce hundreds of thousands of parts. Note that beryllium copper may be used in areas of the mold that require fast heat removal or places that see the most shear heat generated.



Types of Injection Molding Processes

- Double Shot
- IMR
- IML / IMF
- Insert Molding
- EXO
- GIM
- Micro-Hole Molding

Related Entries

DFA	Information	1529	Injection Molding > Injection Molding Requirements > Injection Molding Materials Selection
DFA	Guideline	1530	Injection Molding > Injection Molding Requirements > Injection Molding Part Design

DFA > Injection Molding > Injection Molding Requirements
Entry ID: 1529

Injection Molding Materials Selection

Information

CID: 1	Content Owner: Jabil	Content Type: Information

Introduction

Selection of the proper injection molding material is crucial to part production and function. Designers should consider the mechanical characteristics, molding properties and cost of the material used.

Application specific requirements drive the need for particular material properties like tensile strength, impact resistance and elasticity.

Successful designs for injection molded parts are also built on an understanding of process related issues such as the ability to fill the mold, tendency to create flash, ease of part ejection, and the potential for warp, sink or void creation. Part design can be used to help address some of these issues, but material properties should be considered to ensure the moldability of the part.

Beyond the criteria listed below, there are other factors that should be considered such as chemical resistance, weight, finish, moldability, weldability (ultrasonic heat), etc.

Note: There are many other materials available, these are for reference only. The molding vendor should always be consulted before making final decisions.

Material Properties

Generic Name	Brand Name	Strength	Impact Resistance	Change to Stiffness
Acetal	Delrin	Medium	Medium	Low to Medium
Nylon 6/6	Zytel	Medium	High	Low
Glass Filled Nylon 6/6	Zytel	High	Medium	High
PP	Marlex, Sumika	Low	High	Low
Polycarbonate	Lexan	Medium	High	Medium to High
ABS	Cycolac	Low to Medium	High	Low
Polycarbonate / ABS Alloy	Cycoloy	Medium	High	Medium
PEI	Ultem	High	Medium	High
Fiber Reinforced PEI	Ultem	Very High	Medium	High
PBT	Valox	Medium	High	Low
PS	Styron	Low to Medium	Low	Low
TPU	Santoprene	Low	High	Low

Recommended Wall Thicknesses by Material Type

Note: Thicker and thinner walls are possible dependent on the flow rate of the material and the runner system / gates.

Material	Minimum	Maximum
ABS	0.045" (1.1430mm)	0.140" (3.5560mm)
Acetal	0.030" (0.7620mm)	0.120" (3.0480mm)
Acrylic	0.025" (0.6350mm)	0.150" (3.8100mm)
Liquid Crystal Polymer	0.030" (0.7620mm)	0.120" (3.0480mm)
Long-Fiber Reinforced Plastics	0.075" (1.9050mm)	1.000" (25.4000mm)
Nylon	0.030" (0.7620mm)	0.115" (2.9210mm)
Polycarbonate	0.040" (1.0160mm)	0.150" (3.8100mm)
Polyester	0.025" (0.6350mm)	0.125" (3.1750mm)
PE	0.030" (0.7620mm)	0.200" (5.0800mm)
PPS	0.020" (0.5080mm)	0.180" (4.5720mm)
PP	0.025" (0.6350mm)	0.150" (3.8100mm)
PS	0.035" (0.8890mm)	0.150" (3.8100mm)
PUR	0.080" (2.0320mm)	0.750" (19.0500mm)

Approximate Material Costs

Material Group	Cost
ABS	Low to Very High
Acetal	Medium to High
Acrylic	Low
Nylon	Medium to High
PBT	Medium to Very High
Polycarbonate	Medium to Very High
PET	Low to Medium
PP	Low to High
PPS	High to Very High

Material Group	Cost
PS	Low
TPE	Low
TPU	Medium

Related Entries

DFA	Information	1528	Injection Molding > Injection Molding Requirements > Injection Molding General Information
DFA	Guideline	1530	Injection Molding > Injection Molding Requirements > Injection Molding Part Design

DFA > Injection Molding > Injection Molding Requirements
Entry ID: 1530

Injection Molding Part Design

Guideline

CID: 2	Content Owner: Jabil	Content Type: Information

Introduction

Parts to be injection molded must be very carefully designed to facilitate the molding process. The material used for the part, the desired shape and features of the part, the material of the mold and the properties of the molding machine must all be taken into account. Parting lines where the core and cavity or moving parts meet should be carefully considered to minimize any impact on the final part.

These are the recommended best practices but are guidelines only. The product requirements or process capabilities may allow for other decisions or mitigation plans.

A mold flow study and consulting the vendor on all aspects of part design is highly recommended.

CID: 3	Content Owner: Jabil	Content Type: Requirement

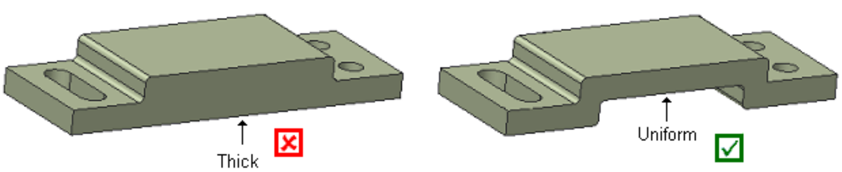
Wall Thickness

Maintain uniform wall thickness

- Different wall thicknesses cool at different rates and can cause warping, twisting or cracking where the different thicknesses meet.

Avoid thick part areas

- Plastic solidifies from the mold surface toward the inside of the part and in thick areas, inward pulling stresses from contraction can cause sink marks on the outer surfaces of the part.



Maintain wall thickness variation of less than 25%

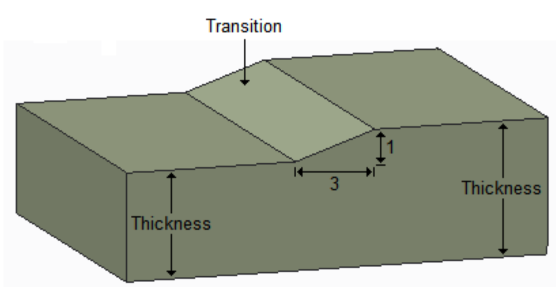
- Too much wall thickness variation can cause warping, twisting or cracking where the different thicknesses meet.

Wall thickness length to width transition = 3 to 1

- Gradual transitions avoid stress concentrations and cooling rate differences.

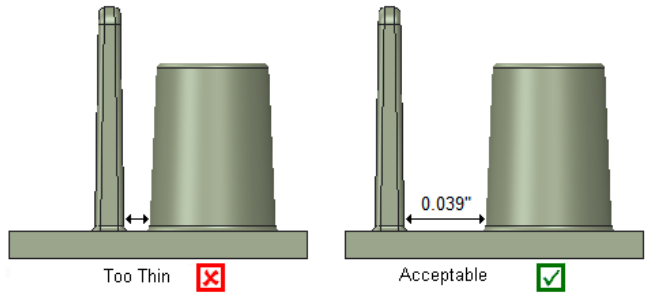
Minimum wall thickness for most common materials = 0.020" (0.5000mm)

- Thin part walls may not be strong enough, may not fill completely and may have issues cooling.



Minimum mold wall thickness between features = 0.039" (1.0000mm)

- A thin mold wall can be hard to cool, affecting quality and resulting in a shorter life for the mold.



Draft Angles

Provide draft angles on surfaces that are perpendicular to the molds parting line

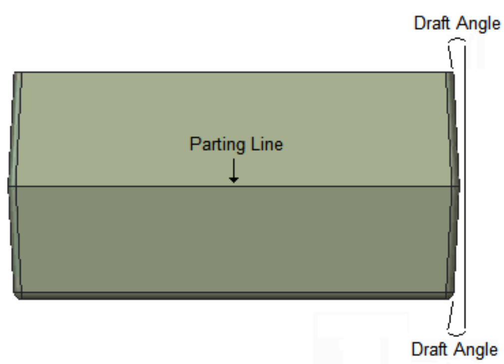
- The lack of a draft angle on a perpendicular surface increases friction and makes it more difficult for the mold to release and eject the part without deformation.

Minimum draft angle for polished surfaces = 0.5 degrees (1 degree recommended)

- The lack of a draft angle may make it difficult for the mold to release and eject the part without deformation.

Minimum draft angle for textured surfaces = 1 degree for each 0.001" (0.0254mm) of texture finish depth

- Increased draft angle is necessary to prevent excess friction and deformation that could occur during part ejection. Consulting the vendor is highly recommended.



Corner Radius

Provide a corner radius on all features such as walls, ribs, bosses etc.

- A corner radius distributes stress, increases strength and improves the flow of molten plastic. It could cause a safety issue if the feature completely fails due to the reduced strength.

Optimal corner radius = 0.25X maximum wall thickness. This includes all features such as walls, ribs, bosses etc.

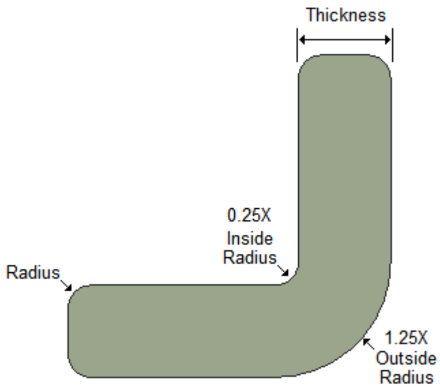
- A corner radius distributes stress, increases strength and improves the flow of molten plastic.

Paired inside and outside radii of a part corner = 0.25X maximum wall thickness for inside radius and 1.25X maximum wall thickness for outside radius

- Maintaining uniform wall thickness around the corner equally distributes stress and minimizes deformation while improving the flow of molten plastic.

Minimum corner radius = 0.015" (0.381mm). This includes all features such as walls, ribs, bosses etc.

- A smaller radius may make it difficult to manufacture the mold, impede the flow of molten material and weaken the part.



Bosses

Derive the boss diameters based on the application

- The boss end use (standoff, screw, molded in fastener, etc) must be considered when selecting the diameters.

Minimum boss outer diameter = 2X inner diameter

- A smaller outer diameter may result in a weak area of the part that can be damaged easily. It could cause a safety issue if the part completely fails.

Maximum boss height = 3X outer diameter

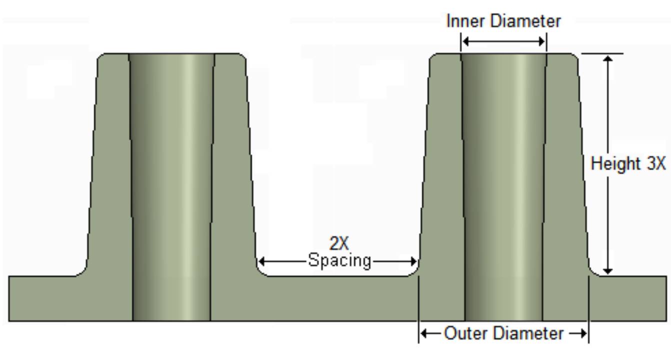
- A boss that is too tall may result in a weak area of the part that can be damaged easily. It could cause a safety issue if the part completely fails.

Minimum boss inner diameter draft angle = 0.25 degrees

- A smaller draft angle may make it difficult for the mold to release and eject the part.

Minimum spacing between adjacent bosses = 2X maximum wall thickness at its base

- Bosses that are too close to each other may create a weak area of the part that can be damaged easily and / or the bosses may not maintain their desired positions. It could cause a safety issue if the part completely fails.



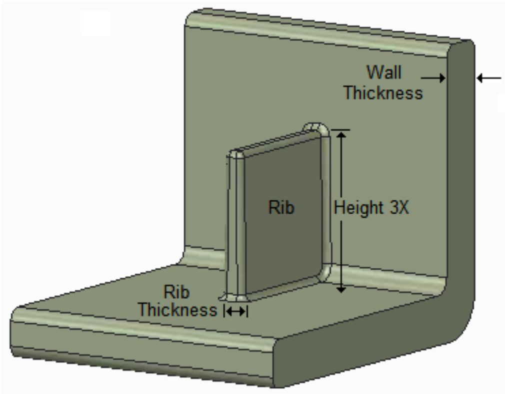
Ribs

Maximum rib height = 3X maximum wall thickness

- Taller ribs can create mold filling, venting and part ejection problems.

Rib thickness at its base = 0.5X maximum wall thickness the rib is attached to

- Ribs that are too thick or too thin can cause stress concentrations, sink marks and mold filling problems.



Miscellaneous

Provide adequate ejection surfaces / features

- Features must be designed into the part that pins can press against to push the part out of the mold.

Minimum spacing between hole and part edge = 2X thickness of the feature the hole pierces

- Not enough space may result in a weak area of the part that can be damaged easily.

Minimum spacing between hole and hole = 2X thickness of the feature the holes pierce

- Not enough space may result in a weak area of the part that can be damaged easily.

Related Entries

DFA	Information	1528	Injection Molding > Injection Molding Requirements > Injection Molding General Information
DFA	Information	1529	Injection Molding > Injection Molding Requirements > Injection Molding Materials Selection

DFA > Laser Welding > Laser Welding Requirements
Entry ID: 1202

Laser Welding General Information

Information

CID: 1	Content Owner: Jabil	Content Type: Information

At its focus, the laser has a diameter of only a few tenths of a millimeter. Accurate tools / jigs and clean parts are needed. There is no contamination allowed in the gap. It is difficult to find the right welding parameters and to debug the process for each specific application. These requirements can make laser welding relatively complicated.

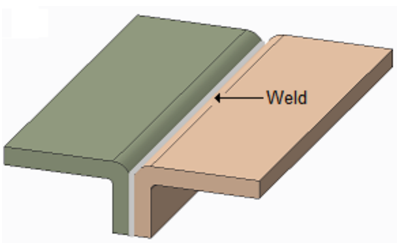
Be aware, laser welding produces joints that are permanent. Laser welded parts cannot be disassembled without damaging the components.

Depending on the material properties there is always a risk of small cracks and the probability of spatters.

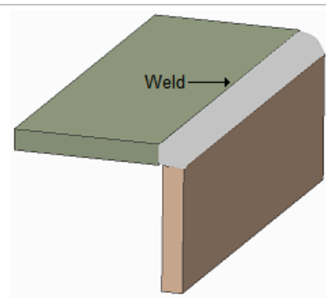
The type of weld chosen depends on the required strength of the joint. As a rule, the strength of the joint should be equal to or greater than the strength of the base material.

- On a butt joint, this means that the weld depth must correspond to the sheetmetal thickness to get the required strength.
- For a pipe or lap joint, the gap between the parts should be as small as possible.

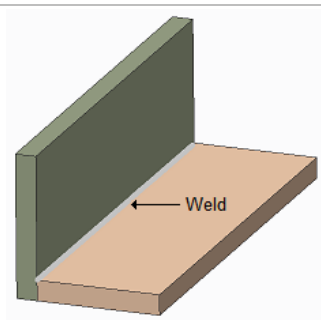
Types of welds:



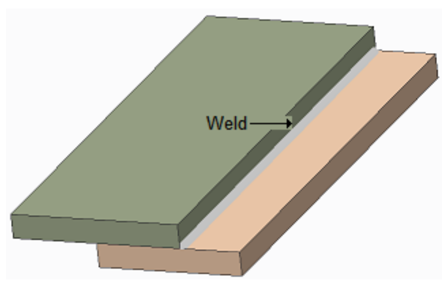
Butt Joint



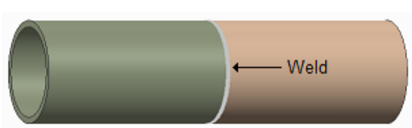
Corner Weld



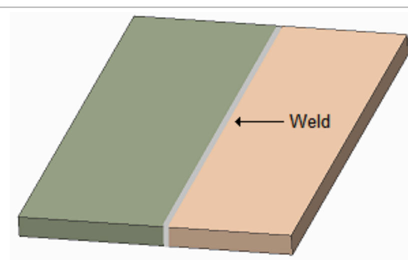
Fillet Weld



Fillet Weld



Pipe Weld



Lap Joint

Related Entries

DFA Guideline 1203 Laser Welding > Laser Welding Requirements > Laser Welding Fixtures
DFA Guideline 1204 Laser Welding > Laser Welding Requirements > Laser Welding Part Tolerance
DFA Guideline 1205 Laser Welding > Laser Welding Requirements > Laser Welding Material Selection
DFA Guideline 1206 Laser Welding > Laser Welding Requirements > Laser Welding Styling and Optical Parts

DFA > Laser Welding > Laser Welding Requirements
Entry ID: 1203

Laser Welding Fixtures

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Laser welding fixtures should be quickly and easily adjustable to be able to react to changes in the parts.

Related Entries

DFA	Information	1202	Laser Welding > Laser Welding Requirements > Laser Welding General Information
DFA	Guideline	1204	Laser Welding > Laser Welding Requirements > Laser Welding Part Tolerance
DFA	Guideline	1205	Laser Welding > Laser Welding Requirements > Laser Welding Material Selection
DFA	Guideline	1206	Laser Welding > Laser Welding Requirements > Laser Welding Styling and Optical Parts

Entry ID: 1204

Laser Welding Part Tolerance

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

A tolerance stackup analysis should be completed to indicate the worst case limits for the manually or automatically welded gap.

The tolerance of the involved parts need to be very small to assure a constant and parallel gap.

Welding is a heating process that might result in distortion of the involved parts. For high precision application any distortion has to be considered in the tolerance calculation.

Related Entries

DFA	Information	1202	Laser Welding > Laser Welding Requirements > Laser Welding General Information
DFA	Guideline	1203	Laser Welding > Laser Welding Requirements > Laser Welding Fixtures
DFA	Guideline	1205	Laser Welding > Laser Welding Requirements > Laser Welding Material Selection
DFA	Guideline	1206	Laser Welding > Laser Welding Requirements > Laser Welding Styling and Optical Parts
DFA	Information	1712	GD&T > GD&T > Tolerance Stackup Analysis

Entry ID: 1205

Laser Welding Material Selection

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

In contrast to conventional welding, for laser welding there is no additional connection material added that will create the formed joint. Therefore the parts that have to be joined must have similar material properties, especially melting point.

- Incompatible materials can cause a poorly welded joint, potentially causing a safety issue if the weld fails.

Common materials used in laser welding:

- Stainless steel
- Aluminum alloys
- Titanium and titanium alloys
- Copper and copper alloys
- Precious metals

Related Entries

DFA	Information	1202	Laser Welding > Laser Welding Requirements > Laser Welding General Information
DFA	Guideline	1203	Laser Welding > Laser Welding Requirements > Laser Welding Fixtures
DFA	Guideline	1204	Laser Welding > Laser Welding Requirements > Laser Welding Part Tolerance
DFA	Guideline	1206	Laser Welding > Laser Welding Requirements > Laser Welding Styling and Optical Parts

DFA > Laser Welding > Laser Welding Requirements
Entry ID: 1206

Laser Welding Styling and Optical Parts

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Leave enough clearance around laser welded locations to protect styling and optical parts from a burn mark or melted material during the manual or automated welding process. Protection could be accomplished by leaving enough clearance from the weld or room to cover the styling and optical parts during welding.

Related Entries

DFA	Information	1202	Laser Welding > Laser Welding Requirements > Laser Welding General Information
DFA	Guideline	1203	Laser Welding > Laser Welding Requirements > Laser Welding Fixtures
DFA	Guideline	1204	Laser Welding > Laser Welding Requirements > Laser Welding Part Tolerance
DFA	Guideline	1205	Laser Welding > Laser Welding Requirements > Laser Welding Material Selection

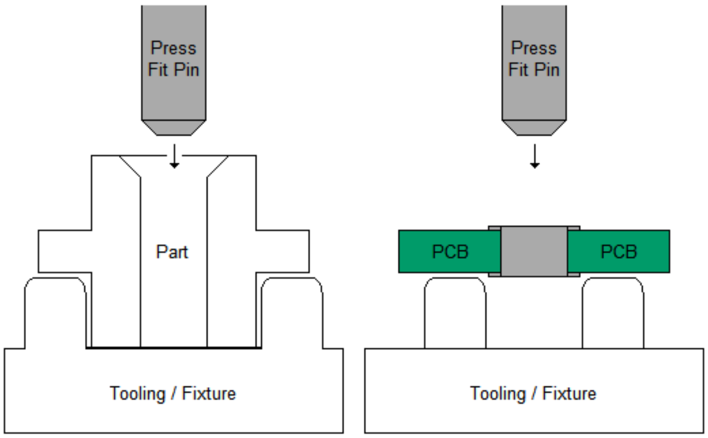
DFA > Press Fit > Press Fit Requirements
Entry ID: 1209

Press Fit General Information

Information

CID: 1	Content Owner: Jabil	Content Type: Information

A press fit, also known as an interference fit or friction fit, is created by inserting a shaft into a hole that is slightly smaller than the shaft diameter. This difference in shaft and hole diameter is known as the interference. The shaft is slowly pressed into the hole, either manually or with automation, causing an elastic deformation in the shaft and / or hole. The deformation in one or both pieces results in large frictional forces between the parts. The friction that holds the parts together relies on the compressive strengths of the materials.



Related Entries

DFA Guideline 1210 Press Fit > Press Fit Requirements > Press Fit Pin Design
DFA Guideline 1211 Press Fit > Press Fit Requirements > Press Fit Part Design

DFA > Press Fit > Press Fit Requirements
Entry ID: 1210

Press Fit Pin Design

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Press fit pin chamfer angles should be 30° or 45°. This can prevent difficulty during manual or automated insertion. In addition, a pin without a chamfer may scrape material off the walls of the hole during insertion.

Select symmetrical press fit pins. Asymmetrical pins generate additional handling for manual or automated assembly and the possibility of upside down pins.

Select the same press fit pin diameter, length and chamfer angle for all pins in a given product. This will simplify manual or automated assembly and prevent the wrong pin from getting pressed into the wrong hole while minimizing the total part numbers. If the wrong diameter is inserted, the pin could fall out potentially causing a safety issue.

Related Entries

DFA	Information	1209	Press Fit > Press Fit Requirements > Press Fit General Information
DFA	Guideline	1211	Press Fit > Press Fit Requirements > Press Fit Part Design

DFA > Press Fit > Press Fit Requirements
Entry ID: 1211

Press Fit Part Design

Guideline

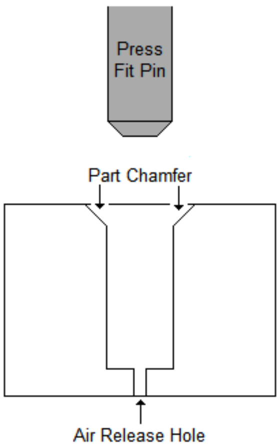
CID: 2	Content Owner: Jabil	Content Type: Requirement

Ensure chamfer angles on press fit parts are 30° or 45°.

- Other angles may cause difficulty during manual or automated insertion.

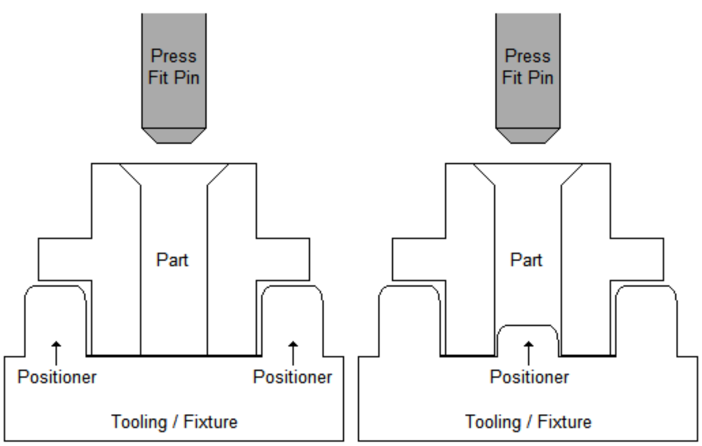
Ensure an air release hole is present for all press fit holes that do not go all of the way through the part.

- This can cause air cushions and prevent the pin from fully inserting during the manual or automated process.



Ensure the design of the press fit part allows it to be held in place in the manual or automated assembly tooling / fixture so that it is perfectly aligned with the pin being inserted.

- Poor alignment can cause difficulty during insertion and / or result in the part getting damaged.



Ensure the hole where the press fit pin is being manually or automatically inserted does not have excess material left at the bottom of the hole.

- This could prevent the pin from being fully inserted, potentially causing a safety issue if it falls out.

Ensure plastic parts do not have ejector marks from the molding process inside press fit holes.

- These marks may cause problems during the manual or automated insertion process.

Related Entries

DFA	Information	1209	Press Fit > Press Fit Requirements > Press Fit General Information
DFA	Guideline	1210	Press Fit > Press Fit Requirements > Press Fit Pin Design

DFA > Screw Attach > Screw Attach Requirements
Entry ID: 1217

Screw Attach Driving Systems

Information

CID: 1	Content Owner: Jabil	Content Type: Information

Information regarding preferred screw attach driving systems:

	Driving System		Advantages	Disadvantages
		**Torx** **Torx Plus**	• Very low axial forces required • Minimized tool slippage and the damage and injuries it can cause • Ergonomically friendly • Extended tool life	
		**Pozidriv**	• Fast self-centering	• Tool easily pops out • High axial forces required to prevent "camout", can reduce bit life and cause worker fatigue / injury
		**Phillips**		
		**Allen**	• Bolt can be inserted into its socket using the key	• Not really suitable for power driver • Due to high torques, rapid tool wear and distortion of the fastener head
		**Slot**		• Unsuitable for power driver • No tool centering • Tool slippage is common

Related Entries

DFA Guideline 1225 Screw Attach > Screw Attach Requirements > Screw Clearance for Power Screwdrivers
DFA Guideline 1226 Screw Attach > Screw Attach Requirements > Power Screwdriver Speed and Torque

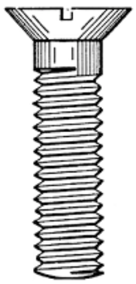
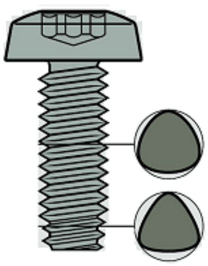
DFA > Screw Attach > Screw Attach Requirements
Entry ID: 1218

Thread Types for Metal Parts

Information

CID: 1	Content Owner: Jabil	Content Type: Information

The following table shows the advantages and disadvantages of different screw types:

Thread Types for Metal Parts		Advantages	Disadvantages
	**Metric**	• Stable screwing process • Accurate torque because of low thread friction • Reusable	• Not self cutting, thread at component or nut required
	**Taptite**	• Self cutting, no need for pre-tapped threads or nuts • Low thread forming torques • High vibration resistance • High strip torque and clamping forces • Reduced assembly costs • Reusable	• Thread friction could influence torque

Screws will behave differently in steel versus aluminun. A hole in aluminum needs very low diameter tolerance because of screwing process variations. Screws for aluminum parts should be pre-oiled to ensure a proper torque.

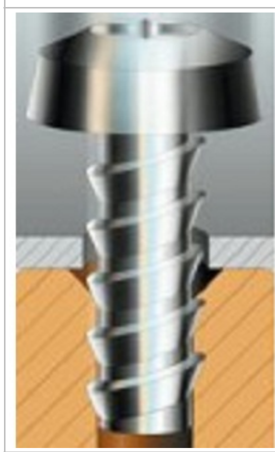
DFA > Screw Attach > Screw Attach Requirements
Entry ID: 1219

Thread Types for Plastic Parts

Information

CID: 1	Content Owner: Jabil	Content Type: Information

The following table shows the advantages and disadvantages of different screw types:

Thread Types for Plastic Parts		Advantages	Disadvantages
	**Remform**	• Self cutting, no need for pre-tapped threads or nuts • Low thread forming torques • High strip torques and clamping forces • Low danger of crack initiation • Reduced assembly costs • Reusable	• Thread friction could influence torque
	**Pushtite**	• Simple and fast assembly, pressed into the hole with a single straight-line stroke • Low push in force, high pull out force • Easy removal and re-insertion	• The boss design must allow for the stroke force

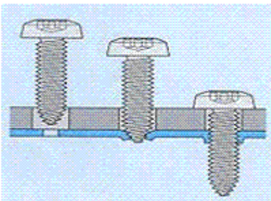
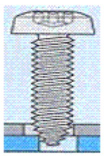
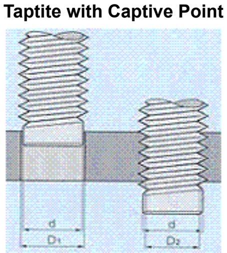
DFA > Screw Attach > Screw Attach Requirements
Entry ID: 1220

Screws for Special Applications

Information

CID: 1	Content Owner: Jabil	Content Type: Information

The following table shows special screws for special applications:

Special Screws	Advantages	Disadvantages
Extrude Tite 	• For thin sheet metal without threads • Forms a sheet metal rim hole • Self-centering • Reusable	• Difficult to insert and to screw • Screws might become slanted / tilted
Taptite with CA Tip 	• Finds the bore more easily and centers displaced bores	
Taptite with Captive Point 	• Mechanical securing of the screw after thread forming	• Removal only possible by destroying the female thread

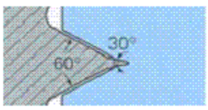
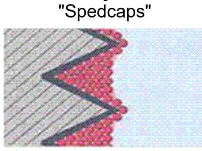
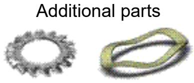
DFA > Screw Attach > Screw Attach Requirements
Entry ID: 1221

Screw Retention

Information

CID: 1	Content Owner: Jabil	Content Type: Information

If there is no chance to avoid screw retention, for safety reasons use the following methods:

	Orientation	Advantages	Disadvantages
	Mechanical Choppers head button 	• Increase of over-wind torque • No additional work content	
	Mechanical Thread with cutting edge "Powerlock" 		• Only applicable in combination with cut male threads
	Chemically Reactive "Spedcaps" 	• Highest retention torque • Ready for use • Sealing properties	
	Chemically Non-Reactive "Spedlack" 	• Main application for adjustment screws	
	Mechanical Additional parts 		• Additional part that needs more assembly time and can get lost

Entry ID: 1222

Screw Orientation

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

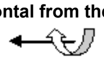
Select right hand screw threads that rotate in a clockwise direction.

- Counter clockwise can increase the process time and does not follow the world standard.

Ensure screws insert vertically from the top for manual and automated assembly.

- Screws inserted from other directions can make manual or automated assembly difficult and increase processing time or necessitate the need for a complicated fixture that rotates the parts so that screws can be inserted vertically from the top. This can also cause ergonomic issues due to the difficulty inserting the screws.

The following table shows the advantages and disadvantages for screw orientations:

	Orientation	Advantages	Disadvantages
	Vertical from the top 	• Easy to screw manually at a standard workstation • Preferred orientation for automated assembly	
	Horizontal from the front 		• Not as easy as the vertical orientation from the top
	Inclined axis 		• Very difficult to align the screwdriver axis manually • May be impossible with automated assembly equipment
	Vertical from the bottom 		• Impossible to do manually, must turn the product or use automated screw equipment

DFA > Screw Attach > Screw Attach Requirements
Entry ID: 1223

Thread Hole for Plastic Parts

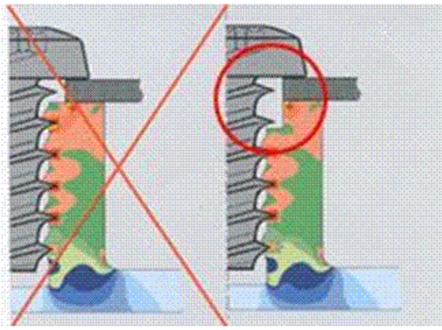
Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Provide thread hole entrances of plastic parts with a clearance.

If there isn't a clearance, the screw threads may displace the plastic creating an uneven contact surface.

The clearance also supports the manual placement of the screw just before driving.



Entry ID: 1224

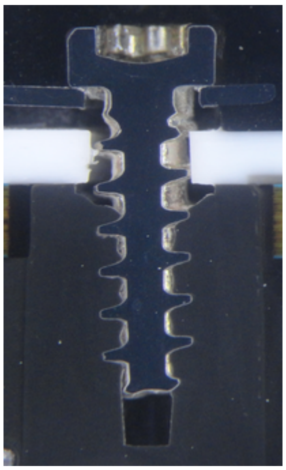
Self-Tapping Screws

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Ensure self-tapping screws have blind holes with an adequate open space (a cavity) at the bottom of the hole.

- If the open space is not large enough to hold all of the shavings, the screw will not seat properly and could potentially fall out causing a safety issue.
- If blind holes are not possible, there is a risk of short circuiting due to loose metal shavings or contamination from other material shavings on the product.



DFA > Screw Attach > Screw Attach Requirements
Entry ID: 1225

Screw Clearance for Power Screwdrivers

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Minimum magnetic screw head clearance for power screwdrivers = screw head diameter + 0.024" (0.6096mm)

Minimum vacuum screw head clearance for power screwdrivers = screw head diameter + 0.048" (1.2192mm)

The clearance above is necessary for the screw head but the risk of damage to surrounding parts if the screwdriver slips off also has to be taken into account. Styling parts may require more clearance to avoid any possibility of cosmetic damage.

Related Entries

DFA	Information	1217	Screw Attach > Screw Attach Requirements > Screw Attach Driving Systems
DFA	Guideline	1226	Screw Attach > Screw Attach Requirements > Power Screwdriver Speed and Torque

DFA > Screw Attach > Screw Attach Requirements
Entry ID: 1226

Power Screwdriver Speed and Torque

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Observe power screwdriver speed for different screw types:

Remform: (see Entry 1219 for details)

500 to 700 rpm - higher speeds can lead to melting plastic.

Taptite: (see Entry 1218 for details)

1000 rpm - higher speeds may make the screwing process difficult to control.

Fastening torque is defined by the customer or vendor specifications.

Self-tapping screws may have a high resistance so make sure the torque requirement is enough to overcome this issue.

Document the speed and torque requirements in the assembly drawings.

Related Entries

DFA	Information	1217	Screw Attach > Screw Attach Requirements > Screw Attach Driving Systems
DFA	Guideline	1225	Screw Attach > Screw Attach Requirements > Screw Clearance for Power Screwdrivers

Entry ID: 1229

Screw Selection

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Select a single standard screw for every location in the product.

- Multiple screw types may lead to the wrong screw getting installed in the wrong location potentially damaging the product and requires multiple tools for installation.
- Standard screws are more readily available and reduce the potential for needing special tools for installation.
- If the screw is too short or does not fit properly, the part could fall out causing a safety issue.
- If a single screw for the entire product is not possible, ensure the screws do not look similar to help prevent the wrong screw getting installed in the wrong location.

Select TORX style screws for diameters 0.079" (2.0000mm) and smaller.

- TORX screws are easier to align, more precise and have less cam-out so the potential for stripping smaller screws is reduced.

Instead of discrete fasteners, choose TORX screws and specify the required torque.

- TORX screws are easier to align, more precise and have less cam-out.

Sheet Metal General Information

Information

CID: 1	Content Owner: Jabil	Content Type: Information

Introduction

Stamping presses and dies are tools used to produce high volume sheet metal parts. These parts achieve their shape through the effects of the die tooling.

Production stamping is generally performed on materials 0.020" (0.5080mm) to 0.080" (2.0320mm) thick, but the process can also be applied to materials as thin as 0.001" (0.0254mm) or to plate stock up to 1.000" (25.4000mm) thick.

Die

The word "die" is a generic term used to describe the tooling that produces stamped parts. A die set assembly consisting of a male and female component is the actual tool that produces the shaped stamping. The male and female components work in opposition to both form and punch holes in the stock. The upper half of the die set, which may be either the male or female, is mounted on the press ram and delivers the stroke action. The lower half is attached to an intermediate bolster plate which in turn is secured to the press bed. Guide pins are used to ensure alignment between the upper and lower halves of the die set.

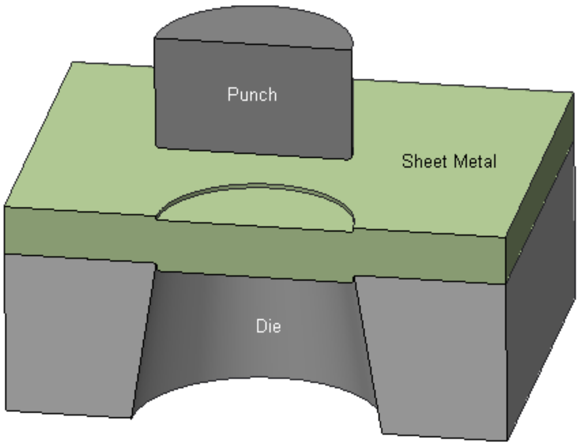
The two parts are mounted in a die set, or sub-press, the die (in a simple blank-through die) being mounted on the base and the punch on the upper shoe. The use of a die set ensures proper alignment of the punch and die regardless of the condition of the press. The simplest dies are those for punching holes in a blank. The machine used to cause these changes of shape has a stationary bed, or bolster, on which the die portion is clamped. A guided slide, or ram, which has the punch portion clamped to it, moves up and down perpendicularly to the bed. The motion and force of the ram are provided by a crankshaft, eccentric, or other mechanical means. Hydraulically actuated presses are also employed. The stamping of sheet metal involves cutting or shearing, bending or forming, and drawing operations. Cutting around the entire periphery of a part is called blanking. Cutting holes in a work piece is called punching or piercing.

Blanking / Piercing

Blanking or piercing to a contour progresses through three stages:

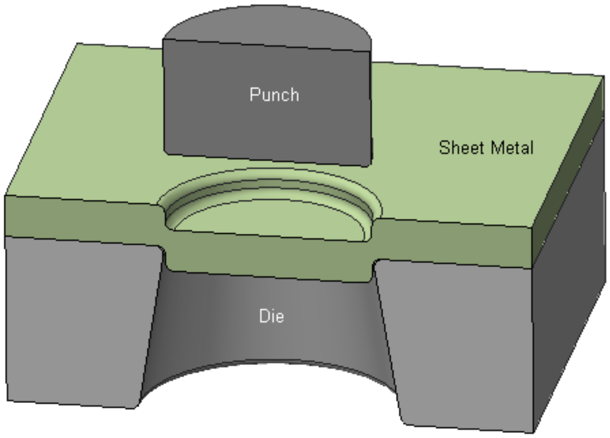
Plastic Deformation

The punch makes contact with the material, and pressure begins to be exerted until the elastic limit of the stock is exceeded and plastic deformation commences.



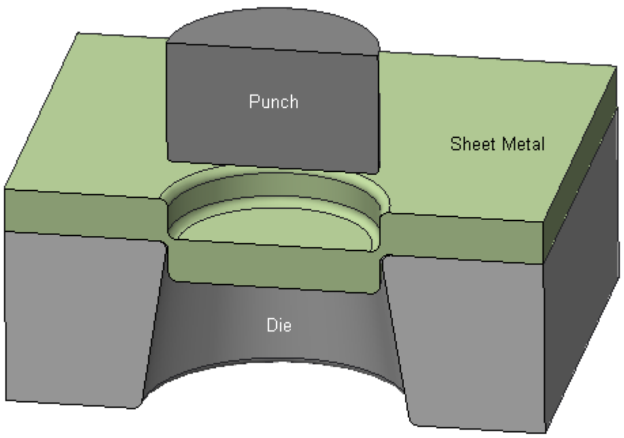
Penetration

The continuing pressure causes the punch to penetrate the stock, thereby displacing the blank or slug into the die opening, the displacement equaling the amount of penetration.



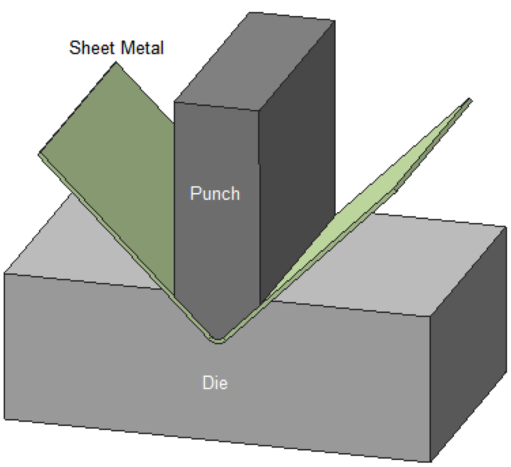
Fracture

In this stage, the fracturing occurs. At this point the blank or slug is separated from the parent stock. Generally, the straight or cut band of the material will average approximately one third of the stock thickness. This, of course, depends on the material's brittleness. The punch could penetrate anywhere from 15 to 40 percent of the thickness before fracture occurs.



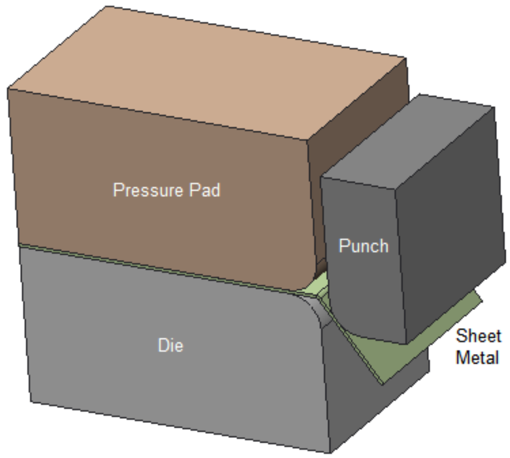
Bent

Bending is the plastic deformation of the work over an axis, creating a change in the part's geometry. Similar to other metal forming processes, bending changes the shape of the work piece, while the volume of material will remain the same.



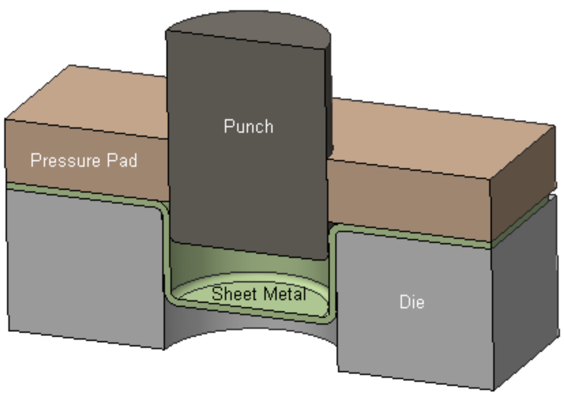
Stretched

Stretch forming is a process in which a piece of sheet metal is stretched and bent simultaneously over a die in order to form large contoured parts. Stretch forming is performed on a stretch press, in which a piece of sheet metal is securely gripped along its edges by gripping jaws. The gripping jaws are each attached to a carriage that is pulled by pneumatic or hydraulic force to stretch the sheet. The tooling used in this process is a stretch form block, called a form die, which is a solid contoured piece against which the sheet metal will be pressed. The most common stretch presses are oriented vertically, in which the form die rests on a press table that can be raised into the sheet by a hydraulic ram. As the form die is driven into the sheet, which is gripped tightly at its edges, the tensile forces increase and the sheet plastically deforms into a new shape. Horizontal stretch presses mount the form die sideways on a stationary press table, while the gripping jaws pull the sheet horizontally around the form die.



Drawn

Drawing is a process in which sheet metal is stretched into the desired part shape. A tool pushes downward on the sheet metal, forcing it into a die cavity in the shape of the desired part. The tensile forces applied to the sheet cause it to plastically deform into a cup shaped part.



Ductility

The metallurgical term for these qualities is "ductility". Ductility is the materials ability to deform and elongate without fracture. The extent to which a stamping is subjected to such deformation is directly related to the part's overall shape and geometry. Other factors also influence the material's formability.

They include:

- The die design
- The press
- The press speed
- Lubrication
- Sheet metal feeding mechanisms
- Monitoring and control systems

DFA > Sheet Metal > Sheet Metal Requirements
Entry ID: 1509

Sheet Metal Edge Clearance

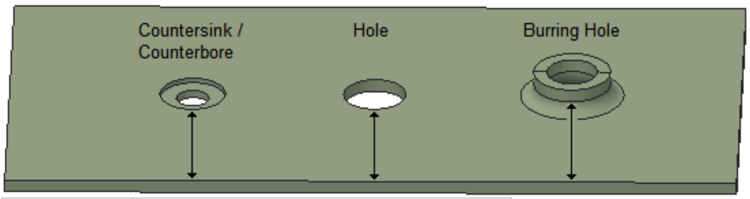
Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

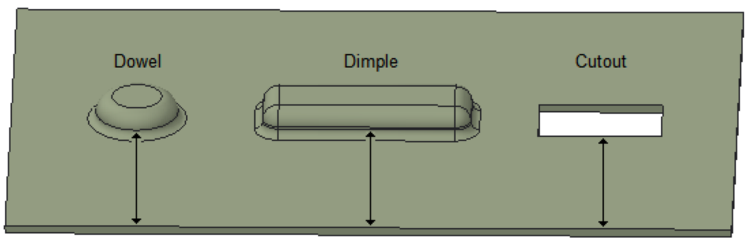
All values are based on typical steel alloy sheet metal thicknesses. Other materials or thicker sheet metal may require more clearance.

Minimum spacing from the outer edge of sheet metal parts to features:

Feature	Minimum Requirement
Edge of hole	2X sheet metal thickness
Edge of countersink / counterbore holes	4X sheet metal thickness
Edge of burring hole	4X sheet metal thickness



Feature	Minimum Requirement
Edge of dowel	4X sheet metal thickness
Edge of dimple	4X sheet metal thickness + inside bend radius
Edge of cutout	2X sheet metal thickness



DFA > Sheet Metal > Sheet Metal Requirements
Entry ID: 1510

Sheet Metal Bend Clearance

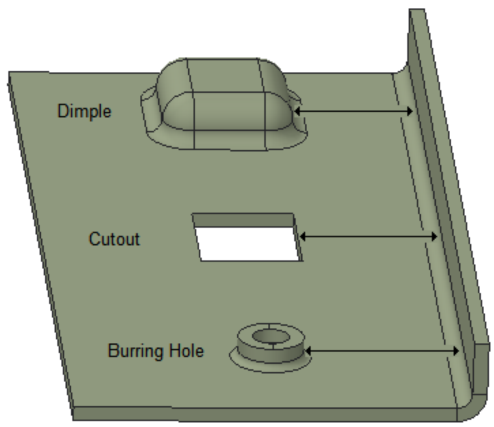
Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

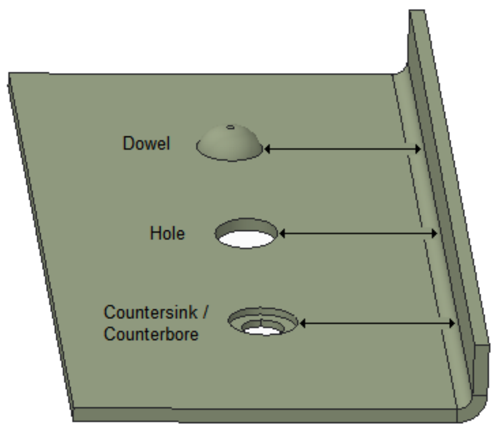
All values are based on typical steel alloy sheet metal thicknesses. Other materials or thicker sheet metal may require more clearance.

Minimum spacing from sheet metal bends to features:

Feature	Minimum Requirement
Edge of dimple	4X sheet metal thickness + inside bend radius
Edge of cutout	2X sheet metal thickness + inside bend radius
Edge of burring hole	4X sheet metal thickness + inside bend radius



Feature	Minimum Requirement
Edge of dowel	4X sheet metal thickness + inside bend radius
Edge of hole < 1.000" (25.4000mm) diameter	2X sheet metal thickness + inside bend radius
Edge of hole >= 1.000" (25.4000mm) diameter	2.5X sheet metal thickness + inside bend radius
Edge of countersink / counterbore holes	4X sheet metal thickness + inside bend radius



DFA > Sheet Metal > Sheet Metal Requirements
Entry ID: 1511

Sheet Metal Feature to Feature Spacing

Guideline

CID: 2 Content Owner: Jabil Content Type: Requirement

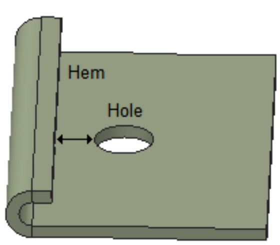
All values are based on typical steel alloy sheet metal thicknesses. Other materials or thicker sheet metal may require more clearance.

Edge of:	To Edge of:	Minimum Requirement:	
Burring Hole	Burring Hole	4X Sheet Metal Thickness + Inside Bend Radius*	Case D
	Countersink / Counterbore Hole	4X Sheet Metal Thickness + Inside Bend Radius	Case D
	Cutout		
	Dimple	4X Sheet Metal Thickness + Inside Bend Radius*	Case D
	Dowel		
	Hem	3X Sheet Metal Thickness + Inside Bend Radius	Case C
	Hole		
Countersink / Counterbore Hole	Countersink / Counterbore Hole	4X Sheet Metal Thickness	Case D
	Cutout		
	Dimple	4X Sheet Metal Thickness + Inside Bend Radius	Case D
	Dowel		
	Hem	4X Sheet Metal Thickness	Case D
	Hole		
Cutout	Cutout	2X Sheet Metal Thickness	Case B
	Dimple	4X Sheet Metal Thickness + Inside Bend Radius	Case D
	Dowel		
	Hem	2X Sheet Metal Thickness	Case B
	Hole		
Dimple	Dimple	4X Sheet Metal Thickness + Inside Bend Radius*	Case D
	Dowel		
	Hem	3X Sheet Metal Thickness + Inside Bend Radius	Case C
	Hole		
Dowel	Dowel	4 x Sheet Metal Thickness + Inside Bend Radius*	Case D
	Hem	3X Sheet Metal Thickness + Inside Bend Radius	Case C
	Hole		
Hem	Hem	N/A	N/A
	Hole	1X Sheet Metal Thickness	Case A
Hole	Hole	2X Sheet Metal Thickness	Case B
		* Use the minimum Inside Bend Radius of the two features.	

(Case A) 1X Sheet Metal Thickness

Applies To:

- Hem to Hole

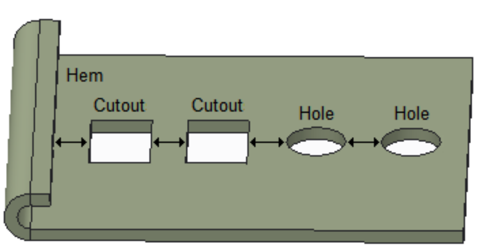


(A) 1X Sheet Metal Thickness

(Case B) 2X Sheet Metal Thickness

Applies To:

- Cutout to Cutout
- Cutout to Hem
- Cutout to Hole
- Hole to Hole

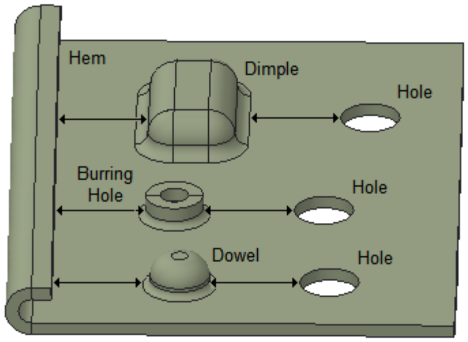


(B) 2X Sheet Metal Thickness

(Case C) 3X Sheet Metal Thickness + Inside Bend Radius

Applies To:

- Burring Hole to Hem
- Burring Hole to Hole
- Dimple to Hem
- Dimple to Hole
- Dowel to Hem
- Dowel to Hole

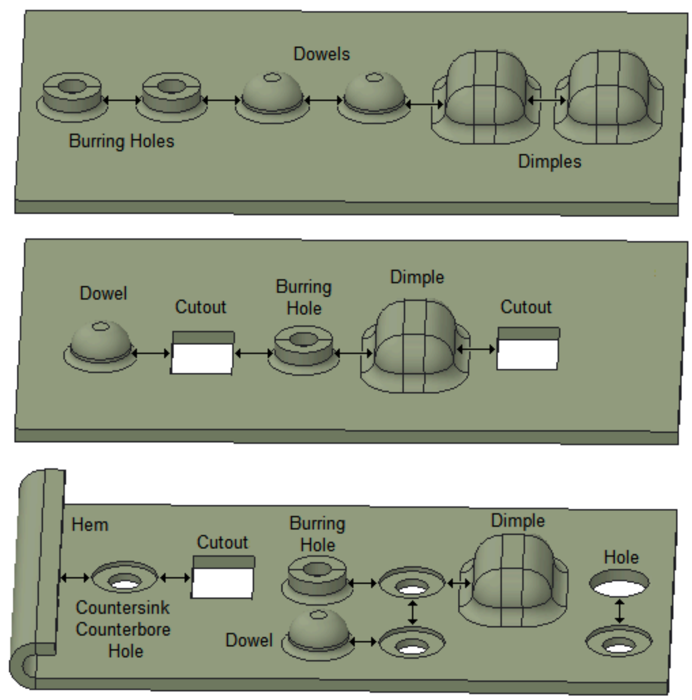


(C) 3X Sheet Metal Thickness + Inside Bend Radius

(Case D) 4X Sheet Metal Thickness + Inside Bend Radius

Applies To:

- Burring Hole to Burring Hole*
- Burring Hole to Countersink / Counterbore Hole
- Burring Hole to Cutout
- Burring Hole to Dimple*
- Burring Hole to Dowel*
- Countersink / Counterbore Hole to Countersink / Counterbore Hole
- Countersink / Counterbore Hole to Cutout
- Countersink / Counterbore Hole to Dimple
- Countersink / Counterbore Hole to Dowel
- Countersink / Counterbore Hole to Hem
- Countersink / Counterbore Hole to Hole
- Cutout to Dimple
- Cutout to Dowel
- Dimple to Dimple*
- Dimple to Dowel*
- Dowel to Dowel*



(D) 4X Sheet Metal Thickness + Inside Bend Radius

* Use the minimum Inside Bend Radius of the two features.

DFA > Sheet Metal > Sheet Metal Requirements
Entry ID: 1512

Sheet Metal Bends

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

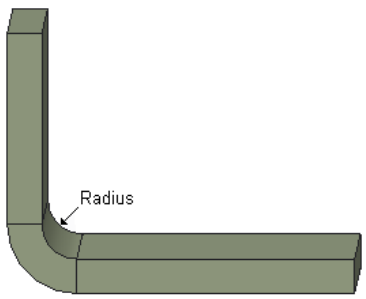
Introduction

All values are based on typical steel alloy sheet metal thicknesses. Other materials or thicker sheet metal may require more clearance.

Bends

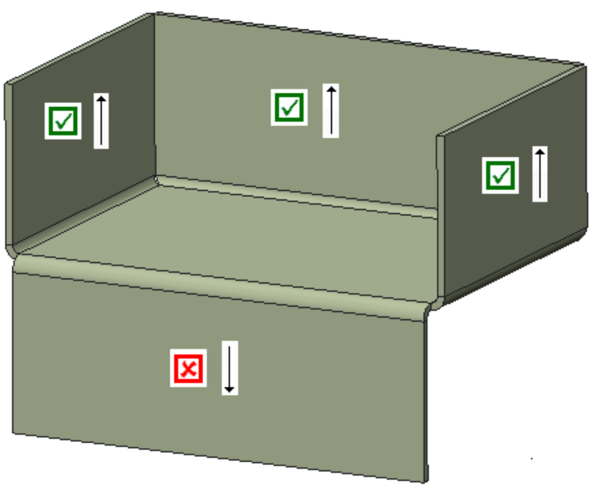
Minimum bend radius = 1X sheet metal thickness.

A radius that is too small can cause material forming problems in soft material and fracturing in hard material.



All bends in the same plane must be in the same direction (up or down).

Bends in multiple directions require more than a single bending step and make manufacturing more difficult.



DFA > Sheet Metal > Sheet Metal Requirements
Entry ID: 1513

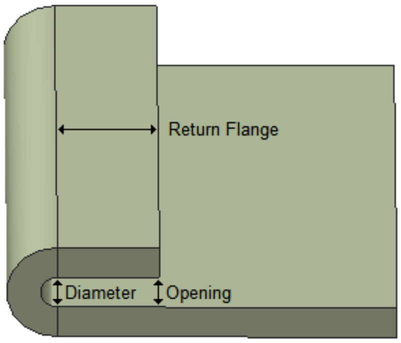
Sheet Metal Hems

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

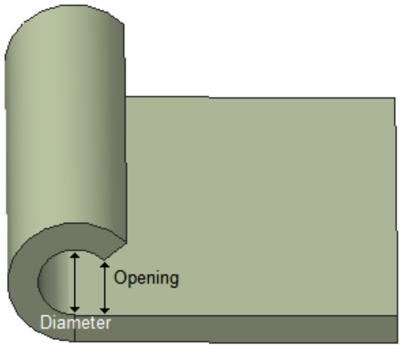
Open Hem

- Minimum open hem internal diameter = 1X sheet metal thickness.
- Minimum open hem return flange length = 4X sheet metal thickness.
- Minimum open hem opening = 1X sheet metal thickness.



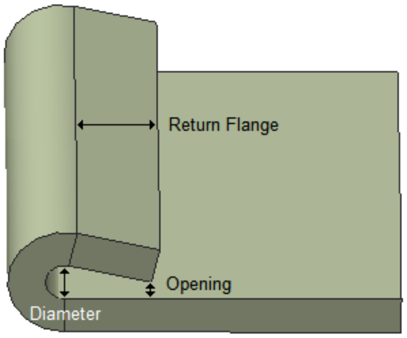
Rolled Hem

- Minimum rolled hem internal diameter = 1X sheet metal thickness.
- Minimum rolled hem opening = 0.75X sheet metal thickness.



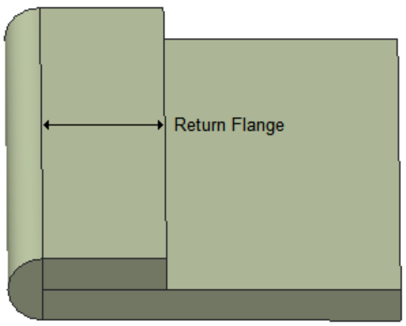
Teardrop Hem

- Minimum teardrop hem internal diameter = 1X sheet metal thickness.
- Minimum teardrop hem return flange length = 4X sheet metal thickness.
- Minimum teardrop hem opening = 0.25X sheet metal thickness.



Flat Hem

- Minimum flat hem return flange length = 4X sheet metal thickness.



DFA > Sheet Metal > Sheet Metal Requirements
Entry ID: 1524

General Sheet Metal Guidelines

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Introduction

The following are a collection of sheet metal guidelines. All values are based on typical steel alloy sheet metal thicknesses. Other materials or thicker sheet metal may require more clearance.

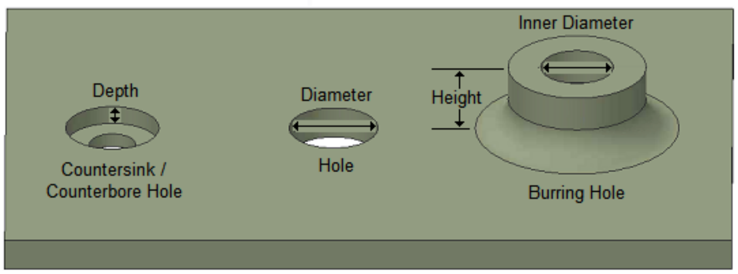
Holes

Minimum hole diameter = 1X sheet metal thickness.

Minimum burring hole inner diameter = 0.079" (2.0000mm)

Minimum burring hole height = 2X sheet metal thickness.

Maximum countersink / counterbore hole depth = 0.6X sheet metal thickness.

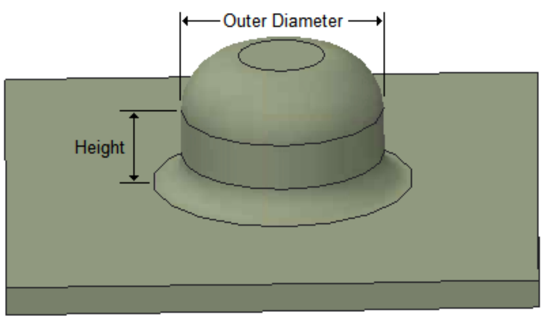


Dowels

Minimum dowel outer diameter height = 0.5X sheet metal thickness.

Minimum dowel outer diameter = 0.118" (3.0000mm)

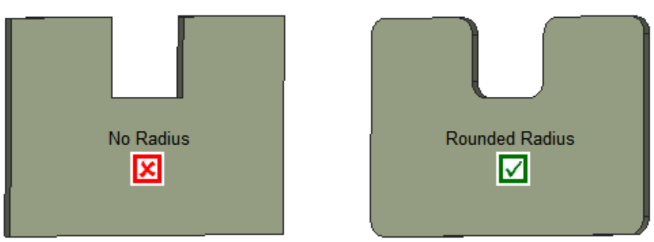
Maximum dowel outer diameter = 0.197" (5.0000mm)



Corners

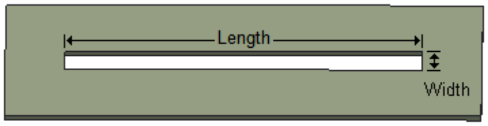
Minimum corner radius for sheet metal thickness < 0.197" (5.0000mm) = 0.25X sheet metal thickness.

Minimum corner radius for sheet metal thickness >= 0.197" (5.0000mm) = 0.020" (0.5000mm)



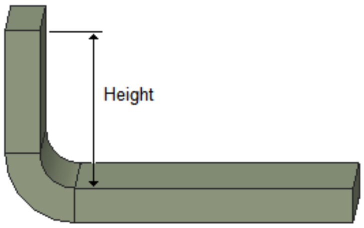
Cutouts

Maximum length to width ratio for cutouts = 15



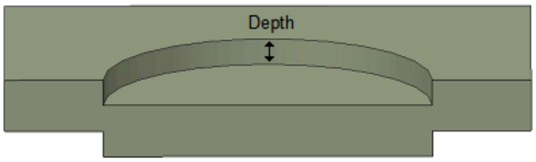
Flanges

Minimum flange height = 3.5X sheet metal thickness.



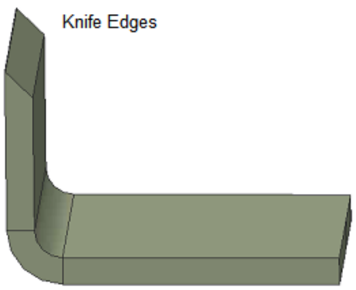
Half-Shears

Maximum half-shear depth = 0.6X sheet metal thickness.



Knife Edges

Avoid knife edge features on sheet metal parts.



DFA > Snap Fit > Snap Fit Requirements
Entry ID: 1232

Snap Fit General Information

Information

CID: 1	Content Owner: Jabil	Content Type: Information

Introduction

Snap fits are commonly used for manual or automated assembly and dis-assembly of injection molded parts because they simplify assembly and its associated costs. Snap fits are very useful because they eliminate screws, clips, adhesives or other joining methods.

A snap fit can either be designed as a permanent snap or a multiple snap. Permanent snaps are used in disposable parts that are never meant to be dis-assembled. If they need to be dis-assembled and re-assembled, multiple snaps are used.

There are complications associated with snap fits. A lot more engineering is required to design a proper snap fit than designing something for screw assembly. Snap fits can also make the injection mold that produces the parts significantly more complicated and expensive. Generally, the savings in manual or automated assembly costs more than makes up for the added cost and complexity of the mold.

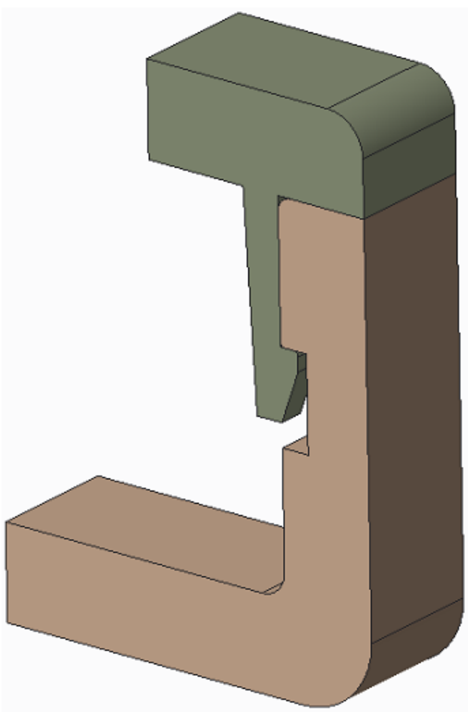
There are two main types of snap fits: cantilever and annular.

CID: 3	Content Owner: Jabil	Content Type: Information

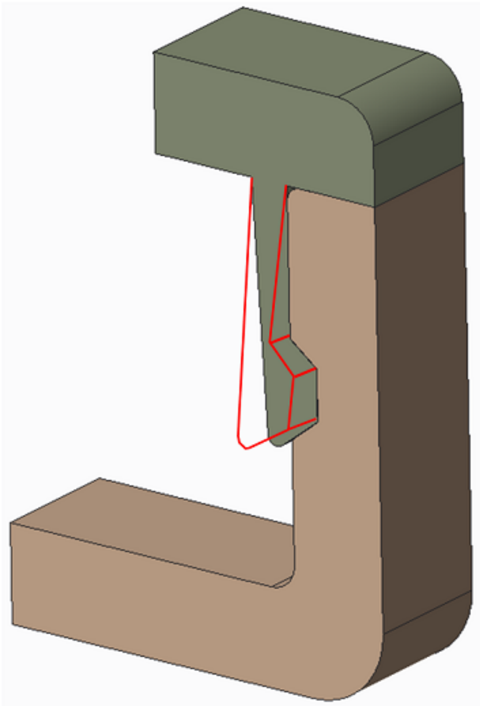
Cantilever Snap Fit

Cantilever snap fits are the most widely used type of snap fit. They consist of a cantilever beam with a bump that deflects and snaps into a groove or a slot in the mating part.

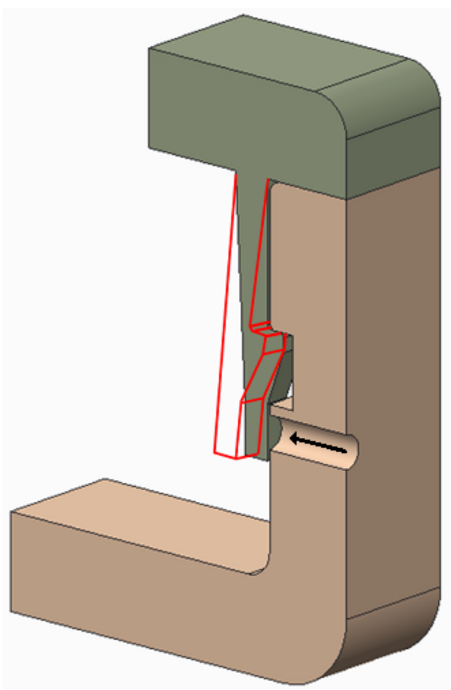
The depth of the overhang defines the amount of deflection during manual or automated assembly. The overhang typically has a gentle ramp on the entrance side and a sharper angle on the retraction side. The small angle on the entrance side helps to reduce the assembly effort, while the sharp angle at the retraction side makes dis-assembly difficult or impossible depending on the intended function.



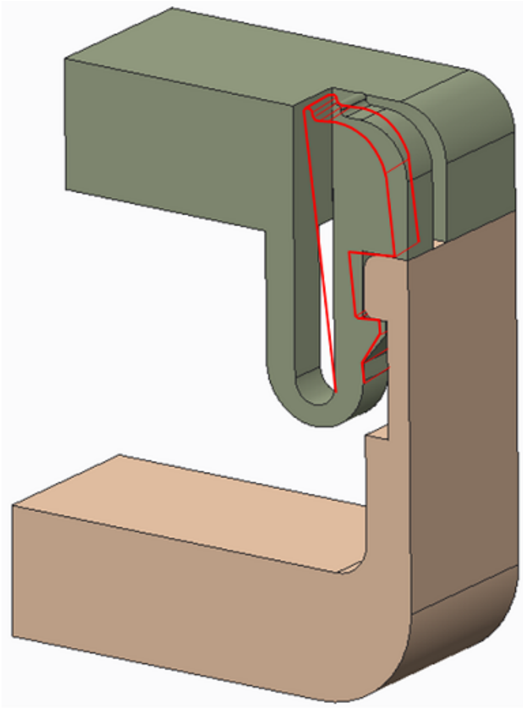
A similar type uses an angled surface for both the insertion and retraction portions of the cantilever and the recess. The snap fit can be removed with the same force used in manual or automated assembly.



This type has a sharp retraction angle, but the designer put a window in the side to allow the snap fit to be disengaged. A potential problem with this design is that the snap fit can be pushed too far, there is no stop. If a snap fit breaks, it is usually impossible to repair so designers will commonly put a stop behind it to prevent it from being over-strained.



A U-beam can be disengaged from the outside. They are used in applications such as battery doors and covers. With this type of snap fit, the plastic does not experience a lot of strain so multiple flexes are possible without damaging the beam. It also has a built-in stop, so the beam cannot be flexed too much and damaged.

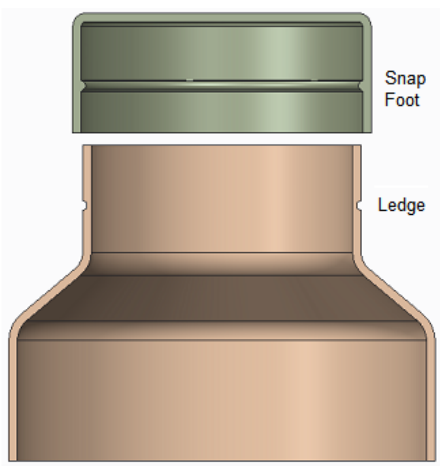


CID: 4	Content Owner: Jabil	Content Type: Information

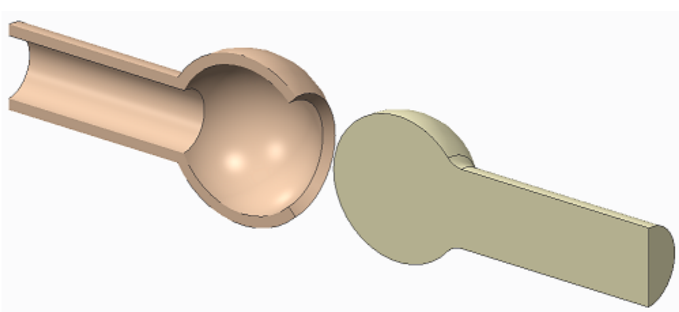
Annular Snap Fit

Annular snap fits can be cylindrical, spherical or barbed. There is strain on the materials when the parts are manually or automatically inserted so flexible materials are used. Typically the shaft is rigid and the hub is elastic.

A cylindrical snap joint consists of a cylindrical part with an external lip (snap foot) which engages a cylindrical part with a corresponding internal lip (ledge). A typical cylindrical snap fit is a bottle cap.



A ball and socket is a spherical snap fit.



Related Entries

DFA Guideline	1233	Snap Fit > Snap Fit Requirements > Snap Fit Stop
DFA Guideline	1234	Snap Fit > Snap Fit Requirements > Snap Fit Positioning Pins
DFA Guideline	1235	Snap Fit > Snap Fit Requirements > Snap Fit Corner Radius

DFA	Information	1471	Snap Fit > Snap Fit Requirements > Cantilever Beam Snap Fit Design Calculations
DFA	Guideline	1484	Snap Fit > Snap Fit Requirements > Snap Fit Gap

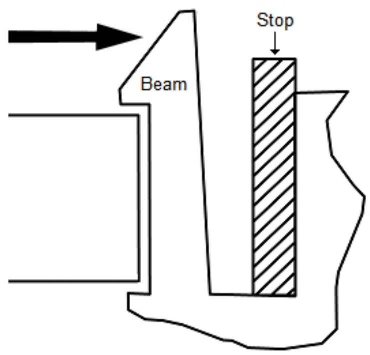
DFA > Snap Fit > Snap Fit Requirements
Entry ID: 1233

Snap Fit Stop

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Provide a snap fit beam stop for parts that may need to be dis-assembled. If a stop is not present, the beam could be over-stressed and damaged.



Related Entries

DFA	Information	1232	Snap Fit > Snap Fit Requirements > Snap Fit General Information
DFA	Guideline	1234	Snap Fit > Snap Fit Requirements > Snap Fit Positioning Pins
DFA	Guideline	1235	Snap Fit > Snap Fit Requirements > Snap Fit Corner Radius
DFA	Information	1471	Snap Fit > Snap Fit Requirements > Cantilever Beam Snap Fit Design Calculations
DFA	Guideline	1484	Snap Fit > Snap Fit Requirements > Snap Fit Gap

DFA > Snap Fit > Snap Fit Requirements
Entry ID: 1234

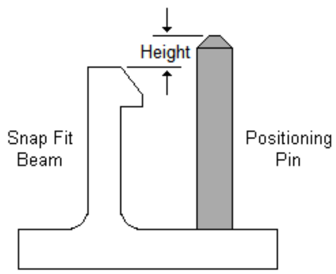
Snap Fit Positioning Pins

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Provide a reference pin for pre-positioning of parts relative to the snap fit beam to avoid unnecessary stress during the manual or automated assembly process.

The positioning pin has to be taller than the snap fit beam.



Related Entries

DFA	Information	1232	Snap Fit > Snap Fit Requirements > Snap Fit General Information
DFA	Guideline	1233	Snap Fit > Snap Fit Requirements > Snap Fit Stop
DFA	Guideline	1235	Snap Fit > Snap Fit Requirements > Snap Fit Corner Radius
DFA	Information	1471	Snap Fit > Snap Fit Requirements > Cantilever Beam Snap Fit Design Calculations
DFA	Guideline	1484	Snap Fit > Snap Fit Requirements > Snap Fit Gap

DFA > Snap Fit > Snap Fit Requirements
Entry ID: 1235

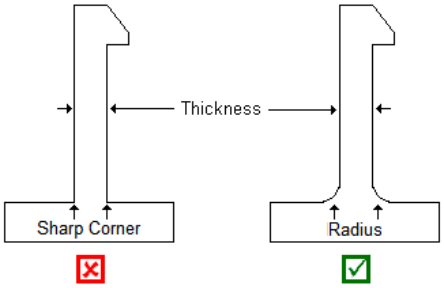
Snap Fit Corner Radius

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Provide a corner radius of 1/2 the thickness of the snap fit beam at its base.

The most common cause of failure in snap fit beams is due to a sharp corner between the snap fit beam and the wall to which it is attached. This is most critical for rigid plastics like glass reinforced nylon.



Related Entries

DFA Information	1232	Snap Fit > Snap Fit Requirements > Snap Fit General Information
DFA Guideline	1233	Snap Fit > Snap Fit Requirements > Snap Fit Stop
DFA Guideline	1234	Snap Fit > Snap Fit Requirements > Snap Fit Positioning Pins
DFA Information	1471	Snap Fit > Snap Fit Requirements > Cantilever Beam Snap Fit Design Calculations
DFA Guideline	1484	Snap Fit > Snap Fit Requirements > Snap Fit Gap

DFA > Snap Fit > Snap Fit Requirements
Entry ID: 1471

Cantilever Beam Snap Fit Design Calculations

Information

CID: 1	Content Owner: Jabil	Content Type: Information

Introduction

When a snap fit is engaged, it stretches a certain amount and then elastically recovers and returns to its original position. The performance of a snap fit hook greatly depends upon its engineering design. A snap fit hook that is not designed properly can break during manual or automated assembly or even during molding or shipping. One of the key design parameters is the amount of strain caused when the beam is deflected to achieve the snap fit assembly. It is important to calculate the amount of strain that the plastic experiences. The calculated strain can then be compared to the material's properties so that a robust snap can be designed. The following document will guide you through how to ensure the design of the snap fit will be appropriate so you won't have any issues during manual or automated assembly / dis-assembly.

Calculations for Cantilever Beam Snap Fits [File is located in the "File Attachments" folder.]

Related Entries

DFA	Information	1232	Snap Fit > Snap Fit Requirements > Snap Fit General Information
DFA	Guideline	1233	Snap Fit > Snap Fit Requirements > Snap Fit Stop
DFA	Guideline	1234	Snap Fit > Snap Fit Requirements > Snap Fit Positioning Pins
DFA	Guideline	1235	Snap Fit > Snap Fit Requirements > Snap Fit Corner Radius
DFA	Guideline	1484	Snap Fit > Snap Fit Requirements > Snap Fit Gap

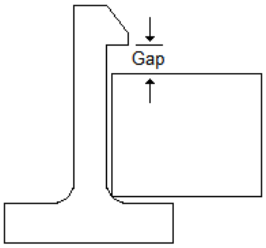
DFA > Snap Fit > Snap Fit Requirements
Entry ID: 1484

Snap Fit Gap

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

The gap between the snap fit hook and the part surface = 0.004" (0.1016mm)



Related Entries

DFA	Information	1232	Snap Fit > Snap Fit Requirements > Snap Fit General Information
DFA	Guideline	1233	Snap Fit > Snap Fit Requirements > Snap Fit Stop
DFA	Guideline	1234	Snap Fit > Snap Fit Requirements > Snap Fit Positioning Pins
DFA	Guideline	1235	Snap Fit > Snap Fit Requirements > Snap Fit Corner Radius
DFA	Information	1471	Snap Fit > Snap Fit Requirements > Cantilever Beam Snap Fit Design Calculations

DFA > Ultrasonic Welding > Ultrasonic Welding Requirements
Entry ID: 1237

Ultrasonic Welding General Information

Information

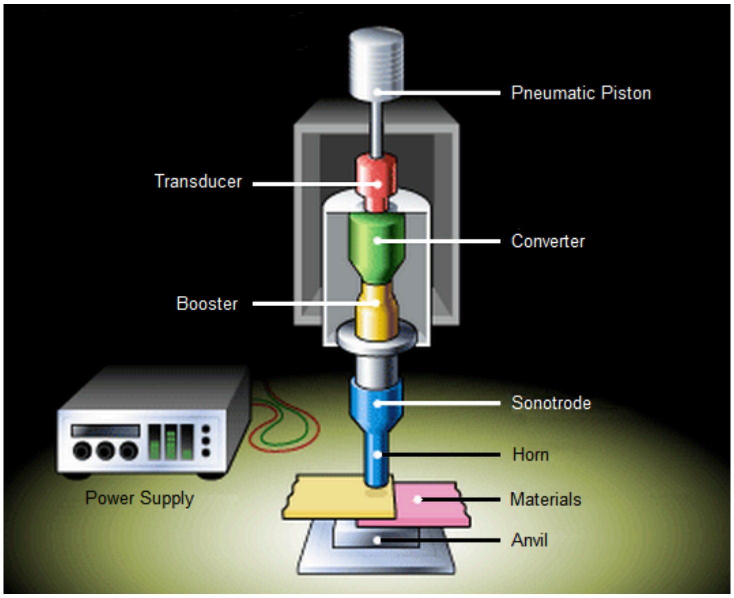
CID: 1	Content Owner: Jabil	Content Type: Information

Introduction

Ultrasonic welding is a well established process first used to bond thermoplastics in the early 1960's. It has been used in many industries including electronics, appliances, automotive, toys, aerospace and medical. The part design, material selection and joint design are all critical factors to ensure a successful assembly process. See Entry 1243 for part design and Entry 1506 for materials selection information.

Ultrasonic welding uses high frequency acoustic vibrations to bind parts together without having to use additional material. Ultrasonic welding eliminates the need for connective bolts, nails, soldering materials or adhesives necessary to bind the materials together.

This type of welding can be used to build assemblies that are too small, too complex or too delicate for more common part bonding techniques.

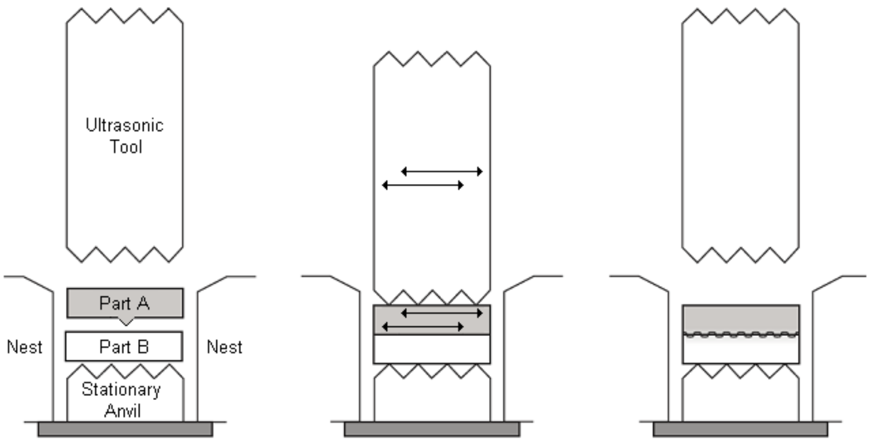


CID: 2	Content Owner: Jabil	Content Type: Information

Process

The parts to be welded are placed into a locating nest. One component rests on a stationary anvil that is serrated to grip the component and hold it still.

The ultrasonic tool descends to apply a clamping pressure between the parts to be welded. The tool then vibrates at a frequency of 20 to 40 kilohertz. The parts are rubbed together under pressure generating heat from the friction. An energy director or shear joint on one of the parts focuses and directs the ultrasonic energy into the mating part. The parts melt together creating a mechanical bond. The horn retracts and the part is removed.

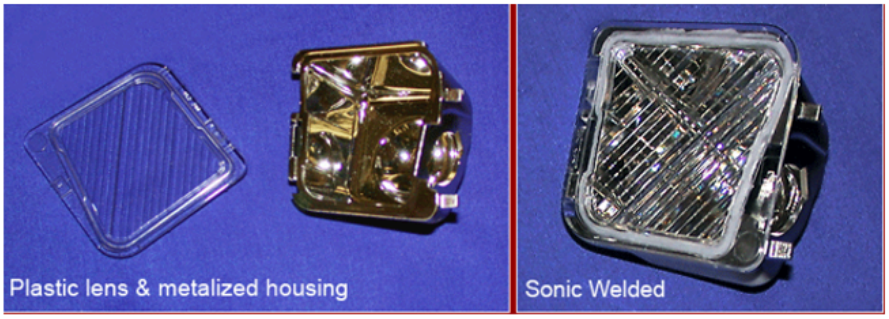


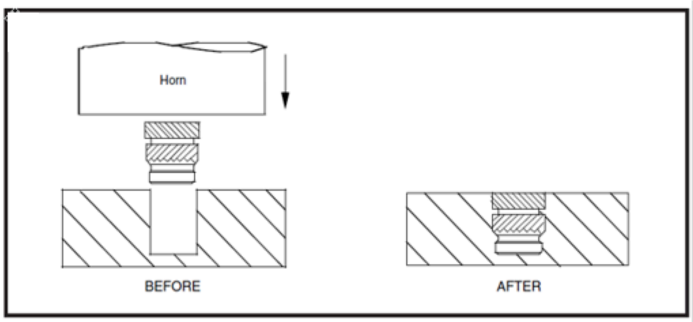
CID: 5	Content Owner: Jabil	Content Type: Information

Applications

The applications of ultrasonic welding are extensive and are found in many industries including electrical and computer, automotive and aerospace, medical and packaging. Whether two items can be ultrasonically welded is determined by their thickness. If they are too thick, this process will not join them and is the main obstacle in the welding of metals. However, wires, microcircuit connections, sheet metal, foils, ribbons and meshes are often joined using ultrasonic welding.

Insertion is the process of embedding a metal component in a thermoplastic part. A hole is pre-molded into the thermoplastic part slightly smaller than the outer diameter of the insert it is to receive. As ultrasonic energy is applied to the insert, frictional heat is generated due to the insert vibrating against the plastic. The plastic melts, permitting the insert to be driven into place. The insert is surrounded by molten plastic, which flows around the knurls, flutes, and undercuts on the outer surface of the insert. Ultrasonic insertion combines the high performance strength of a conventional molded-in insert with the advantages of post molded installation.





CID: 4	Content Owner: Jabil	Content Type: Information

Advantages

- Ease of automated assembly
- Energy efficiency
- High productivity with low costs
- No consumables necessary
- No need for elaborate ventilation systems to remove fumes or heat

The speed parts can be welded is based upon weld time, hold time and the distance the horn must travel to make contact with the part. The speed of the actuator is typically 100 strokes per minute with a 50ms weld time, 50ms hold time and 0.250" (6.3500mm) stroke length.

Insertion Advantages

- No induced stress in the plastic around the metal insert
- Allows multiple inserts to be driven in simultaneously

Disadvantages

- A very accurate and stable fixture is required
- Part design can have a significant negative impact on energy transmission to the joint
- Tight component tolerances are necessary

The maximum joint length that can be welded by a single horn is approximately 9.800" (248.9200mm). This is due to limitations in the power output capability of a single transducer, the inability of the horn to transmit very high power and amplitude control difficulties due to the fact that joints of this length are comparable to the wavelength of the ultrasound.

Related Entries

DFA	Information	1239	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Shear Joint Selection
DFA	Information	1240	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Energy Director Joint Selection
DFA	Guideline	1242	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Shear Joint Part Design
DFA	Guideline	1243	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Energy Director Part Design
DFA	Guideline	1246	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding General Part Design
DFA	Guideline	1250	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Styling Parts
DFA	Information	1506	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Materials Selection

DFA > Ultrasonic Welding > Ultrasonic Welding Requirements
Entry ID: 1239

Ultrasonic Welding Shear Joint Selection

Information

CID: 1	Content Owner: Jabil	Content Type: Information

Introduction

One of the most critical factors in ultrasonic welding is the joint design for two mating surfaces. Making this decision while parts are still in the design stage is very important so the choices can be incorporated. There are many joint designs with advantages and disadvantages for each application. The appropriate joint will be based on the material(s), part profile, bonding requirements, part molding limitations and cosmetic appearance.

Energy director joints and shear joints are the primary types with many variations and some hybrids that combine elements of both.

Materials selection is an important factor in choosing the appropriate joint design, see Entry 1506 for assistance in choosing between using an energy director joint or shear joint design.

For shear joints, the smearing action of the two melt surfaces eliminates leaks and voids since the molten area of the interface is never allowed to come into contact with the surrounding air. Cooling is slower and crystallization and flaking of the material is impossible making shear joints a good choice for strong, hermetic seals.

The shear joint requires weld times in the range of 3-4 times that of energy director joint designs because larger amounts of material are being welded.

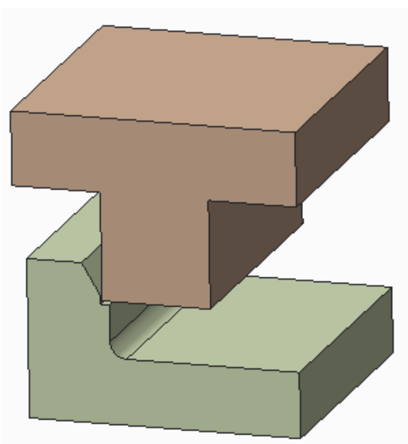
It should be noted that a shear joint is not recommended for parts with a maximum dimension of 3.000" (76.2000mm) or greater, sharp corners or irregular shapes. This is due to difficulty in holding the molding tolerances necessary to obtain consistent results. An energy director type joint as described in Entry 1240 would be suggested for parts falling outside of these parameters.

CID: 2	Content Owner: Jabil	Content Type: Information

Shear Joint Types

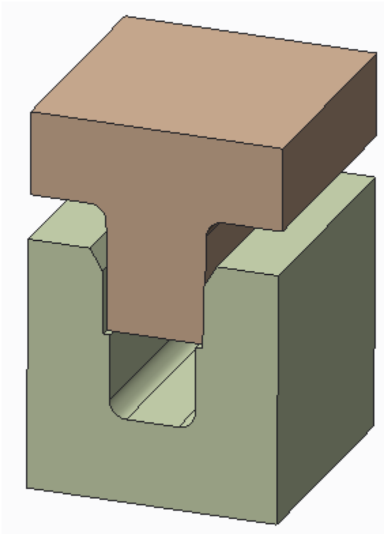
Step

A typical all purpose joint that is the most commonly used when a hermetic seal is not critical. There may be some flash present after welding.



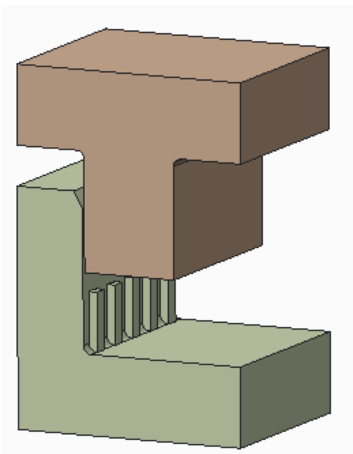
Tongue and Groove

This is the strongest joint and best hermetic seal. It may require more time to complete the weld due to the larger volume of material that needs to be melted.



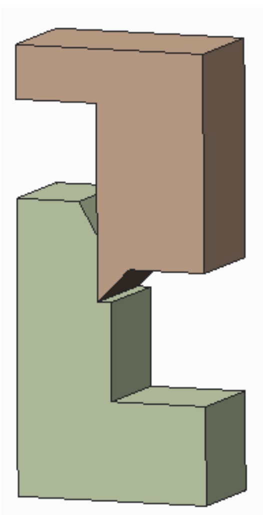
Interrupted

This design provides a high flow rate but may not be the best choice for hermetic seals. Flash is less of an issue due to the lower volume of material that is melted.



Hybrid Chisel

This hybrid combines a modified energy director with the typical shear joint step to establish a small contact surface that focuses the energy to initiate the melting process. This design is good for parts that have a thin exterior wall.



Related Entries

DFA	Information	1237	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding General Information
DFA	Information	1240	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Energy Director Joint Selection
DFA	Guideline	1242	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Shear Joint Part Design
DFA	Guideline	1243	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Energy Director Part Design

DFA	Guideline	1246	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding General Part Design
DFA	Guideline	1250	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Styling Parts
DFA	Information	1506	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Materials Selection

DFA > Ultrasonic Welding > Ultrasonic Welding Requirements

Entry ID: 1240

Ultrasonic Welding Energy Director Joint Selection

Information

CID: 1	Content Owner: Jabil	Content Type: Information

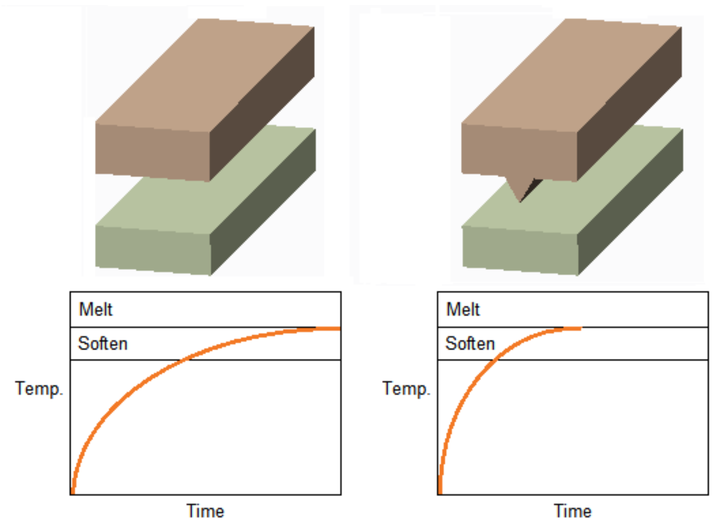
Introduction

One of the most critical factors in ultrasonic welding is the joint design for two mating surfaces. Making this decision while parts are still in the design stage is very important so the choices can be incorporated. There are many joint designs with advantages and disadvantages for each application. The appropriate joint will be based on the material(s), part profile, bonding requirements, part molding limitations and cosmetic appearance.

Energy director joints and shear joints are the primary types with many variations and some hybrids that combine elements of both.

Materials selection is an important factor in choosing the appropriate joint design, see Entry 1506 for assistance in choosing between using an energy director joint or shear joint design.

While it is technically possible to weld joints without an energy director, the time and temperature profile for a joint with and without an energy director demonstrates the benefit of including them for all designs. It also concentrates the ultrasonic energy to rapidly initiate the softening and melting of the energy director material to cover the entire mating surface, forming the joint. This modification permits rapid welding while achieving maximum strength.

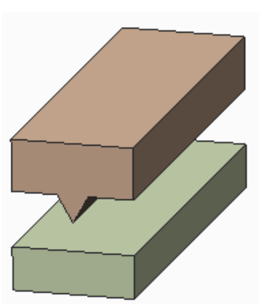


CID: 2	Content Owner: Jabil	Content Type: Information

Energy Director Joint Types

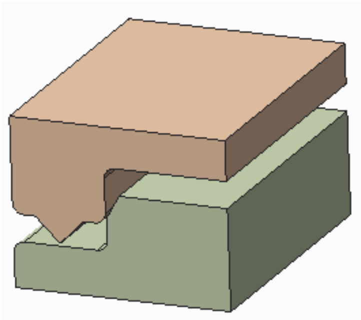
Butt

A typical all purpose joint, used when a hermetic seal and alignment is not critical. There may be some flash present after welding.



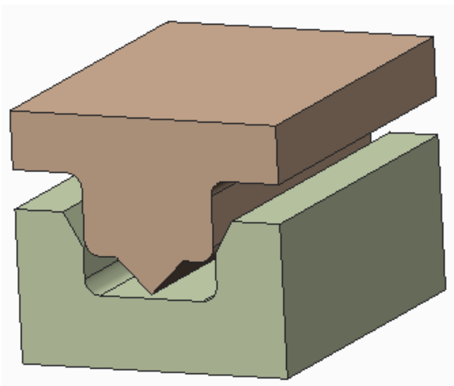
Step

The step joint provides a strong, self aligning joint. It is usually stronger than a butt joint due to the fact that material flows into the vertical clearance. This joint provides strength in shear as well as tension and a good external cosmetic appearance.



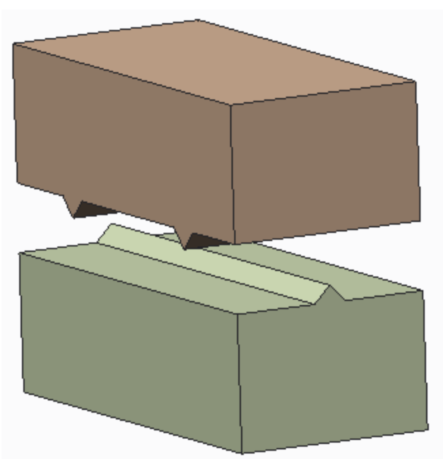
Tongue and Groove

The major benefits of using this joint design are that it provides self alignment and prevents both internal and external flash. Containment of the material within the groove helps provide a good hermetic seal. It is usually a very strong joint since the melted material flows into both vertical clearances.



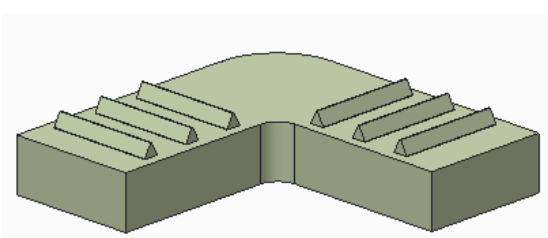
Criss Cross

This design incorporates energy directors on both mating sections that are perpendicular to each other, and provides minimum initial contact at the interface while allowing a potentially larger volume of material flow. This generally results in increased strength in the weld.



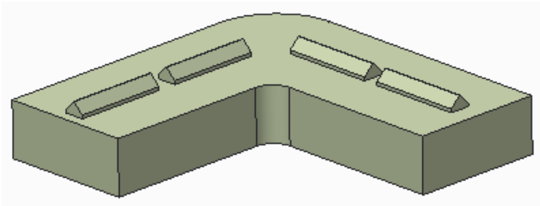
Perpendicular

If peeling forces are an issue, energy directors perpendicular to the wall will minimize the possibility of failures. Acceptable for structural joints but not recommended for hermetic seals.



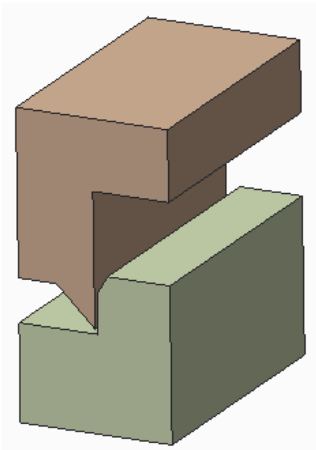
Interrupted

Interrupted energy directors are used to reduce the overall contact area / power required and to reduce flash. Acceptable for structural joints but not recommended for hermetic seals.



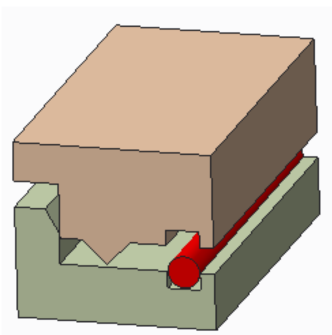
Chisel

Useful for parts with a thin wall or narrow welding ledge. A standard energy director would be shorter than a chisel energy director resulting in less material flow. Another benefit is that it can be placed at the inside edge of a step so that it will not slip off a narrow welding ledge.



O-Ring

For difficult to weld materials or irregular shapes, a compressible seal can be incorporated to get a hermetic seal.



Related Entries

DFA Information	1237	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding General Information
DFA Information	1239	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Shear Joint Selection
DFA Guideline	1242	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Shear Joint Part Design
DFA Guideline	1243	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Energy Director Part Design
DFA Guideline	1246	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding General Part Design
DFA Guideline	1250	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Styling Parts
DFA Information	1506	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Materials Selection

Entry ID: 1242

Ultrasonic Welding Shear Joint Part Design

Guideline

CID: 3	Content Owner: Jabil	Content Type: Information

Introduction

These dimensions are guidelines only, your parts may differ slightly in order to achieve your design requirements.

For shear joint design selection, see Entry 1239.

A critical element for high quality ultrasonic welding is that the mating part materials must have similar melting points. For part materials selection, see Entry 1506.

The requirements in the General Part Design Entry 1246 also apply to shear joint parts.

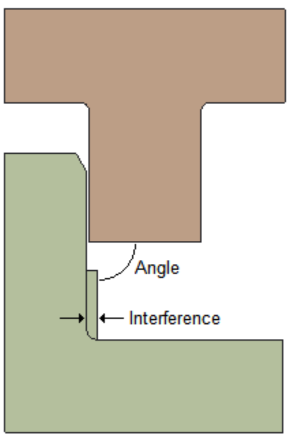
CID: 2	Content Owner: Jabil	Content Type: Requirement

Shear Joint Part Guidelines

The surfaces creating the interference between the top and bottom parts should be flat and at 90° from each other.

The following table gives general guidelines for interference and part tolerances in relation to maximum part dimension.

Maximum Part Dimension	Interference Per Side	Part Dimension Tolerance
< 0.750" (19.0500mm)	0.008" (0.2032mm) to 0.012" (0.3048mm)	+/-0.001" (0.0254mm)
0.750"(19.0500mm) to 1.500" (38.1000mm)	0.010" (0.2540mm) to 0.016" (0.4064mm)	+/-0.002" (0.0508mm)
1.500" (38.1000mm) to 3.000" (76.2000mm)	0.014" (0.3556mm) to 0.020" (0.5080mm)	+/-0.003" (0.0762mm)



Related Entries

DFA	Information	1237	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding General Information
DFA	Information	1239	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Shear Joint Selection
DFA	Information	1240	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Energy Director Joint Selection
DFA	Guideline	1243	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Energy Director Part Design
DFA	Guideline	1246	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding General Part Design
DFA	Guideline	1250	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Styling Parts
DFA	Information	1506	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Materials Selection

DFA > Ultrasonic Welding > Ultrasonic Welding Requirements
Entry ID: 1243

Ultrasonic Welding Energy Director Part Design

Guideline

CID: 2	Content Owner: Jabil	Content Type: Information

Introduction

These dimensions are guidelines only, your parts may differ slightly in order to achieve your design requirements.

For energy director joint design selection, see Entry 1240.

A critical element for high quality ultrasonic welding is that the mating part materials must have similar melting points. For part materials selection, see Entry 1506.

The requirements in the General Part Design Entry 1246 also apply to energy director parts.

CID: 3	Content Owner: Jabil	Content Type: Requirement

Energy Director Part Guidelines

An energy director is only needed on one of the mating surfaces.

For wide joints and other applications, two or more energy directors may be necessary.

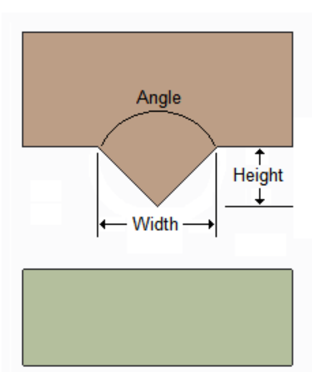
The peak of the energy director should be sharp, energy directors that are round or flat at their peak will not flow as efficiently.

When working with parts that are made of the same material, the energy director can be designed into either part. It is generally placed on the part contacted by the horn.

For parts with different materials, the general practice is to place the energy director on the part with the material that has the higher melt temperature and stiffness.

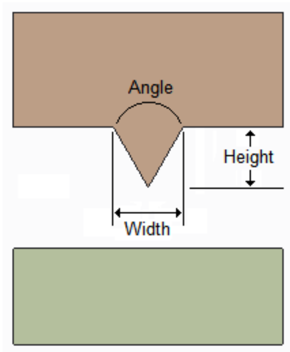
For Amorphous Materials

- Minimum wall thickness = 2.0000mm
- Energy director angle = 90°
- Energy director height = width of the joint divided by 8 to 10
- Minimum energy director height = 0.008" (0.2032mm)
- Minimum width of the energy director at its base = 20% of the joint width



For Semi-Crystalline Materials

- Minimum wall thickness = 2.0000mm
- Energy director angle = 60°
- Energy director height = width of the joint divided by 8 to 10
- Minimum energy director height = 0.015" (0.3810mm)
- Minimum width of the energy director at its base = 20% of the joint width



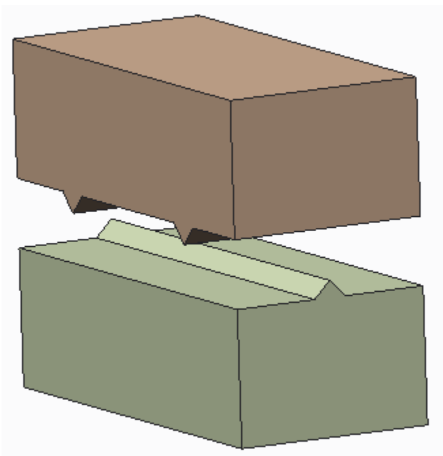
CID: 6	Content Owner: Jabil	Content Type: Information

Special Cases

Criss Cross Joints

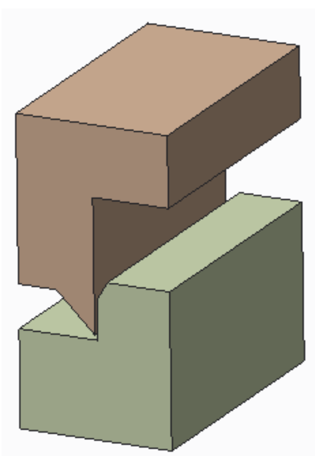
Each energy director should be approximately 60% of the size that would be used in a standard single energy director design, with an angle of 60° versus the standard 90°.

This design generates a very high material flow. Containing flash should be addressed by using a tongue and groove or step design.



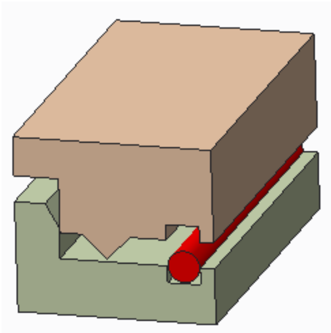
Chisel Joints

Typically used when nominal wall thickness is 0.060" (1.5240mm) or less. A standard energy director will be too small at less than 0.010" (0.254 mm) tall resulting in lower weld strengths. The knife edge can be 0.015" (0.3810mm) to 0.020" (0.5080mm) tall and should utilize a 45° angle.



O-Ring Joints

In order to achieve a hermetic seal in less easily welded materials it may be necessary to use an O-ring. It is important to note that the O-ring should be compressed a maximum of 10% to 15% and only at the end of the weld.



Related Entries

DFA	Information	1237	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding General Information
DFA	Information	1239	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Shear Joint Selection
DFA	Information	1240	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Energy Director Joint Selection
DFA	Guideline	1242	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Shear Joint Part Design
DFA	Guideline	1246	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding General Part Design
DFA	Guideline	1250	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Styling Parts
DFA	Information	1506	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Materials Selection

DFA > Ultrasonic Welding > Ultrasonic Welding Requirements
Entry ID: 1246

Ultrasonic Welding General Part Design

Guideline

CID: 3	Content Owner: Jabil	Content Type: Information

Introduction

These dimensions are guidelines only, your parts may differ slightly in order to achieve your design requirements.

For additional part design requirements specific to shear joints, see Entry 1242.

For additional part design requirements specific to energy directors, see Entry 1243.

A critical element for high quality ultrasonic welding is that the mating part materials must have similar melting points. For part materials selection, see Entry 1506.

Using the vibrating horn and / or fixture for alignment may not be sufficient to ensure accurate, repeatable alignment and avoid cosmetic issues. There are a variety of joint designs that are self aligning, see Entry 1239 and Entry 1240 for assistance in choosing the appropriate joint type.

When flash cannot be tolerated for cosmetic or functional reasons, a well should be incorporated.

The parts should be rigid if the acoustic vibrations must travel some distance to the joint. Soft materials do not transmit vibrations well.

The top part should be as shallow as possible, in effect just a lid.

Maximum joint length that can be welded by a single horn = 9.800" (248.9200mm)

CID: 4	Content Owner: Jabil	Content Type: Requirement

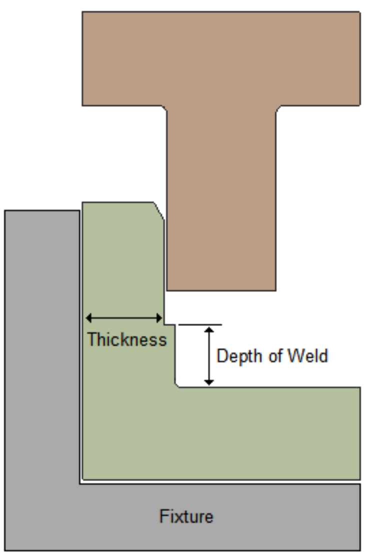
General Guidelines

The general guideline for depth of weld is to use 75% of the lower part outer wall thickness.

Minimum outside wall thickness of the lower part = 0.080" (2.0320mm)

The outside wall of the lower part may deflect or bulge in the welding zone. A suitable area should be included on the exterior of the part to allow the fixture to provide support.

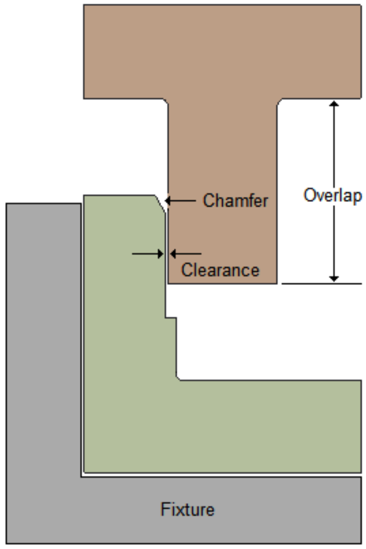
The top part should be of sufficient structural integrity to withstand internal deflection.



A lead-in / chamfer should be incorporated.

The fit should be close but not so tight that force must be used to put the parts together before welding. The ideal part clearance will fall between 0.002" (0.0508mm) and 0.004" (0.1016mm), depending on the size of the parts.

Whenever possible, the distance that one part overlaps into the other should be at least 0.040" (1.0160mm).



Highly polished or uneven surfaces in contact with the horn may result in cosmetic issues after welding.

CID: 2	Content Owner: Jabil	Content Type: Requirement

Sharp Corners and Edges

Sharp corners and edges localize stress. When a molded part is subjected to ultrasonic vibrations, damage (fracturing / melting) may occur in the high stress areas. This can be remedied by having a generous radius of 0.020" (0.5080mm) on sharp corners and edges.

Appendages and Tabs

Small or narrow appendages and tabs molded onto the interior or exterior surfaces of a part can be affected by the acoustic vibrations, resulting in fracturing.

To mitigate the issue:

- Include a radius where the appendage or tab intersects the main part
- Increase the material thickness

CID: 5	Content Owner: Jabil	Content Type: Requirement

Openings and Bends

Openings in the part between the horn and weld area can interrupt the transmission of the ultrasonic energy. Depending on the size of the opening, little or no welding will occur directly beneath the opening.

A bend in the part dampens the transmission of energy making it difficult to pass vibrations from the horn to the weld area.

Position of Joint Surface

The joint surface should all be in the same plane and parallel to the horn surface. If the joint surface is not in one plane, the unequal distances from the horn surface may produce uneven welding.

Horn Contact and Placement

The horn contact area should be directly above the joint area in order to properly transmit the vibrations.

The area of horn to part contact must be larger than the total joint area. Failure to do so may limit energy transmission resulting in poor welding and cosmetic issues.

Related Entries

DFA	Information	1237	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding General Information
DFA	Information	1239	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Shear Joint Selection
DFA	Information	1240	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Energy Director Joint Selection
DFA	Guideline	1242	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Shear Joint Part Design
DFA	Guideline	1243	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Energy Director Part Design
DFA	Guideline	1250	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Styling Parts
DFA	Information	1506	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Materials Selection

DFA > Ultrasonic Welding > Ultrasonic Welding Requirements
Entry ID: 1250

Ultrasonic Welding Styling Parts

Guideline

CID: 2	Content Owner: Jabil	Content Type: Requirement

Do not use ultrasonic welding on styling parts. This can result in marks on the surface of the styling part. If it can't be avoided, provide enough clearance that a foil can be used to protect it.

Related Entries

DFA	Information	1237	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding General Information
DFA	Information	1239	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Shear Joint Selection
DFA	Guideline	1243	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Energy Director Part Design

DFA > Ultrasonic Welding > Ultrasonic Welding Requirements
Entry ID: 1506

Ultrasonic Welding Materials Selection

Information

CID: 1	Content Owner: Jabil	Content Type: Information

Introduction

The selection of the material(s) is critical in getting dependable and reproducible ultrasonic welds.

Thermoplastics are rigid and solid at normal temperatures but at elevated temperatures they soften and melt. Thermoplastics are further delineated into amorphous and semi-crystalline polymers.

Material	Shear Joint	Energy Director	Notes
Thermoplastic - Amorphous polymers	Yes	Yes	Good choice, materials with high melting temperatures are more difficult to weld
Thermoplastic - Semi-crystalline polymers	Yes	No	
Thermoset plastics	No	No	Not suitable for ultrasonic welding

CID: 2	Content Owner: Jabil	Content Type: Information

Amorphous Polymers

Amorphous polymers are generally easy to weld and are acceptable for both energy director and shear joint designs.

Amorphous polymers have a random molecular structure that does not have a narrow melting point. Instead, amorphous material softens gradually as temperature rises. This makes welding parameters less critical and there is reduced chance for thermal damage if the ultrasonic energy is on longer than necessary.

Amorphous Materials

- ABS
- Acrylic
- PMMA
- Polystyrene
- Polysulfone
- SAN

High melt temperature amorphous resins, such as polycarbonate and polysulfones are more difficult to weld.

Semi-Crystalline Polymers

Semi-crystalline polymers have a highly ordered molecular structure. They change rapidly from a solid to a molten state, and back again, over a relatively narrow temperature range and are sensitive to heat above their melting point. Even short times at higher temperatures may cause thermal damage.

With energy director joints, there is air contact with the molten plastic while the energy director is melting and spreading sideways. This may allow the material to crystallize before there is enough heat to weld the entire surface of the joint. Crystallized zones can crack and flake off from the welding area. The air contact may also cause oxidation of the plastic resin. Due to these possible problems, energy directors are not recommended for semi-crystalline materials.

Shear joints are a good choice for semi-crystalline materials. Since there is little air contact, cooling is slower and crystallization and flaking of the material is much less likely.

Semi-Crystalline Materials

- Polyethelyne

- PP
- PBT
- PET
- PEEK
- Acrylic
- PVC and uPVC
- Polycarbonate
- Melamine
- Acetal
- Nylon
- Polyphenylene Sulfide
- Polyester

CID: 3	Content Owner: Jabil	Content Type: Information

Thermoset Plastics

Thermoset plastics are not suitable for ultrasonic welding.

Thermoset Materials

- Epoxies
- Phenolic (Bakelite)
- Polyester Resins
- Polyimide
- Urea
- Vulcanized Rubber

Related Entries

DFA	Information	1237	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding General Information
DFA	Information	1239	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Shear Joint Selection
DFA	Information	1240	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Energy Director Joint Selection
DFA	Guideline	1243	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Energy Director Part Design
DFA	Guideline	1246	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding General Part Design
DFA	Guideline	1250	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Styling Parts
DFA	Information	1506	Ultrasonic Welding > Ultrasonic Welding Requirements > Ultrasonic Welding Materials Selection

Missing File Attachments

The following file attachments are referenced in the DFx content, but could not be included in the extract. Please provide copies of these files along with the content extract.

Entry 1712 - Tolerance Stackup Analysis Spreadsheet
Entry 1471 - Calculations for Cantilever Beam Snap Fits