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1 PURPOSE

This document is provided as a guideline for the classification, inspection, and evaluation for acceptability of surface finishes and external features which are considered cosmetically sensitive, when a Plexus Customer has not provided such specifications.

2 SCOPE

This document applies to all Plexus manufacturing sites engaged in HLA and/or Mechatronics of medical devices (finished or unfinished), network equipment, or other products deemed to have cosmetically sensitive attributes. The methods and guidelines described herein may apply throughout the product manufacturing cycle, from Receiving (Inspection) to packaging the finished product for shipment. In addition, the supply chain should be taken into account and this document flowed down accordingly when this document is invoked.

3 PARENT DOCUMENT

[SOP 6342](#) HLA and Mechatronics Assembly Requirements

4 ORDER OF PRECEDENCE

In the event of conflict, the following order of precedence shall prevail:

- a. Customer specifications
- b. Industry standards referenced by the Customer or Plexus
- c. This document

5 SUPPLIER AGREEMENT

When this document is invoked, the supplier should be contacted to establish agreements for incoming product acceptance. Such agreements should also be referenced on the Purchase Orders.

6 SURFACE CLASSIFICATION

A finished unit may contain one or more surface classifications as outlined below.

6.1 Class A:

- Front or user interface surfaces of product
- Top and rear of “desktop” type products, where such surfaces are highly visible to the end-user
- Front hardware such as handles, covers, etc.
- Overlays, switch membranes, or display surfaces
- Any silkscreened area
- Any exterior facing label

6.2 Class B:

- Outside Top, Side, or Rear of product (or sides of “desktop” type units, where such surfaces are not readily viewed by the end-user)
- PWB or Card assembly faceplates on the rear of the product
- Surfaces with service-only exposure to end-user
- Rear hardware of chassis, such as handles, covers, etc.
- Any interior label (service-only exposure to end-user)

6.3 Class C:

- Inside or exterior surfaces that are not visible to the end-user or do not retain any aesthetic value

7 INSPECTION VIEWING CRITERIA

7.1 Lighting

All class surfaces should be viewed under typical factory lighting; overhead white fluorescent in the range of 60 – 120 foot-candles. A workbench with two 40W fluorescent bulbs is appropriate. Reflective light sources will not be used to highlight or exaggerate flaws.

7.2 Orientation

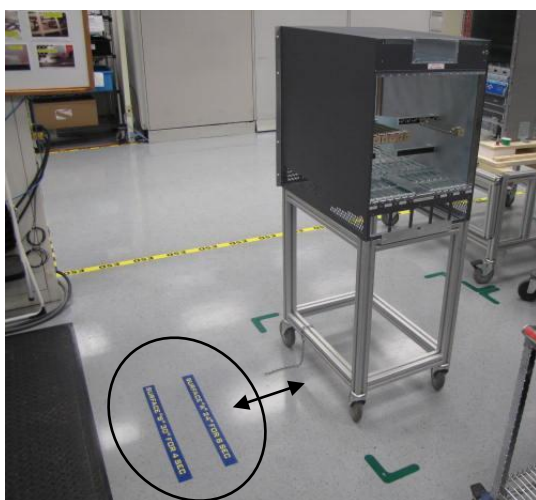
All cosmetic surfaces will be viewed in an orientation of their final installation, at either 90 degrees or 45 degrees. The surface should not be manipulated or rotated for the purpose of enhancing or highlighting perceived defects.

7.3 Viewing Time and Distance, per Surface Classification

Surfaces will be viewed for the time and from the distance specified in the following table:

Viewing Surface	Class A / 7 sec.	Class B / 5 sec.	Class C / 3 sec.
< 12 in ² (77 cm ²)	12 in (300 mm)	24 in (600 mm)	36 in (900 mm)
$\geq 12 \text{ in}^2 \leq 30 \text{ in}^2$ ($\geq 77 \text{ cm}^2 \leq 194 \text{ cm}^2$)	18 in (450 mm)	30 in (750 mm)	48 in (1200 mm)
> 30 in ² (194 cm ²)	24 in (600 mm)	48 in (1200 mm)	60 in (1500 mm)

It may be advantageous to construct a viewing booth or similar arrangement at appropriate quality inspection points within the process flow for the control of lighting, orientation, and viewing distance. Viewing time may be monitored using a conveniently located audible stop-clock. Such an arrangement provides repeatability in the accept/reject inspection process, and helps reduce operator inconsistencies.



Viewing Distances identified using tape

8 DEFECT CLASSIFICATION FOR PARTS AND SURFACES

8.1 Table 1 – {See notes following}

Condition	C L A S S	Plastic Parts	Painted/Coated Surfaces	Plated/Metal Parts	Overlays, Membranes, Displays, Silk-screens
Scratches per 0.1 m² (ft ²) See Notes {1,2,3,12}	A B C	0.13mmWx50mmL , or 6.5mm² total area (WxL) (.005"Wx2"L, or .01 in ² total area (WxL)) 0.25mmWx127mmL , or 32mm² total area (WxL) (.01"Wx5"L, or .05 in ² total area (WxL)) Acceptable	0.13mmWx25mmL , or 3mm² total area (WxL) (.005"Wx1"L, or .005 in ² total area (WxL)) 0.25mmWx76mmL , or 20mm² total area (WxL) (.01"Wx3"L, or .03 in ² total area (WxL)) Acceptable	0.25mmWx25mmL , or 6.5mm² total area (WxL) (.01"Wx1"L, or .01 in ² total area (WxL)) 0.5mmWx127mmL , or 65mm² total area (WxL) (.02"Wx5"L, or 0.1" in ² total area (WxL)) Acceptable	See Note {15}
Chips per 0.1 m² (ft ²) See Note {2,12}	A B C	0.25mmWx0.25mmL x0.25mmD (.01"Wx.01"Lx.01"D) 1.3mmWx1.3mmLx0.5mmD (.05"Wx.05"Lx.02"D) Acceptable	0.25mmWx0.25mmL x0.25mmD (.01"Wx.01"Lx.01"D) 1.3mmWx1.3mmLx0.5mmD (.05"Wx.05"Lx.02"D) Acceptable	0.25mmWx0.25mmL x0.25mmD (.01"Wx.01"Lx.01"D) 1.3mmWx1.3mmLx0.5mmD (.05"Wx.05"Lx.02"D) Acceptable	None
Pits, Specks or Contamination See Note {3,12}	A B C	0.25mmWx0.5mmLx0.25mmD (.01"Wx.02"Lx.01"D) 0.5mmWx0.5mmLx0.25mmD (.02"Wx.02"Lx.01"D) Acceptable	0.25mmWx0.5mmLx0.25mmD (.01"Wx.02"Lx.01"D) 1.3mmWx1.3mmLx0.25mmD (.05"Wx.05"Lx.01"D) Acceptable	0.25mmWx0.5mmLx0.25mmD (.01"Wx.02"Lx.01"D) 0.5mmWx0.5mmLx0.25mmD (.02"Wx.02"Lx.01"D) Acceptable	See Note {15}
Smudges per 0.1 m² (ft ²) See Note {3}	A B C	None 1.3mmWx3.8mmLx0.5mmD (.05"Wx0.15"Lx.02"D) Acceptable	None 1.3mmWx3.8mmLx0.5mmD (.05"Wx0.15"Lx.02"D) Acceptable	None 1.3mmWx3.8mmLx0.5mmD (.05"Wx0.15"Lx.02"D) Acceptable	None
Run Marks per 0.1 m² (ft ²) See Note {4}	A B C	None None Acceptable	None None Acceptable	None None Acceptable	None
Glossiness	A B C	All classes: Permitted if blended. No grain interruption or drastic contrast apparent.	All classes: Permitted if blended. No grain interruption or drastic contrast apparent.	All classes: Permitted if blended. No grain interruption or drastic contrast apparent.	None
Tool Marks from Fabrication Process See Notes {3, 5}	A B C	None None Acceptable	None 0.5mmWx2.5mmL (0.02"Wx0.1"L) (3X) Acceptable	Acceptable Acceptable Acceptable	None

Corrosion See Note {6}	A B C	N/A	None	None	None
Discoloration, Cloudiness per Surface	A B C	None None 20% of Surface	None None 20% of Surface	None See Notes {7, 14} None 20% of Surface	None
Fingerprints	A B C	None None Acceptable	None None Acceptable	None None Acceptable	None
Sinks per Surface	A B C	None 0.5mmWx2.5mmL (.02"Wx0.1"L) (3X) Acceptable	N/A	N/A	None
Burns	A B C	None None Acceptable See Note {8}	None	None None Acceptable See Note {8}	None
Weld (Flow) Lines	A B C	None None Acceptable	N/A	N/A	N/A
Flash and Burrs	A B C	None 0.5mmWx2.3mmL (.02"Wx.09"L) (3X) Acceptable See Note {9}	N/A	None (Burrs) None (Burrs) Acceptable See Note {13}	N/A
Gate	A B C	None None Acceptable See Note {9}	N/A	N/A	N/A
Parting Lines	A B C	None None Acceptable	N/A	N/A	N/A
Cracks	A B C	None	None	None	None
Blush	A B C	.25mmWx.75mmL (.01"Wx.03"L) (2X) 0.5mmWx1.0mmL (.02"Wx.04"L) (3X) 0.5mmWx2.3mmL (.02"Wx.09"L) (5X)	N/A	N/A	N/A
Jetting	A B C	None None Acceptable	N/A	N/A	N/A
Cold Slug	A B C	None None Acceptable	N/A	N/A	N/A
Short Shot / Under-fill	A B C	None None Acceptable	N/A	N/A	N/A
Debris	A B C	None None None	N/A	N/A	N/A

Color	A	Per Customer Supplied (CS) Sample (Class A and B) or $\Delta E^* < 4$ against Preset Standard See note {16}	Per CS Sample (Class A and B) or $\Delta E^* < 4$ against Preset Standard See note {16}	See Note {10}	Per CS Sample
	B				
	C	Variation permitted	Variation permitted		
Texture Variation	A	Per CS Sample	Per CS Sample	N/A	Per CS Sample
	B	Per CS Sample	Per CS Sample		
	C	Variation permitted	Variation permitted		
Oil Film	A	None	None	See Note {11}	None
	B				
	C				
Bubbles trapped within or below coating	A	None	None	None	None
	B				
	C				
Splay	A	None	N/A	N/A	N/A
	B	None			
	C	Acceptable			

8.2 Table 1 - Notes

{1} Wear marks are permitted on surfaces that are by design made to come into contact with other parts such as card guides, PCA carrier edges, fan tray guides, etc.

{2} Scratches or chips in plated parts shall not penetrate through plating to base metal. Scratches or chips in painted / powder-coated surfaces shall not penetrate through coating to reveal underlying material.

{3} Pre-plated material can be expected to show marks from sheet-to-sheet contact, turret and brake operations, and general handling from mill to fabrication to assembly.

{4} Typical paint / powder-coating build-up at edges and corners will not be considered to be rejectable run marks.

{5} "Tool marks from fabrication process" indicates marks from brakes along bends, roller marks in pre-plated sheet metal, injection mold ejection points, etc. It does NOT permit post-fabrication tool marks such as those made by a screwdriver, rivet gun, or part stacking.

{6} Allowances for minor corrosion will be made at sheet metal edges of pre-plated material:

- Corrosion shall not extend outside of sheared edge.
- Corrosion shall not crumble off part or cloth when wiped.

{7} Discoloration: A "best effort" degree of streak from plating rinse is tolerable.

{8} Minor burns are acceptable on Class C surfaces.

{9} Must not interfere with fit or function.

{10} Pre-plated surfaces shall not be cosmetically judged for color or texture, except for Class A and B surfaces.

{11} It is acceptable that metal parts such as pre-plate with no secondary finishing or painting / powder-coating retain oil film from sheet supply and processing. However, these items must be sufficiently cleaned so that there is no visible build-up.

{12} Brushed aluminum PCA faceplates shall be allowed only half the width and half the length of scratching or other defects specified by the table.

{13} Burrs on any metallic edge of any surface must not be sufficiently sharp so as to pose a safety concern.

{14} Zinc (grey) oxide/discoloration will be permitted on pre-plated surfaces regardless of class on no more than 10% of a surface. Iron (red) oxide will not be permitted on pre-plated surfaces (see Note 3 for pre-plate identification).

{15} Overlays, Membranes, Displays, or Silk-screen defects (dots, scratches, imperfections, contamination, or specks) must be no larger than **0.15 mm** (0.006") in diameter. There should be no more than one such "defect" across **30 linear cm** (12 linear inches). Commercially available inspection templates may be used (in combination with magnification) to verify whenever suspect material has been found.

{16} The Spectrophotometer must be with a BYK Spectro-guide sphere gloss set to illumination/Observation angle of D65/10° and CIELAB colour system. The Preset sample is taken from either a drawing specification or from a sample.

9 OTHER COSMETICALLY-SENSITIVE PARTS OR FEATURES

9.1 EMI Gaskets

9.1.1 Deformation/damage **+/- 0.5 mm** (+/- 0.020") in X-axis (length) on no more than 3 fingers per gasket is allowed.

9.1.2 Up to the lesser of **6.4 mm** (0.25") or 1 finger of lost contact is permissible per entire gasket length.

9.1.3 No tearing of fingers is allowed. This is a safety issue.

9.2 Label Placement and Alignment

The importance of accurate label placement and alignment should not be underestimated. First impressions heavily influence product acceptance, and accurate label placement is an important part of the overall cosmetic assessment.

9.2.1 Customer-specified labels should be aligned per the customer's engineering drawing. When exact placement dimensions are not provided, perpendicularity should be assumed. Any additional external labels or test inspection labels not specified (but authorized) by the customer, such as process ID and QA labels placed by Plexus, should be neatly applied in a perpendicular manner and not obscure any other customer specified markings.

9.2.2 Alignment jigs / fixtures are highly recommended to aid in proper positioning of labels. Care

must be taken to assure that the materials selected will not pose an ESD threat, if used in an ESD Protected Area.

9.3 Label Classification

Table 2 – Defect Classification for Labels

Condition	Exterior Facing	Interior (Service Only Exposure)
Legibility	100% Legible	100% Legible
Blurred Characters	Unacceptable	Acceptable, but must be legible
Ink Smudging	Unacceptable	Acceptable, but must be legible
Background Discoloration	Unacceptable	Allowable to less than 5%
Perpendicularity or Alignment <small>See Note 1</small>	Perpendicular/100% Alignment	Not Critical, however target should be reasonable perpendicularity
Bar Code Voids, Splits, or Spotting	Maximum 5% allowed, however bar code MUST be readable	Maximum 5% allowed, however bar code MUST be readable
Damage to Label Substrate	Unacceptable to any degree	Allowable to less than 5%
Wrinkling	Unacceptable to any degree	Allowable to less than 5%
Bubbling	Unacceptable to any degree	Allowable to less than 5%
Edge or Corner Curling	Unacceptable to any degree	Allowable to less than 5%

Note 1: Perpendicularity or alignment may pertain to either the printed contents/characters in relation to the label substrate, or the label substrate's position on the surface to which it is affixed.

9.4 Connectors (Fluidics, Pneumatics, Hydraulics)

The importance of proper joining of fluidic, pneumatic and hydraulic systems should not be underestimated from an appearance standpoint. First impressions heavily influence product acceptance, and proper application of bonding materials is an important part of the overall cosmetic assessment.

Residue from application of adhesives, sealants, or other bonding substances should not be excessive where over-application results in drips, runs, or other visible accumulation on hoses, pipes, tubes or connectors. Excess residue should be properly removed using appropriate cleaning agents after assembly operations.

9.5 Fasteners Condition

Reference [Spec/Guideline 6351](#) – “Mechanical Fasteners and Torque Requirements”.

10 TOUCH-UP AND REWORK

10.1 Painted and Powder-coated Surfaces

- Class A surfaces: Touch-up allowed only in areas such as corners or edges, and done in a manner that will still meet visual inspection criteria.
- Class B surfaces: Local area touch-up (by Q-tip™, brush, etc.) is permitted to a total of 1% of the surface area. Large area touch-up (by spray, etc.) is permitted but must be indistinguishable from the original finish.
- Class C surfaces: Any touch-up is acceptable.

10.2 Plated Surfaces (Pre- and Post-Plate)

- a. Class A and B surfaces: Touch-up on post-plated surfaces is allowed only in areas such as corners or edges, and done in a manner that will still meet visual inspection criteria. The only allowable touch-up to pre-plated surfaces are sheared edges. The touch-up must not flake off or exhibit any rusting or corrosion.
- b. Class C surfaces: Any touch-up is acceptable.

11 GLOSSARY OF TERMS

- Blush – Discoloration or change in gloss (typically near gate or abrupt change in wall thickness).
- Burrs – Visible sharp edges or features created in the manufacturing process by cutting, punching, brushing, etc.
- Cloudiness – Haziness or opacity in an expected clear surface treatment.
- Cold Slug – The first material to enter a mold during injection. This solid material leaves a distinct border with adjacent melted material.
- Color Variation – Visible change in the color of a part as a result of the material or finish. Also, any visible change in the color of a part as a result of a part to part comparison on an assembled product.
- Contamination – Embedded foreign material.
- Corrosion – Rust or other destructive progressive chemical feature.
- Crack – A narrow break or split in the base material, plating, or paint.
- Debris – Foreign material trapped within or resting upon part.
- Discoloration – Cloudiness or inconsistent variation in the color of a part. Similar to Color Variation.
- Drips/Runs – Plating material, paint, or connector adhesive that runs or drips on the surface leaving a noticeable stain or trail.
- Flash – Excess material along parting line or part edge from ingress into mated mold faces.
- Gate – Excess material left from ingress into mold cavity.
- Jetting – Serpentine line at part surface indicative of improper gate size, injection speed or flow.
- Oil Film – An oily residue typically present on unfinished pre-plate as a result of plate machining processes.

- Parting Line – Raised material along mating line of mold halves.
- Pits – Crater-like surface imperfections.
- Pre-plate – Electroplated sheet metal which, by its nature, is often inconsistent in finish appearance, and may exhibit streaking and color variation.
- Short Shot – Missing material due to incomplete filling of the mold.
- Sink – A surface depression caused by non-uniform material solidification or shrinkage.
- Smudge – Marring of surface finish causing a smeared appearance.
- Texture Variation – Detectable texture difference within area or from expected.
- Tool Marks – Indicates marks from brakes along bends, coining at turret forms, roller marks in pre-plated sheet metal, injection mold ejection points, etc. NOT wayward assembly screwdriver tips.
- Weld (Flow) Line – Line of convergence of two molded plastic flow fronts.
- Splay - Off-colored streaking along the surface of a molded part. Often silvery in color.



REVISION HISTORY

REV	RELEASE DATE	ORIGINATOR	REASON FOR CHANGE (S)
A	13 August 2009	Sam Theabo	Initial Release
B	24 Mar 2010	Debi Richardson	Incorporated CR #31998. Added BOI as applicable site
B-1	26 Jan 2016	Ruth Cruz	CR 66012 Add GDL as applicable site with Israel Rodriquez and Marco Flores as site reviewers.
C	26 OCT 2017	Paul Gettins	CR 76525 Addition of the Spectrophotometer in determining colour matching.
D	16 Aug 2022	Zach Rambo	CR 106302 Added criteria for “Splay”.