

<b>Viasat, Inc.</b>	Process Area: <b>Quality</b>	Document Number: <b>070-QA-044</b>	Revision: <b>06</b>
Name of Document: <b>Standard for Workmanship and General Practices</b>		Process Category: <b>Quality</b>	Page: <b>1</b>

## 1 Purpose and Scope

To establish procedures and ensure consistency in requirements for general workmanship and standard practices of electronics hardware.

The documents referenced herein shall represent the minimum workmanship standards for all fabricated printed circuit boards, electronic sub-assemblies and assemblies, as well as mechanical assemblies, which represent Viasat products. The requirements herein are applicable not only to Viasat and its Divisions but all contracted product for which this standard would be imposed.

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## 3 General Procedure

Verify all workmanship attributes comply with drawing specifications as well as the appropriate reference standard Workmanship

All procedures applied in the manufacture of products as referenced in Section 4 are expected to be in accordance with the best manufacturing practices that will produce the highest quality products. Viasat, Inc. or any Divisions, as the Buyer, reserves the right to review all Supplier procedures on workmanship practices during a process audit under the AS9100 / ISO 9001 Quality Management System or any

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additional or subsequent systems that Viasat, Inc. may deem necessary to impose. Those procedures should detail or reference practices such as:

- soldering practices as specified in IPC documents
- marking of parts and assemblies
- wiring assembly and installation practices
- welding and brazing practices
- plating practices
- riveting practices
- surface finishing practices (e.g., faying, sealing, painting, sanding, conformal coating, passivation, etc.)
- machining operations practices
- screw assembly practices
- deburring practices
- sharp edges removal practices
- proper removal of unwanted contaminates and surface films

The Supplier shall schedule and perform inspections on the contracted product throughout the manufacturing process to insure compliance with approved procedures for workmanship practices.

Examples of areas to be inspected are:

- mounting and installing parts and subassemblies
- cleaning of parts and assemblies
- installation of threaded fasteners and rivets
- installation of gear and bearing assemblies
- assembly of wiring
- installation of wiring
- soldering, welding and brazing

The Supplier should develop inspection checklists so that consistent inspections can be conducted to insure good workmanship.

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## 4 Metal Fabrication Workmanship Requirements

### SURFACE ROUGHNESS

Unless otherwise specified, surface roughness shall be no greater than a 125 micro inch finish.

### BURRS AND SHARP EDGES

#### Definition

A burr is a rough or irregular piece of material that typically occurs at the edge of a part feature. The burr is usually the result of the part fabrication process.

#### Burr Types

- **Tight Burr** – A burr that is strongly attached to the part. The burr cannot be moved or dislodged.
- **Rolled-over Burr** – A burr that is curled over on itself. Concern is that contaminants can be trapped in the burr.
- **Embedded Burr** – Any burr that has been pressed into the base metal. The burr cannot be moved or dislodged.
- **Loose Burr** – A burr that is not firmly attached to the part. The burr can be moved or dislodged.
- **Feather Burr** – A very thin or fine burr typically less than .001” thick. The burr can be moved or dislodged.

#### Deburring Requirements

Unless otherwise specified, when the drawing specifies that the fabricated item shall be deburred, Table 1 shall be used to determine the acceptability or non-acceptability of burrs according to the specified part class. The requirement is applicable to all edges and corners.

Burr removal shall not result in a chamfer or radius that exceeds .015 inches, or one-quarter of the material thickness, or the maximum edge break radius as specified on the drawing, whichever is smaller.

After the deburring process the parts shall meet the dimensional tolerances specified on the drawing.

#### Part Classifications

- **Class 1 - General Service Parts**  
Non critical parts. Can include commercial parts and special test equipment (STE). Includes applications where burrs would not impact product functionality or cosmetic requirements.
- **Class 2 - Dedicated Service Parts**  
Includes military and commercial parts where high performance and extended life is required.
- **Class 3 - High Reliability Parts**  
Includes space, military, and commercial parts where continued performance or performance on demand is critical. Equipment failures or downtime cannot be tolerated and must function when required.

**Table 1. Burr Acceptability Criteria**

Criteria	Part Classification		
	Class 1	Class 2	Class 3
Inspection Magnification	None	10X	30X
Allowable Burr Type (unless specified on drawing)	Tight Burr, Embedded Burr	Tight Burr, Embedded Burr	Tight Burr, Embedded Burr

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Criteria	Part Classification		
	Class 1	Class 2	Class 3
Part Dimensions	Burr does not violate overall part dimensional requirements	Burr does not violate overall part dimensional requirements	Burr does not violate overall part dimensional requirements
Part Function	Does not affect part form or function as determined by engineering.	Does not affect part form or function as determined by engineering.	Does not affect part form or function as determined by engineering.
Acceptable Burr Locations	Non-critical areas of part as determined by engineering.	Non-critical areas of part as determined by engineering.	Non-critical areas of part as determined by engineering.
Burr Attachment Condition	Not removable by hand or tweezers.	Not removable by hand or tweezers.	Not removable by hand or tweezers.
Post Burr Removal Condition	Does not violate overall part dimensional requirements  Does not affect part form or function  Exposed base metal must be approved by engineering.	Does not violate overall part dimensional requirements  Does not affect part form or function  Exposed base metal must be covered by an engineering approved coating.	Does not violate overall part dimensional requirements  Does not affect part form or function  Exposed base metal must be covered by an engineering approved coating.

#### *Post Burr Removal Base Metal Repair*

If exposed base metal is left as the result of burr removal, the vendor shall notify the buyer listed on the PO and provide the location and size of the exposed base metal. The buyer will then contact the cognizant engineer who shall determine whether the base metal can be left as is or shall specify the coating and application method for covering the base metal.

#### **INSIDE SHARP CORNERS**

Inside sharp corners shown, but not specified as such on the drawing, may have a .015 inch maximum radius, or .015 inch maximum chamfer.

#### **THREAD RELIEF**

Unless otherwise noted on the drawing, thread reliefs shall be as follows:

**External:** The relief diameter shall be equal to:

- Minimum minor diameter  $+0.000/-0.010$  inches for threads .25 inch diameter and under.
- Minimum minor diameter  $+0.000/-0.020$  inches for threads over .25 inch diameter

**Internal:** The relief diameter shall be equal to:

- Maximum major diameter  $+0.020"/-0.000$  inches for threads .25 inch diameter and under.
- Maximum major diameter  $+0.040"/-0.000$  inches for threads over .25 inch diameter

Length of the thread relief shall not exceed 2-1/2 threads.

#### **CONCENTRICITY**

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Unless otherwise specified, all diameters shown concentric to each other shall be concentric within .010 total indicator runout.

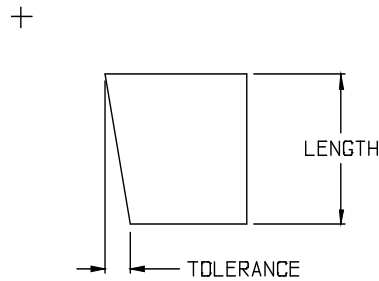
**PERPENDICULARITY OF HOLES**

Unless otherwise specified, clearance holes shown perpendicular to a surface shall be perpendicular within 0.5 degrees. Unless otherwise specified, tapped holes shown perpendicular to a surface shall be perpendicular within 1.0 degree.

**PARALLELISM OF PLANE SURFACES**

Unless otherwise specified, all machined or sheared surfaces shown parallel shall be so within the tolerance zone for given length of the surface shown by Figure 1 and Table 1.

**Figure 1. Parallelism for Plane Surfaces**



**Table 1. Parallelism Length/Tolerance**

Length (inches)	Tolerance (inches)
0.00 – 1.00	.003
1.00 – 3.00	.005
3.00 – 5.00	.010
5.00 – 25.00	.015
25.0 – 60.0	.050

If tolerance exceeds tolerance on the drawing, the drawing tolerance shall take precedence.

**FLATNESS**

Machined surfaces shall be flat within .002 inch/inch.

**SQUARENESS OF 90 DEGREE BENDS**

Sheet metal bends shown as 90° on drawing shall be 90 +/- 1.0 degree. All formed parts shall have minimum bend reliefs where required.

**GRAIN DIRECTION**

Unless otherwise specified, grain direction in formed metal parts may run in any direction convenient to manufacturing, provided these parts do not fracture at bends.

**COUNTERBORE AND SPOTFACE FILLET RADII**

Counterbore and spotface fillet radii shown as sharp shall be sharp to:

- .010 maximum radius for bore sizes between 0.00 and 1.00 inches
- .030 maximum radius for bore sizes between 1.00 and 2.00 inches

**TANGENCY OF FILLETS AND ROUNDS**

Fillets and rounds shown tangent to adjacent surfaces shall fair smoothly with tangent surfaces +/- .005 inches.

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## **5 Welding and Brazing Workmanship Requirements**

### **Aluminum Brazing**

Viasat brazing procedure specifications

When the class of braze is not specified on the Viasat drawing, or other applicable document, Class A requirements shall apply per AWS 3.7M/C3.7:2011.

Filler material shall be compatible to the material being brazed.

Brazing filler material will be AWS A5.8m/A5.8 approved foil or paste as specified on the drawing.

Fluxes shall conform to AWS A5.3M/A5.31 and shall be compatible to filler material and shall remove oxides to prevent their reformation during the braze process.

### **Controlled Atmosphere Brazing (CAB)**

Assemblies will be cleaned and assembled following a documented procedure with traceability to each braze run and will include.

- Thermocouple placement and quantity
- Thermal Profiles
- Cooling time

### **Welding**

When not specified on the drawing Viasat welded assemblies will be based on the best practices identified in AWS D17.1/D17.1M:2010-AMD1.

Parts must be checked and verified that they are to print, before welding. Once welding begins selective welding techniques must be exercised, so that surface distortion is held to a minimum.

### **BUTT WELDS**

Unless otherwise specified, all butt weld joints shall have complete penetration.

### **WELD SIZES**

Fillet weld sizes shall be at least 140% of the thickness of the thinner material unless specified otherwise.

### **JOINT APPEARANCE**

Welds shall be free from harmful defects (e.g., cracks, porosity, undercuts, voids, and gaps). All welds and brazes shall show no burn-through. Weld bead appearance, cross-section and ripples shall be uniform and smooth.

### **GRINDING**

Grinding shall affect the minimum area possible to satisfy the drawing requirements. Welds shall not be ground unless required by drawing.

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## 6 Mechanical Assemblies

6.1 When mounting and installing parts and/or subassemblies, the following practices will be adhered to wherever applicable:

- Assembled parts and hardware should be secured or mounted in a manner that satisfactorily accomplishes the intended purpose without degrading or becoming damaged in the environment in which they are to be used.
- Electronic equipment comprised of missing, inoperative, defective, bent, broken, or otherwise damaged parts will be deemed unacceptable.
- Parts (e.g., hinges, catches, handles, knobs, etc.) installation should avoid damaging adjacent hardware or the mounting surface.
- Rework to damaged finishes will be considered successfully performed when the surfaces are touched-up with a continuous protective coating of identical composition as the original coating material.
- The touch-up color should match the original finish such that the blended colors are not visually noticeable.

6.2 Installation of Threaded Fasteners and Rivets

Threaded fasteners and rivets should be carefully selected and applied so as to produce a safe, non-corroding, functional and long-lived joining of materials. Commonly practiced procedures, guidelines and requirements are:

- Screws, nuts and bolts should show no evidence of cross threading, mutilation, or detrimental or hazardous burrs.
- The mixing of fasteners composed of different metals should be strictly controlled (e.g., steel nuts against aluminum flat washers) because dissimilar metals encourage corrosion and unequal resistance to mechanical stresses. Exceptions would include breakaway applications.
- Uneven/over stresses between soft and hard materials should be avoided because such stresses cause unwanted fatigue or early failure (e.g., steel screws fastening plastic pieces, aluminum screws to stainless steel nuts, etc.).
- All screw-type fasteners should be tight. Tight is defined as the screw or rivet being firmly secured with no noticeable movement between the attached parts before or after applying maximum force by hand without tools. It should be noted that tight may not guarantee unloosening, over time, due to vibration and movement between joined metals.
- In critical applications or whenever tightening of fasteners is insufficient, the Supplier manufacturing processes should specify the proper torque requirements for threaded fasteners.
- Self-locking fasteners and lock-wiring will be acceptable when specified on the engineering drawing.
- Split-ring lock washers may be used if buffered by flat washers when specified on the engineering drawing.
- Star lock washers will not be allowed.
- Anti-seizing chemical locking agents (e.g., Loctite) may be used and only sparingly, with the exception of instances when grounding bonds of less than 0.10 Ohm are required as specified on the engineering drawing.
- The riveting operation should be carefully performed such that the rivets are tight and satisfactorily headed with the rivet heads tightly seated against their bearing surface.



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## **7 Cleaning of Parts and Assemblies**

The proper methods for cleaning parts and assemblies during the fabrication of product are essential in assuring the expected performance and long operational life. The subsequent procedures are offered as examples of acceptable cleanliness practices.

Product shall be cleaned of:

- loose, spattered or excess solder
- weld metal
- metal chips
- mold release agents
- smudges
- any other foreign material which might detract from the intended operation, function, or acceptable appearance of the product
- unwanted particles that could loosen or become dislodged during the normal expected life of the product
- all corrosive material prior to parts assembly into the product
- contaminants (e.g., lubricating oils, mold release agents, waxes, sand, corrosion products, solder fluxes, finger prints, dust, etc.)
- all contaminants without incurring damage or change of electrical and mechanical properties of the product by using the safest and most appropriate agent and methods

After cleaning, the product should be allowed to dry. Any remaining loose contaminants should be blown or vacuumed away, and all moving parts and assemblies should be relubricated according to design requirements. In addition, post inspection should reveal no damage, unusual wear or presence of contamination on the product.

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## 8 Wiring/Cable Crimping and Installation Workmanship

Obsolete. See current revision of IPC/WHMA-A-620.

## 9 Acceptance Criteria for Circular Coax Crimps

Obsolete. See current revision of IPC/WHMA-A-620.

## 10 Handling of Equipment

Proper handling of parts and equipment must be exercised to preclude physical and/or electrical damage such as cracks, scratches, twists, fractures, etc. and the possibility of hidden damage such as that produced by flexure of component leads, stressing of solder joints, over tightening of fasteners, electrostatic discharge (ESD), etc. In process work is often particularly susceptible to such damage and, as such, special precautions that may include special fixtures, stowage totes, etc. should be considered.

## 11 Cosmetic Inspection Criteria

### 11.1 Purpose and Scope

The purpose of this standard is to define and establish acceptance and rejection criteria for surface finish for incoming and outgoing inspections applicable at Customer, approved Supplier or Subcontractor and Viasat. The company uses similar inspection criteria as today's technology and market leader. Viasat can meet any surface finish on request; our finishing standard is common industrial finish described in Surface Categories Section.

Each finishing class stands for special manufacturing and handling processes, which are proportional to the related costs. Every customer has to decide if a special cosmetic finish is a requirement or "nice to have". Manufacturing processes of bare material (e.g. cold rolled steel, pre galvanized steel, extruded parts) as well from machining processes (e.g. punching, forming, and welding) may leave visible marks at the finished products, which are not avoidable. Anodized material is more scratch resistant than Alodine material.

This standard applies to Surface Finishes such as Paint, Chemical Conversion Coating (Alodine, Anodize), Plating, Molding and silk-screening.

### 11.2 Inspection Purpose

The inspection purpose is to determine any conditions for which the part or system will be rejected. The intent of inspection is

- To ship a part or system that meets the finish standard of this specification.
- It is **NOT** the intent of inspection to find all imperfections on a part or system.

### 11.3 Terms and Defect Definitions

#### Accept per approved engineering drawing

- Some cosmetic imperfections are not avoidable in certain process and design circumstances. Approved engineering documents will point this out.

#### Abrasion

- Surface imperfection that doesn't remove or displace material appears as a scuff or changes to the surface finish.

#### Bare Metal

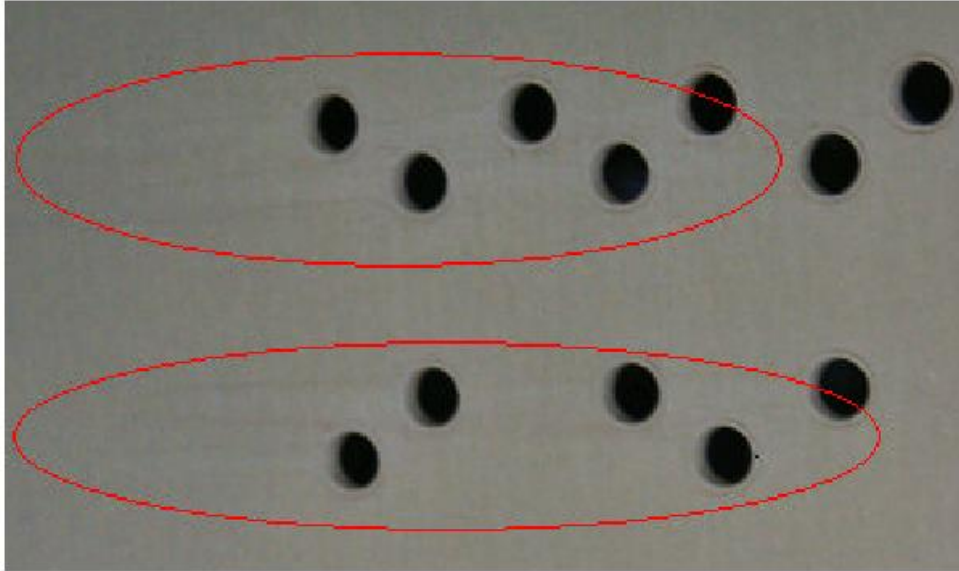
- A metal surface that has an intact protective coating but no cosmetic finish.

**Base Metal**

- A bare metal surface on which the protective coating has been compromised.

**Bleed Out**

- A Substance that runs out of seams. Color can vary from brown, dark brown to gray white at plating.

**Bleeding**

- Rough and not densely packed dull gray lines at plated material.

**Blister**

- A bubbling in the surface of the finish. Non-adhesion or lack of proper sticking of the coating to the surface caused by trapped air, gas or moisture.

**Blush**

- Discoloration or change in gloss.

**Break-out**

- **Tearing of metal, or other material away from a casted or molded edge as a result of a cutting/trimming process. This is likely to occur at flash points, or parting lines due to undersized, or dull die cutting/trimming tools.**



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### Burns

- Brown marks or streaks on a surface of the part caused by trapped gases burning the surface of the plastic during molding operation.

### Bubble

- A bubbling in the surface of the finish. Non-adhesion or lack of proper sticking of the coating to the surface caused by trapped air, gas or moisture.

### Bump

- Protrusions caused by trapped air / gas or moisture usually seen in finished parts.

### Burnish Marks

- Marks or lines that cannot be felt usually caused by tooling dies most common on flattened cold rolled material e.g. Steel or aluminum sheets



### Burrs

- Sharp edges around part features caused by manufacturing process like punching, shearing, milling or drilling.



**Caution:** Sheet metal edges that are compliant to UL 1439 can still cut through protective gloves and/or human hands.

### Chipping

- Areas in which the adhesion between the paint and the surface is poor, causing the paint to come off with light rubbing.

### Cloudiness

- A haziness or lack of clarity in otherwise transparent part.

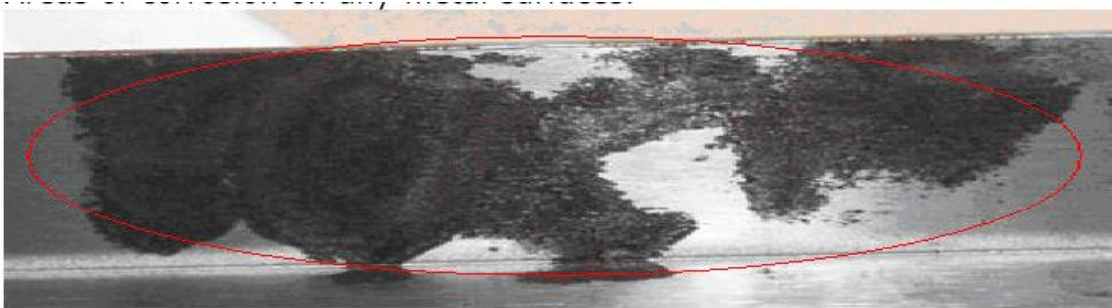
### Contamination

- Rough and not densely packed dull gray lines at plated material. Colored specks of foreign material embedded in or on the surface part.



### Corrosion

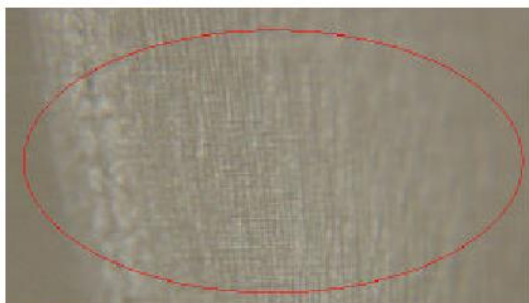
- Areas of corrosion on any metal surfaces.



**Caution:** Small areas of rust are acceptable where plating is removed by a standard manufacturing or welding process, e.g. sheared (cut) edges.

### Cracking

- Crackled appearance due to poor adhesion usually from surface contamination before plating.
- Hairline cracks of anodized material caused by bending, high temperature curing after silk screening of the aluminum or tool mark hair cracks on the opposite site of the aluminum.
- Fine damages which may extend in a pattern on or beneath the surface or through a layer of material.



### **Crazing**

- A fine mesh of minute cracks on the surface of some plastics due mainly to the effects of UV light.

### **Delaminating**

- Separation, peeling of thin layer of material

### **Dent**

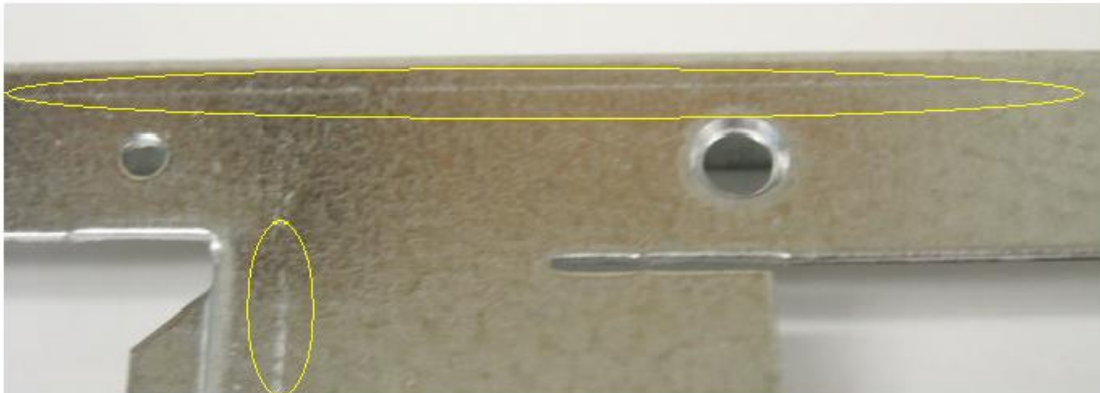
- A surface depression caused by an impact.



**Caution:** Tooling marks are not dents.

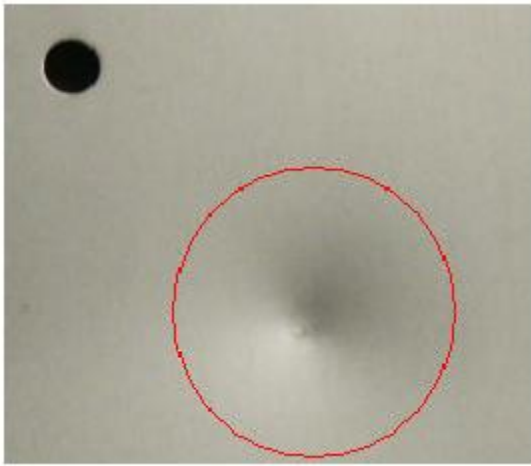
### **Die marks**

- Marks made on the metal's surface when it is formed, usually consist of long straight lines.



**Ding**

- Roughly funnel shaped dent caused by an impact.

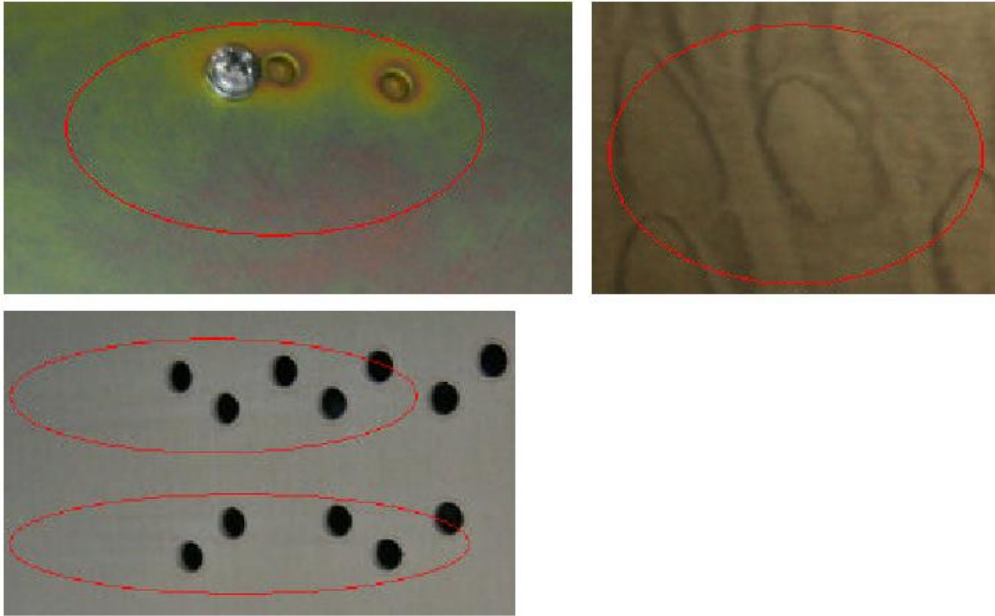
**Dirt**

- Any particle of foreign material.



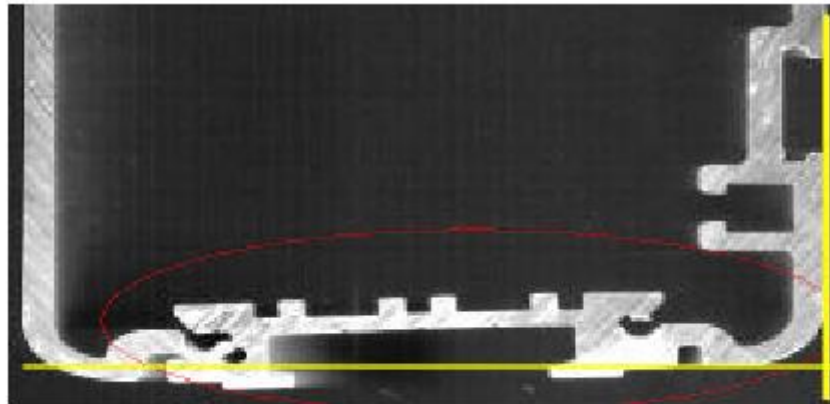
**Discoloration**

- Any change from the original color or shade in the finish.



**Distortion**

- A deformation of a diecasted part





**Dust**

- Small particles.



**Fill In**

- An excess of ink that alters the form of a screened feature not affecting legibility.

**Fingerprints**

- An impression left on the surface due to operator handling.



**Finish**

- An area of smoother finish of molded plastic parts.

**Flaking**

- Areas in which the adhesion between the paint and the surface is poor, causing the paint to come off with light rubbing.

**Flash**

- Thin, excess material usually around the area of the mold parting line or internal shutoff areas.

**Flow Marks**

- Waviness of edge or excess linear surface texture of silk-screened areas.

**Fracture**

- Material splitting usually on the outside bend radius.

**Gates**

- Point at which plastic is injected in cavity, usually on parting line.

**Gloss**

- A uniform appearance of a painted or molded area. E.g. Shiny, matt

**Glossiness**

- An area of either excessive or deficient gloss.

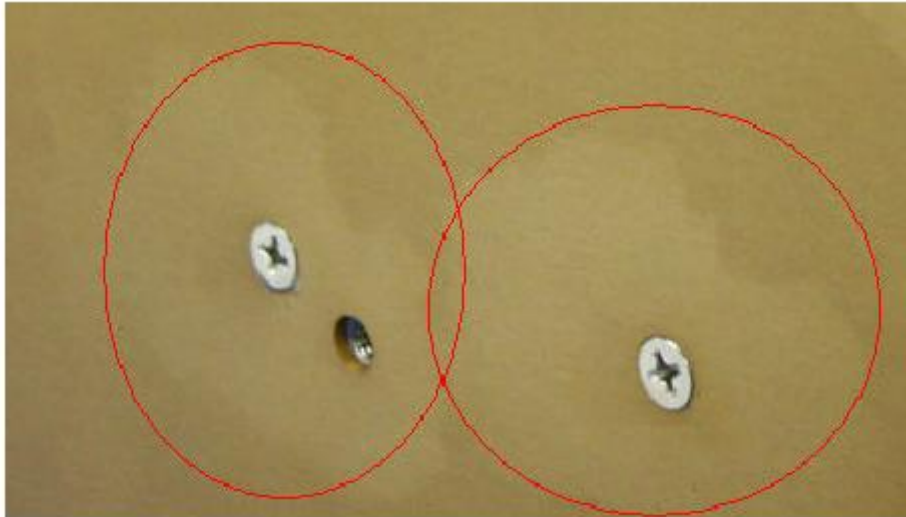
**Gouge**

- A groove or scratch that extends through the finish and into the metal caused by a sharp object. A depth is measurable.



**Grease**

- Any lubricant transferred to the part's surface, shiny or glossy patches on the surface of the part.

**Haze**

- Cloudiness on an otherwise transparent part.

**Inconsistency**

- Variation of gloss, thickness of line or surface texture.

**Inclusions**

- Small craters on surface caused by dust or dirt.

**Lint**

- Any unintended foreign substance in the coating or on the surface.

**Marbling**

- Colored streaks on a surface caused by improper mixing of molten plastic.

**Marks**

- Pits, sanding, or other marks on base material that remains visible after coating.

**Matt Finish**

- A less glossy finish of a surface area.

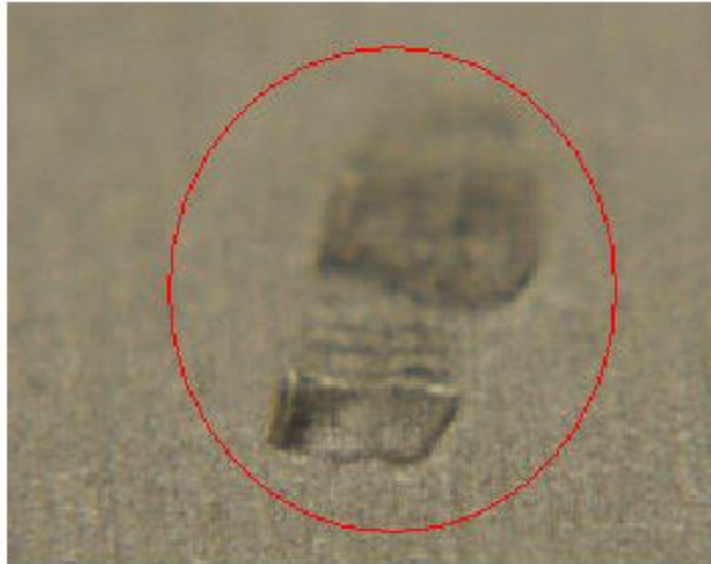
**Metal Fuzz**

- Fine grit metal shavings that are clumped together may also be magnetic.

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### **Nicks**

- Like gouges but short of length caused by impact.



### **Non-adhesion**

- Lack of proper sticking of the coating or a glued material to the surface.

### **Non-uniform Coverage**

- Areas that have an insufficient or excessive coating.

### **Oils**

- Oily material on the surface due to materials used in manufacturing processes. Oily looking spots caused by Loctite locking feature.

### **Orange Peel**

- Paint defect, rippled or mottled appearance viewable as concentric lines caused by under pressurizing not dried paint surfaces.

### **Orange Skin**

- Paint defect, rippled or mottled appearance.

### **Oxidation**

- Has a rough feel of appearance. Dull gray, dark gray, black, brown, dark cinnamon or possibly white colored substance.

### **Peeling**

- Areas in which the adhesion between the paint and the surface is poor, causing the paint to come off with light rubbing.

**Pitting**

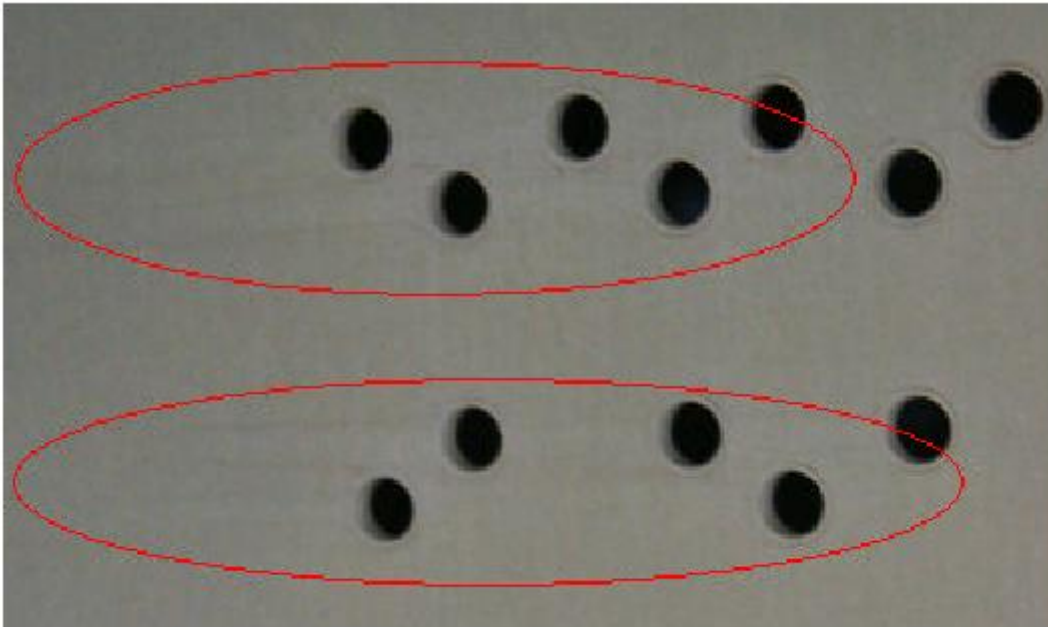
- Small craters on surface.

**Punch mark**

- Mark on the surface of a material due to punch process.

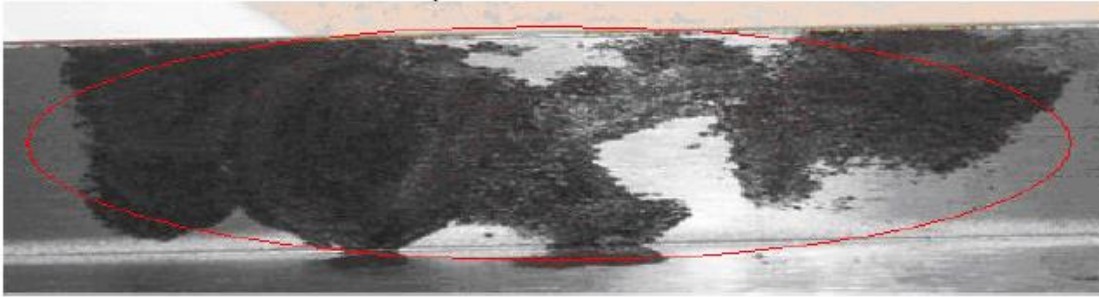
**Runs**

- Drips, bleeding, visible lines or raised areas of excessive paint or chemical coating similar to non-uniform coverage.



### Rust

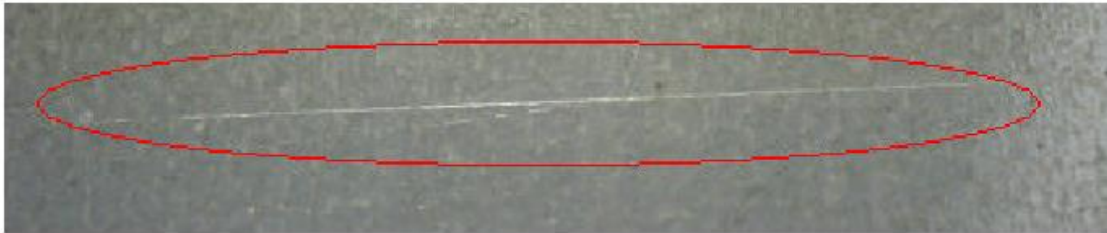
- Areas of corrosion on any metal surfaces



**Caution:** Small areas of rust are acceptable where plating is removed by a standard manufacturing or welding process, e.g. sheared (cut) edges.

### Scratch

- A shallow groove that can be seen but not felt.

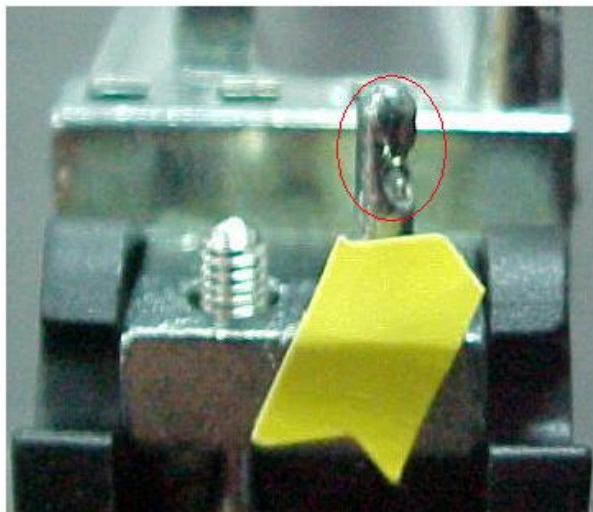


### Scuff marks

- A series of very light, concentrated scratches that can be seen but not felt.

### Short-Shot

- Incomplete molded feature.



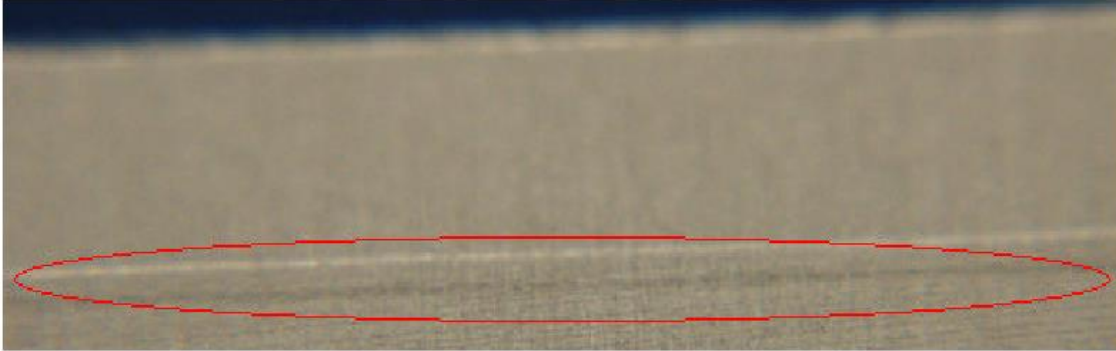
### Sink

- Depression or dimple caused by non-uniform material shrinkage.

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### Slug Mark

- A surface deformity caused by the punching process.
- 



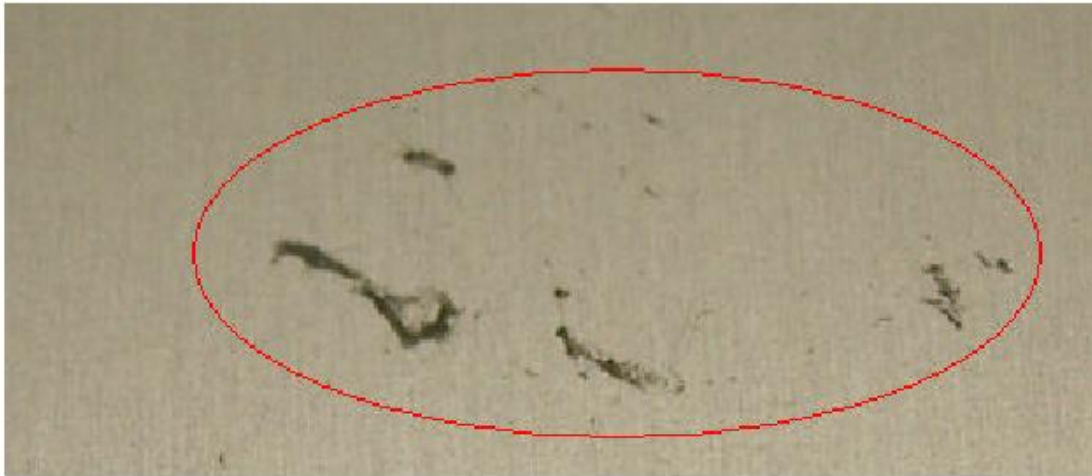
### Smearing

- The presence of ink on areas not called out in the master artwork.



**Smudge**

- Any dirt particle of foreign material.



**Specks**

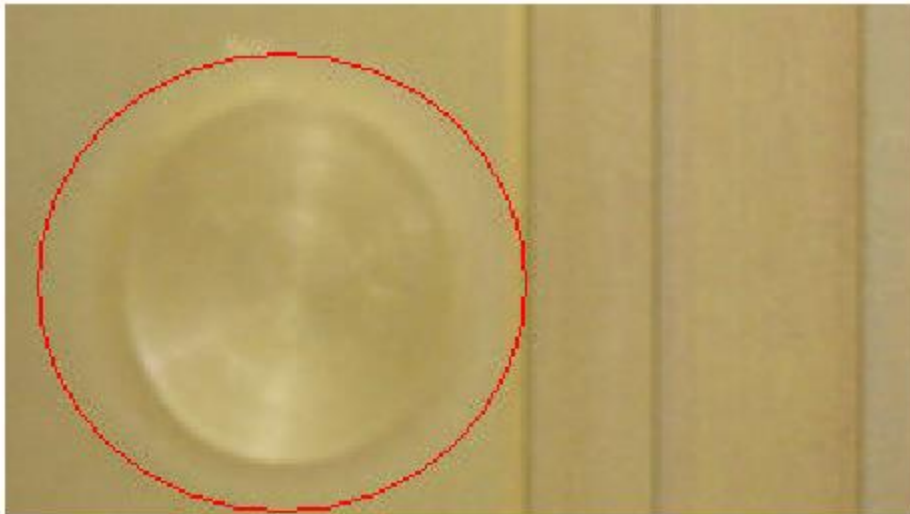
- Small particles.





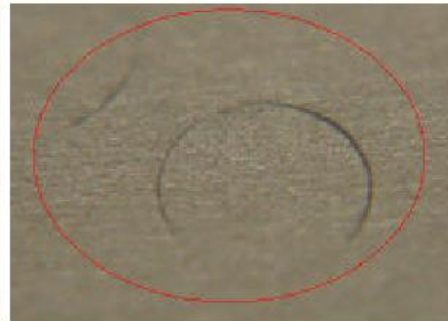
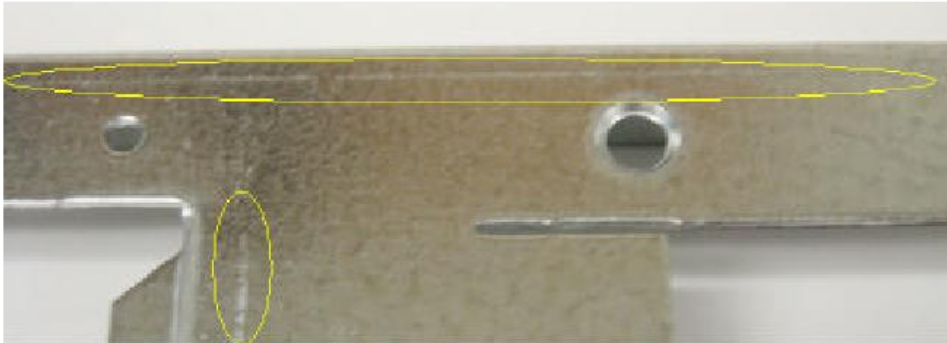
### Spot Weld Mark

- Dish shaped surface caused by spot welding process.



### Tooling Marks

- Very shallow lines which are parallel to bends in part.
- Unwanted impact of a tool during punch process.



**Caution:** Some tooling marks are not avoidable in some process steps. E.g. punching, forming, and bending.

### Texture

- An area of rougher finish of plastic molded parts.
- A rougher but uniform finish of painted parts.

### Visible Surface

- Surfaces those are visible when the enclosure or part is installed in a completed assembly.

### Void

- The failure of ink to define a graphic feature.

### Warpage

- Dimensional distortion in a part after molding, pressing or laminating. Twist or bows in the part.

### Water Spots

- Rough and not densely packed dull gray lines at plated material.

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### **Weld lines**

- Line where molten plastic or metal joins form a part. A weld line usually appears as a noticeable line or gloss variation across the surface of the part.

### *11.4 Preferred Appearance Quality*

#### **PAINT**

- **Preferred**
  - Painted surfaces should be defect free and the texture and color should be uniform throughout the entire surface.
  - The finish on a continuous surface shall exhibit no gross imperfections such as gouges, large chips, runs, blisters, oil spots, flaking, or any defects that will affect the functional properties of the finish.
  - Paint touch-up is acceptable.
  - A touch-up is not acceptable if visible at the viewing distance for that class of surface.

#### **SILK-SCREENING**

- **Preferred**
  - Silk-screened logos or symbols should be defect free, and should withstand cleaning with mild solvents and the tape pull test.

#### **PLATING**

- **Preferred**
  - Visible outside surfaces should be defect free, and die and slug marks should not be visible.
  - The coating surface shall have a uniform, metallic appearance without visible defects such as blisters, pits, pimples, and cracks.
  - Imperfections that arise from surface conditions of the substrate and persist in the coating shall not be cause for rejection.
  - Scratches and surface imperfections that occur after plating shall not penetrate the plating and expose base metal or under-plating and are subject to further review.

#### **CHEMICAL CONVERSION COATING (Alodine)**

- **Preferred**
  - The finish shall have uniform appearance; be semi-bright, smooth, and clear to slightly yellow or iridescent in color. Visual appearance will vary between different alloys and between machined, milled, cast, and grained surfaces.
  - Outside surface shall be free from scratches, dents, or gouges.

#### **INSPECTION REQUIREMENTS**

- **Viewing Conditions**
  - The inspector shall scan the surface in a continuous manner. All judgments shall be made from the specified lighting, viewing distance, angle and material classes as described below.

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### 11.5 Surface Categories

- **Class A**
  - Is a **critical** cosmetic surface usually front exterior surface which is most often closely viewed by the user / customer.
  - Panels
  - Instrument cases
  - Desktop cases
  - Customer specified
- **Class B**
  - Is a semi-critical cosmetic surface usually exterior surface which is adjacent to Class A, not viewed as often but easily seen.
- **Class C**
  - Is a non-critical cosmetic surface either exterior surface rarely viewed by the user / customer, such as back surface; or an internal surface that is visible but not normally viewed by the user / customer.

### 11.6 Light Source

- **Light Specification**
  - White, cool artificial office lighting (e.g. fluorescent light)
  - Do not use direct sunlight.
- **Light Intensity**
  - Uniform intensity between 70 and 120 foot-candles. (750 and 1250 Lux)



**Caution:** At levels of greater light intensity caution should be used to not over inspect the parts in order of accentuate surface flaws.

- **Light position**
  - Reflection free, non-directional from the top.

**Caution:** No direct overhead light above inspection table.

### 11.7 Inspection Table Surface

- The table surface should be made of a non-reflective dark color to avoid twilight conditions.
- Preferred: Black rubber mat Acceptable: Dark blue or dark green rubber mat
- **Unacceptable: Light color table surfaces e.g. white, gray, yellow, metallic etc.**

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**Caution:** Reflective light-colored surfaces eliminate or accentuate surface flaws.

#### 11.8 Viewing Time

- **Class A**
  - Systems: Ten (10) seconds per 200 square inches per part
  - Front Panels: Five (5) seconds per 50 square inches per part
- **Class B**
  - Seven (7) seconds per 200 square inches per part
- **Class C**
  - Five (5) seconds per 200 square inches per part

#### 11.9 Viewing Orientation

- During inspection, view objects in an orientation perpendicular to each surface. During assembly, view objects in normal orientation of manufacturing process. In some cases inspection should be held prior to assembly. Any visible surface flaw has to be verified against the acceptable defect matrix.

**Caution:** Parts shall not be manipulated to reflect a single light source in order to accentuate surface flaws.

#### 11.10 Magnification Tools

Magnification tools may be used to find root causes for defects or to verify correctness of special areas.

**Caution:** Magnification is not to be used when inspecting for cosmetic defects.

#### 11.11 Viewing Distance

Viewing Distances from the surface being inspected

- **Class A**
  - 24 Inch (610 mm)
- **Class B**
  - 30 Inch (760 mm)
- **Class C**
  - 36 Inch (760 mm)

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11.12 Acceptable Defects Matrix

**Acceptable Defects for Class "A" Surfaces**

Viewing Time	Viewing Distance
Ten (10) seconds per 200 square inches per part, five (5) seconds per 50 square inches for front panels	24 inch (610 mm)

DEFECT	ACCEPT	REJECT
Bleed Out	Up to 5/16" away from seam. Touch up allowed.	Any greater than 5/16"
Blister	None	Any
Blush	Accept per approved engineering document.	
Bubble	None	Any
Burns	Accept per approved engineering document.	
Burrs	Reference Table 1.	Reference Table 1.
Cloudiness	None	Any
Contamination	None	Any
Corrosion/Rust/Oxidation	None	Any
Cracks	None	Any
Dent/Ding/Pitting	None	Any
Discoloration Color Consistency	Accept per approved engineering document for 100% uniformity of surface	Partial discoloration
Dirt/Lint/Specks/Smudge	Less than or equal to 0.02"	Any greater than 0.02"
Flash	Accept per approved engineering document.	
Flow Marks	None	Any
Fingerprints	None	Any
Flaking/Chipping/Peeling	None	Any
Metal Fuzz	None	Any
Paint Non-Adhesion/Non-Uniformity/Inconsistency	None	Any
Paint Runs	None	Any
Scratches/Gouges	Qty. 3, less than or equal to 0.01" x 0.03"	More than qty. 3. Any bare metal or base metal on a painted surface.
Scuff Marks	Accept per approved engineering document.	
Short-Shots	None	Any

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DEFECT	ACCEPT	REJECT
Sink	Less than or equal to 0.003" deep	Any greater than 0.003"
Smearing	None	Any
Spot Weld, Welding Lines	Accept per approved engineering document.	
Texture/Gloss/Finish	100% uniformity of surface, Accept per approved engineering document.	Partial variation.
Tooling Marks/Die Marks/Slug Mark/Punch Mark/Burnish Marks	Accept per approved engineering document.	
Voids	Less than or equal to 0.01"	Any greater than 0.01"
Water Spots	None	Any

### Acceptable Defects for Class "B" Surfaces

Viewing Time	Viewing Distance
Seven (7) seconds per 200 square inches per part.	30 inch (760 mm)

DEFECT	ACCEPT	REJECT
Bleed Out	Up to 3/8" away from seam. Touch up allowed.	Any greater than 3/8"
Blister	None	Any
Blush	Accept per approved engineering document.	
Bubble	None	Any
Burns	Accept per approved engineering document.	
Burrs	Reference Table 1.	Reference Table 1.
Cloudiness	None	Any
Contamination	None	Any
Corrosion/Rust/Oxidation	None	Any
Cracks	None	Any
Dent/Ding/Pitting	None	Any
Discoloration Color Consistency	90% uniformity of surface	More than 10% surface discoloration or consistency.
Dirt/Lint/Specks/Smudge	Qty. 3, Less than or equal to 0.03"	More than qty. 3 per surface or any greater than 0.03"
Flash	Less than or equal to 0.005" in height	Any greater than 0.005" in height
Flow Marks	None	Any

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DEFECT	ACCEPT	REJECT
Fingerprints	None	Any
Flaking/Chipping/Peeling	Less than or equal to 0.03"	Any bare metal greater than 0.03" or any exposed base metal
Metal Fuzz	None	Any
Paint Non-Adhesion/Non-Uniformity/Inconsistency	None	Any
Paint Runs	None	Any
Scratches/Gouges	Qty. 2, less than or equal to 0.02" x 0.09"; Qty. 1; Less than or equal to 0.01" x 0.25"	More than limit qty. per surface. Any exposed base metal on painted surfaces.
Scuff Marks	Accept per approved engineering document.	
Short-Shots	None	Any
Sink	Less than or equal to 0.005" deep	Any greater than 0.005"
Smearing	None	Any
Spot Weld, Welding Lines	Less than or equal to 0.005" in height or depth	Any greater than 0.005" in height or depth
Texture/Gloss/Finish	Less than or equal to 0.02" x 0.25"	Any greater than 0.02" x 0.25"
Tooling Marks/Die Marks/Slug Mark/Punch Mark/Burnish Marks	Accept per approved engineering document.	
Voids	Less than or equal to 0.03"	Any greater than 0.03"
Water Spots	None	Any

### Acceptable Defects for Class "C" Surfaces

Viewing Time	Viewing Distance
Five (5) seconds per 200 square inches per part.	36 inch (460 mm)

DEFECT	ACCEPT	REJECT
Bleed Out	Up to 3/8" away from seam. Touch up allowed.	Any greater than 3/8"
Blister	None	Any
Blush	Accept per approved engineering document.	
Bubble	None	Any
Burns	Accept per approved engineering document.	
Burrs	Reference Table 1.	Reference Table 1.



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<b>DEFECT</b>	<b>ACCEPT</b>	<b>REJECT</b>
Cloudiness	None	Any
Contamination	None	Any
Corrosion/Rust/Oxidation	None	Any
Cracks	None	Any
Dent/Ding/Pitting	None	Any
Discoloration Color Consistency	80% uniformity of surface	More than 20% surface discoloration or consistency.
Dirt/Lint/Specks/Smudge	Qty. 3, Less than or equal to 0.06"	More than qty. 3 per surface or any greater than 0.06"
Flash	Less than or equal to 0.005" in height	Any greater than 0.005" in height
Flow Marks	None	Any
Fingerprints	None	Any
Flaking/Chipping/Peeling	Less than or equal to 0.09"	Any bare metal greater than 0.09" or any exposed base metal
Metal Fuzz	None	Any
Paint Non-Adhesion/Non-Uniformity/Inconsistency	None	Any
Paint Runs	None	Any
Scratches/Gouges	Qty. 4, less than or equal to 0.02" x 0.25"; Qty. 1; Less than or equal to 0.01" x 0.5"	More than limit qty. per surface. Any exposed base metal on painted surfaces.
Scuff Marks	Accept per approved engineering document.	
Short-Shots	None	Any
Sink	Qty. 1, Less than or equal to 0.015" deep	Any greater than 0.015"
Smearing	None	Any
Spot Weld, Welding Lines	Less than or equal to 0.005" in height or depth	Any greater than 0.005" in height or depth
Texture/Gloss/Finish	Less than or equal to 0.02" x 0.09"	Any greater than 0.02" x 0.09"
Tooling Marks/Die Marks/Slug Mark/Punch Mark/Burnish Marks	Accept per approved engineering document.	
Voids	Less than or equal to 0.03"	Any greater than 0.03"
Water Spots	None	Any

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## **12 References**

### **Documents**

- IPC-A-600 – Workmanship Standards for printed circuit boards
- IPC-A-610 – Workmanship Standards for electronic sub-assemblies
- IPC/WHMA-A-620 – Requirements and Acceptance for Cable and Wire Harness Assemblies