METHODE ELECTRONICS, INC.

NA Automotive

Methode Visual Quality Standard

NAA-QG-01 Revision: D
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Quality Group Manager Date 26/MAR/2015

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Unsigned, printed copies are not controlled.

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1 Scope

This standard describes the surface appearance and cosmetic quality requirements for class “A” surface of decorated parts used by Methode Electronics Inc. North America Automotive division. The purpose of these requirements is to ensure that the level of final finish on Methode’s products meets or exceeds the level expected by our customers.
This standard applies to both finished parts produced by suppliers and those produced in Methode’s manufacturing plants.
Typical applications are molded parts with texture or graining, painted parts, parts with graphics, and chromed parts.

2 Deviations

OEM standards, Methode standards, drawing callouts or drawing notes included in the individual part’s drawings supersede the specifications in this standard.

Deviations from this standard, if required must be detailed in the appropriate part drawing. In the same way boundary or limit samples can be used to document requirements outside of the specification, these must be negotiated and agreed with the Customer. Customer shall sign the samples and they must be controlled.

3 Surface Characteristics

3.1 Surface Finish

The Society of the Plastics Industry (SPI) sets standards for the plastics industry. One of the standards regulates the type of polish on molded plastic products. Methode Electronics uses SPI standards to define surface finishes.

The surface finish grade shall be specified in appropriate part number drawing. If identification is not provided or is unclear in the part drawing Supplier and Customer shall agree on surface identification during product launch phase, until drawing is updated or clarified.

Fig 3.1-1 Surface finish grade specified in part drawing

3.2 Surface Identification

Surface identification shall be specified in appropriate part number drawing. If identification is not provided or is unclear in the part drawing Supplier and Customer shall agree on surface identification during product launch phase, until drawing is updated or clarified.

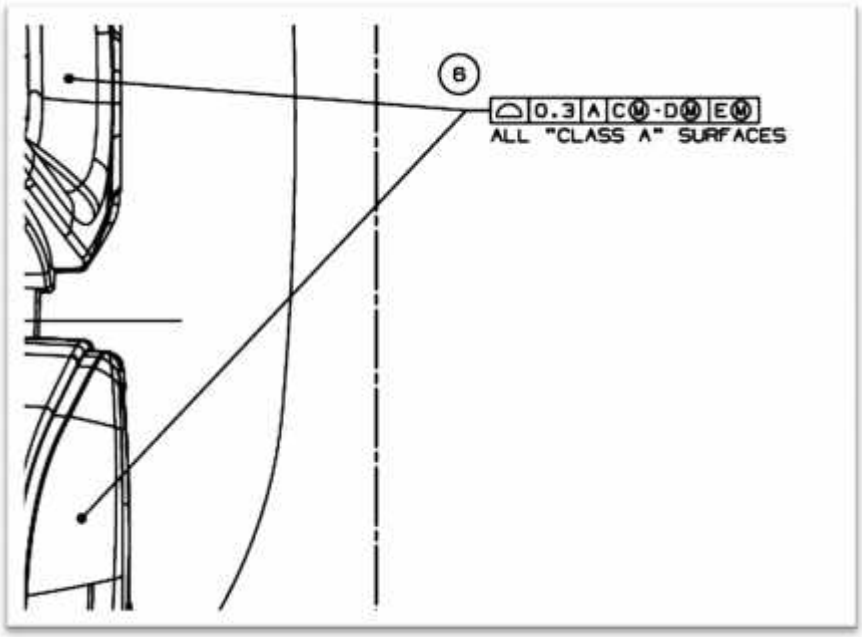


Fig 3.2-1: Surface identification in part drawing. Designated surface is identified as Class “A”

3.3 Class “A” Surface

All very highly visible surfaces of the part in the installation position, as viewed by the customer. Or as specified in the individual part drawing. Typically top or front surfaces of the part.

3.4 Class “B” Surface

Highly visible surfaces of the part when in the installation position, as viewed by the customer. Or as specified in the individual part drawing.

3.5 Class “C” Surface

Moderately visible surfaces. Or as specified in the individual part drawing.

3.6 Class “D” Surface

Recessed surfaces, clearly indented surfaces, non-coated surfaces or surfaces hidden in the installed position.

4 Inspection Setup Guidelines

Inspection setup includes guidelines for initial surface condition inspection that takes account of lighting intensity for viewing, viewing angles, viewing distance and inspection time. These factors can be adjusted if inspection effectiveness results are low (see 4.5).

4.1 Lighting Intensity

Visual inspection of part must be performed under normal lighting conditions of 80-120 Foot-Candles (861-1291 lux) in white fluorescent light. Light must be installed in the overhead position.

To check for cosmetic defects visible only under back lighting/illumination, Supplier and Customer will work to define custom illumination intensity level to screen the parts for this condition. This check is recommended to be conducted in dark booth environment with black background.

4.2 Viewing Angle

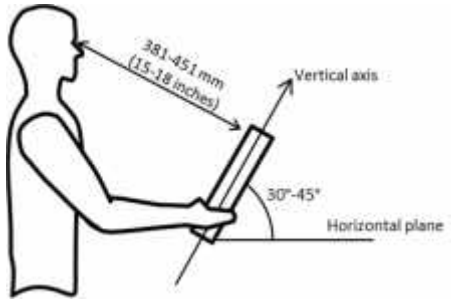
All viewing shall take place such that light is not reflected directly into the eyes of the viewer.

Hold the part 30°- 45° from the horizontal plane.

Keep the part (portion of the part under inspection) in direct line with the eyes

Rotate the part 30° to the right and left, about the vertical axis.

Fig 4.2-1 & 4.2-2 show a typical representation of viewing angles; keep in mind it is not required to hold part with hands, a fixture or other means can be used for keeping the desired angle. This is especially important if holding with hands can hide a portion of Class “A” surface.



4.2-1 Hold the part 30°- 45° from the horizontal plane.

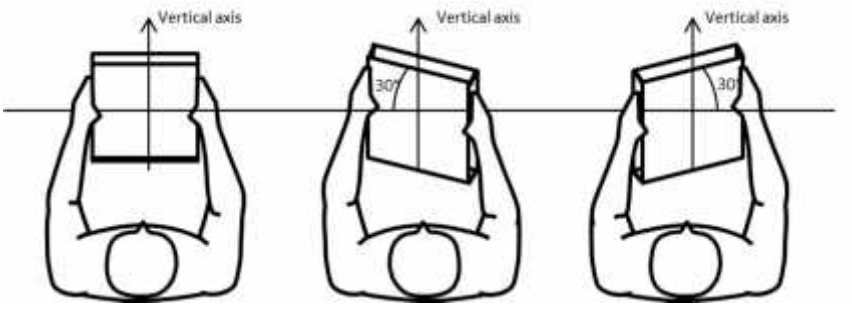


Figure 4.2-2: Rotate part 30° to left and right, about the vertical axis

4.3 Viewing Distance

Viewing distance is 381-451 mm (15-18 inches)

4.4 Inspection Cycle Time

Inspection interval is a function of surface area of part. Part must be inspected for this minimum inspection time.

Table 4.4-1 Inspection interval time per sample size

Surface Area (mm^2) (ref.)	Surface Area (in^2) (ref.)	Inspection interval (s)
≤ 2,580 mm^2 (50.8 x 50.8mm)	≤ 4 in^2 (2" x 2")	2 s MIN
2,580-10,322 mm^2 (101 x 101mm)	4-16 in^2 (4" x 4")	4 s MIN
10,322-41,290mm^2 (203 x 203 mm)	16-64 in^2 (8"x8")	6 s MIN
41,290-92,903.4 mm^2 (304.8 x 304.8mm)	64-144 in^2 (12" x 12")	8 s MIN
> 92,903 mm^2	>144 in^2	10 s MIN

4.5 Inspection Effectiveness

Inspection effectiveness is measured using the attribute agreement analysis method. This tool is also used to ensure the capability of inspection process and operator training.

4.5.1 Introduction to attribute agreement analysis

Measurement System Analysis (usually referred to as MSA) is a structured procedure which is used to assess the ability of a measurement system to provide good quality data.
A Measurement System is the combination of people, equipment, materials, methods and environment involved in obtaining measurements
Where the measurement system collects data which categorizes each item (such as pass/fail, or counting defects such as scratches) then the analysis is of the agreement in the categories chosen. This type of data is Called Attribute data. In this case we use an MSA method called Attribute Agreement Analysis

4.5.2 Guidelines for evaluation

Table 4.5-1 shows AIAG MSA guidelines for effectiveness evaluation.

Table 4.5-1 MSA acceptance guidelines

Result	Agreement between appraisers	Escapes rate	False Fail rate
Acceptable Measurement System	>=90%	<=2%	<=5%
Marginally acceptable Measurement System. Can be improved.	>=80%	<=5%	<=10%
Unacceptable Measurement System. Needs to improve.	<80%	>5%	>10%

5 Color & Gloss Matching

Surface of the test specimen should be inspected for 10 seconds to determine the hue (color tone and tint) and glossiness with reference to a color reference sample and color boundary sample (if available).

Color measurement can be performed using spectrophotometer or color difference meter.

Acceptance criteria is

$$\Delta E \leq 1.2.$$

$$\Delta E = \Delta E^*ab = [(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2]^{1/2}$$

Where,

L= unit for lightness,
a=red-green aspect,
b=yellow-blue aspect

Determination of gloss can be made using a suitable gloss measurement like ByK-Gardener Glossgard 60° gloss meter.

Determination of hue and gloss by visual inspection is preferred under the calibrated Macbeth light.

6 Surface Finish & Texture Matching

Judgment as to conformance of surface finish is made by comparing a part to master finish guide plaque. Comparison is visual inspection unless otherwise specified by customer.

Judgment as to conformance of surface texture is made by comparing a part to master texture plaque. Comparison is visual inspection unless otherwise specified by customer.

7 Inspection using dot gauge

It is recommended to visually inspect and evaluate using the criteria listed in the cosmetic quality specifications.
For dispute resolution on evaluation results, refer to the Methode dot gauge (NAA-MQ-01) or equivalent to measure the size of defects.

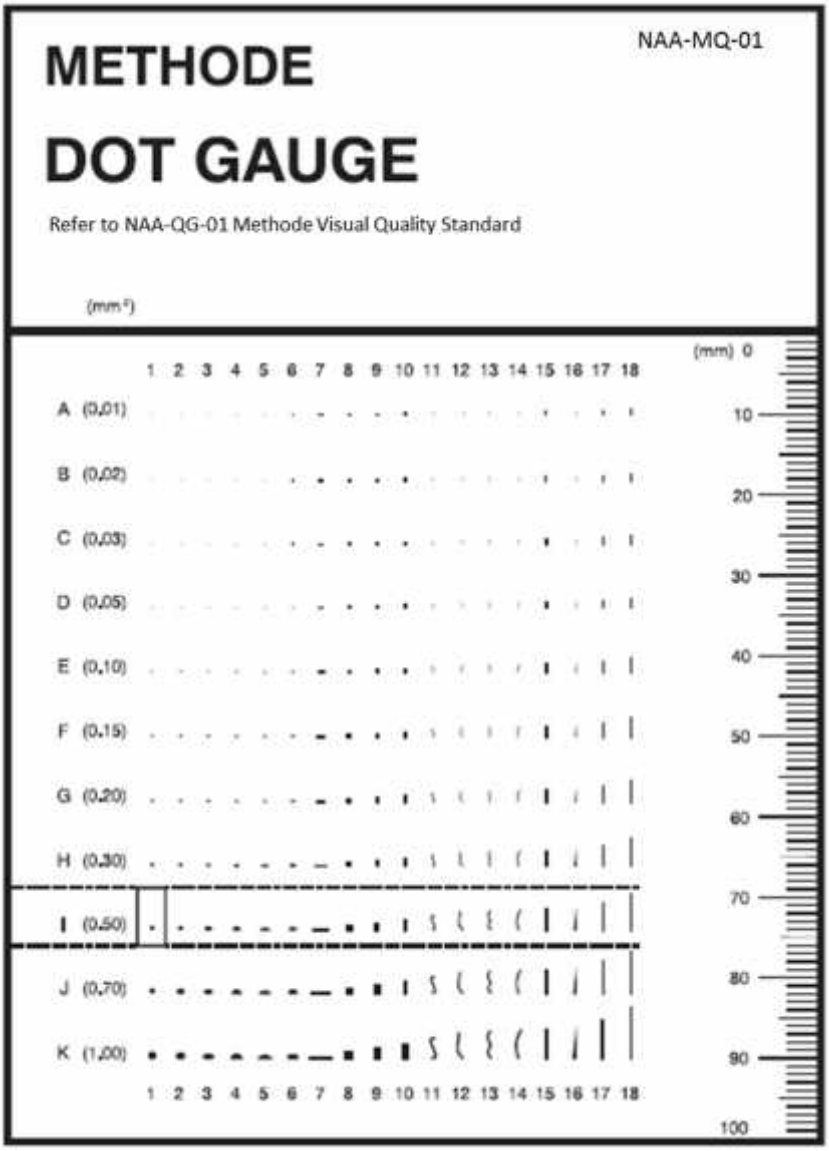


Fig.7.1-1 Reference of Methode dot gauge (NAA-MQ-01)

8 Cosmetic Quality Specification

8.1 Molded parts

General appearance evaluations for molded parts shall be conducted according to the Cosmetic Specifications of Injection Molded Parts published by the SPI (Publication number AQ-103).

Table 8.1-1. Typical appearance attributes found in SPI standard

Appearance attribute	Description
Contamination	Large area of discoloration from foreign mater or foreign matter embedded in the surface of a part.
Discoloration	Any change from the original color standard. Unintended, inconsistent color.
Nicks	Like gouges but of shorter length. Caused by impact rather than abrasion
Scratches	Surface imperfection due to abrasion that removes small amounts of material. Depth is not measurable. Differs from scratch in mold which leaves a consistent mark.
Specks	Small discolored points of matter embedded in the surface. Typically black, caused by material contamination or material degradation.
Bubbles	Void pockets, typically seen only in transparent parts. These may appear as a bulge or protrusion in an opaque part.
Cracking	Stress induced splitting or fissures causing separation of material.
Crazing	Multiple tiny cracks due to stress exerted on the part..
delamination	Separation (peeling) of layer of plastic that can result in a visual defect.
Flash	Excess plastic at parting line or mating surface of the mold. Normally very thin and flat protrusion of plastic along an edge of a part.
Flow lines /Knit lines	See Weld lines
Gouge	Surface imperfections due to abrasion that remove small amounts of material. Depth is measurable.
Haze	Cloudiness on an otherwise transparent part.
Marbling	Color streaks caused by incomplete mixing of different colored plastics. Also referred to as streaking.
Pin push	Protrusion or distortion caused by an ejector pin pushing into part more than normal. Protrusion is most evident on the surface opposite the ejector pin.
Shine	Glossy or shiny areas on textured surface. Usually caused by a dirty or worn mold. Can also be caused by lack of sufficient pressure to properly replicate texture in mold.
Sink	Surface depression caused by non-uniform material solidification and shrinkage. Most often noted at the interface between differing wall thickness
Weld lines	Witness lines where 2 or more fronts of molten plastic converge. This is also called knit lines or flow lines.
Splay	Off colored streaking often silver like. Splay is caused by moisture in the material or thermal degradation of the resin during processing. A similar look can be caused by cold material skipping across the surface during a fast fall (jetting)

8.2 Painted Parts

Table 8.2-1 describes the quality specification for class “A” surface of painted parts. This specification is the minimum acceptance criteria for painted parts.
If areas in part are identified as class “B”, “C” and, “D” Supplier and Customer shall agree on specification adjustments on a part to part basis.
Paint performance requirements such as hardness, adhesion, etc. are not treated in this standard.

8.3 Graphics

When decorated parts include printed graphics or laser etched graphics use the follow these specification during inspection.
Table 8.3-1 and 8.3-2 describes the quality specification for printed graphics depending on manufacturing process of product realization. The illustration Fig 8.3-1 & 8.3-2 are of typical graphic for reference purposes only.

8.4 Plated Parts

Table 8.4-1 describes the quality specification for plated parts. This is the minimum acceptance criteria for chrome plated plastic parts. This specification is also applicable to metallic chrome plated parts. cosmetic quality criteria for plated plastic parts is meant to cover decorative and cosmetic aspect of plated surface, performance requirements such as corrosion resistance, adhesion, etc. are not treated in this standard.

Table 8.2-1 Cosmetic Quality specifications for painted parts.

Appearance attribute	Description	Size allowed (Class "A")	Quantity allowed (Class "A")
Chips	Removal of coating from underlying coating or substrate in small irregular pieces (No color change)	$0.5mm^2$ per I(0.50) on Dot Gauge	2 MAX separated by 70mm
Contamination	Large area of discoloration from foreign mater or foreign matter embedded in the surface of a part.		
Dirt	Foreign object of contaminant in coating film		
Glossiness	Shininess of painted surface.		
Lint	Any unintended foreign substance in the coating or on the surface of the part.		
Nicks	Like gouges but of shorter length. Caused by impact rather than abrasion		
Scratches	Surface imperfection due to abrasion that removes small amounts of material. Depth is not measurable. Differs from scratch in mold which leaves a consistent mark.		
Specks	Small discolored points of matter embedded in the surface. Typically black, caused by material contamination or material degradation.		
Hue and Color Difference/Off color	Variation of hue and color within a surface against a master color plaque or reference sample.	ΔE≤1.2 L=±1.0 a/b =±0.3	N/A
Bleeding	Evidence of one color overlapping or altering another color (painting). Spreading of pigment beyond the intended boundaries (silk screen, printing). Component of lower coating film diffuses into topcoat and discolors.	None	None
Bare substrate	Voids in the paint film exposing bare substrate	None	None
Blush	Discoloration or change in gloss. Whitish or milky areas of coating	None	None
Boiling/Pinholes/ Popping	Small bubbles in coating which may have small holes at top.	None	None
Blotchiness	Unevenness in the paint coverage over a surface when surface is backlit.	None	None

Appearance attribute	Description	Size allowed (Class "A")	Quantity allowed (Class "A")
	Blotchiness creates different shades of same color in one surface, attributed to over and under spray condition.		
Bullseyes	Coating surface depressions	None	None
Corrosion	Rust, oxidation (metallic substrates only)	None	None
Cracking	Stress induced splitting or fissures causing separation of material. Cracks/split/punctures in substrate	None	None
Crazing	Multiple tiny cracks due to stress exerted on the part. Hairline breaks in paint film.	None	None
Craters/fisheyes	Small round depressions which may cause expose underlying substrate	None	None
Delamination	Separation of ink from the plastic layers.	None	None
Dry spray	Textured or seedy appearance of paint film with low gloss.	None	None
Mottle	Blotchy non uniform appearance of metallic paints. (Metallic colors only)	None	None
Non-adhesion	Lack of inadequate sticking of paint, print or any coating to the plastic surface.	None	None
Orange peel	Rippled, mottled, rough or wavy appearance viewable as concentric lines resembling the skin of an orange. Caused by under pressurizing. Orange peel is often the first sign of possible sink or shorting.	Visual comparison to ACT standard: Min 7	N/A
		ByK Gardner Wavescan: Min 6	N/A
Overspray	Paint deposited from a different target area	None	None
Paint drops	Small drops of paint deposited in the finished surface.	None	None
Peeling	Loss of adhesion between coating films or between coating and substrate.	None	None
Picture framing	Fat coating edge (Coating buildup on panel edge)	None	None

Appearance attribute	Description	Size allowed (Class “A”)	Quantity allowed (Class “A”)
Pitting/porosity	Crater like imperfections on the surface of the part. Small holes in the coating film.	None	None
Poor repair	Inferior coating appearance due to improper paint repair techniques.	None	None
Ragged mask lines	Unsightly appearance of two-tone mask lines.	None	None
Rub through	Area of surface coating where film is worn through exposing the underlying surface.	None	None
Sags/Runs/drips	Dripping or sagging of paint or ink. Movement of ink beyond intended surfaces. Usually caused by too much or too thick paint or ink. Localized flow of coating which produces extreme film thickness variation	None	None
Smearing	Excess ink or paint in area that should be free of ink or paint. This is similar to bleeding but it is mainly due to rubbing of surface before adequately dried.	None	None
Streaking/wipe marks	Series of blisters that appear as a streak	None	None
Thin coating	Coating film is thinner than specified such that underlying coating is visible and/or color does not match standard.	None	None
Water spots, rinse blisters	Irregular rings telegraphing through the coating surface due incomplete rinse or improper water removal prior to coating.	None	None
Wet mark	Damage to coating caused by something coming in contact with wet coating film	None	None
Wrinkling	Shrinkage of coating that results in uneven wrinkled appearance.	None	None

Table 8.3-1 Cosmetic Quality specifications for printing

Appearance attribute	Description	Size allowed (Class A)	Quantity allowed (Class A)
Edge marks, chips, cracks	Random imperfections along the image edges. A part of printed pattern to which ink does not stick	Width of feature <0.7mm: ¼ of line width Width of feature >=0.7m Defect in center of printed feature: 0.05mm^2 per D(0.05) on Dot Gauge Defect in edge of printed feature: 0.10mm^2 per E(0.10) on Dot Gauge	1MAX *For illuminated applications if the flaw causes light leakage with change of color it is not allowed. See Fig 8.3-2
Blurs	Un-sharp reproduction of lines or lettering		
Pin holes / Void	A small air bubble on ink		
Fill-ins:	An excessive use of ink that alters the form of screened or printed feature. Placement of ink where no ink should be.	None	None
Smearing	Excess ink or paint in area that should be free of ink or paint. This is similar to bleeding but it is mainly due to rubbing of surface before adequately dried.	None	None

Table 8.3-2 Cosmetic Quality specifications for laser etched parts.

Appearance attribute	Description	Size allowed (Class A)	Quantity allowed (Class A)
Edge marks	Random imperfections along the edge of etched feature. Imperfection can extend beyond the edge or in to the etching,	Width of feature <0.7mm: ¼ of line width Width of feature >=0.7m 0.10mm^2 per E(0.10) on Dot Gauge	1MAX *For illuminated applications if the flaw causes light leakage with change of color it is not allowed. See fig 8.3-2
Marks	Random imperfections along inside the etched feature	Width of feature <0.7mm: ¼ of line width Width of feature >=0.7m 0.05mm^2 per D(0.05) on Dot Gauge	1MAX *For illuminated applications if the flaw causes light leakage with change of color it is not allowed. See fig 8.3-2

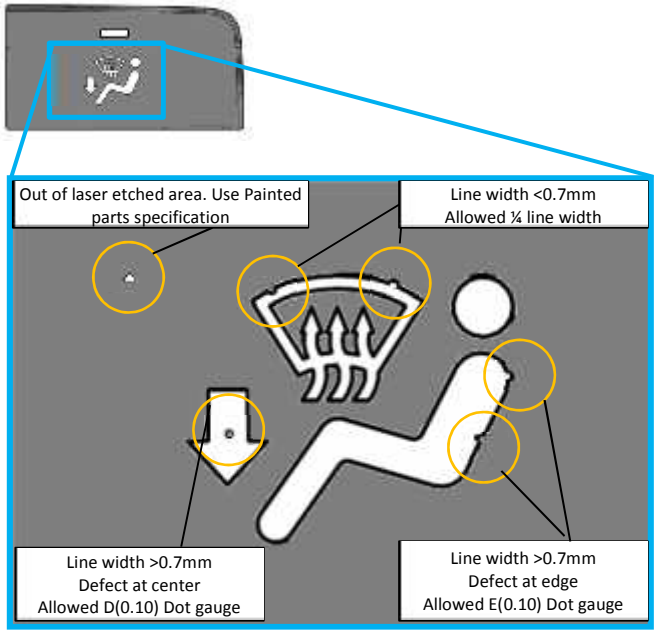


Fig 8.3-1 Illustrative reference for laser etched parts defects

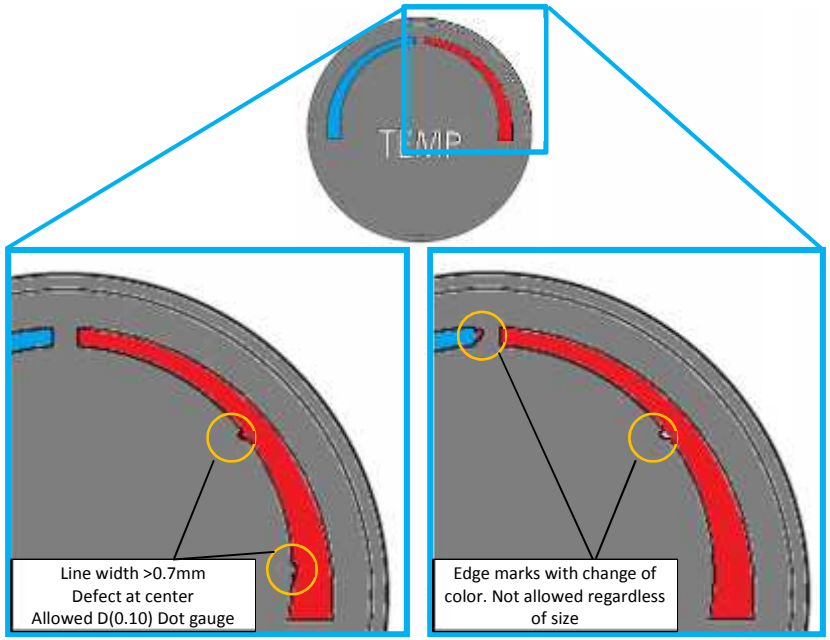


Fig 8.3-2 Illustrative reference for laser etch with change of color/light leak

Table 8.4-3 Cosmetic Quality specifications for plated parts

Appearance attribute	Description	Size allowed (Class A)	Quantity allowed (Class A)
Scratches	Superficial abrasion in the surface that does not expose the substrate	$0.2mm^2$ per G(0.20) on Dot Gauge	2 MAX separated by 70mm
Pits/Dents	Small imperfections that do not penetrate the substrate.		
Peeling, Blister	Adhesion loss between substrate and plating	None	None
Rough surface, sharp edges.	Superficial abrasion or rough surface. A sharp edge.	Must not retain fiber from a cotton cloth when wiped.	N/A
Dull surface	Non-uniform or less shiny portion within a surface	None	None
Chrome Stain	Chrome acidic stain (brown)	None	None
Nicks in substrate	Small indentations in the substrate visible through the plating	None	None
Exposed substrate	Lack of proper plating coverage.	None	None
Scuff	Abrasion on surface (Usually due to contact on plate surface)	None	None
Chrome burn	Dull chrome deposits at edges of part	None	None
Flow lines read through	Substrate weld lines visible in chrome	None	None
Blush	Dull circular appearance near the gate area	None	None

Revisions to this Document:

Version (X)	Date (dd/mmm/yyyy)	Description of Change
Rel	24/APR/2010	Initial Release
A	30/NOV/2010	Updated as per customer input
B	10/JUL/2011	Added D-car components
C	10/MAY/2012	Updated Section 1.3, 2.1, 2.2, 4.1, 8.1 and appendix D.
D	26/MAR/2015	Overall review of standard. Definitions are incorporated to specification tables. Matched formatting with Supplier Quality Manual. 1-Modified scope to include • Suppliers • In-house product. • Molded parts 3-Introduce Surface class “C” & “D” per GM standards. 3-Include reference photos with Methode prints extracts. 4.2-Added figure to viewing angle 4.5 Added guidelines for effectiveness evaluation based on AIAG. 7-Modified formatting of Dot gage. 8.2-Clarified specifications for painting 8.3-Clarified specification for printing based on feature width. Eliminated : • Ford specific part requirements. • Test methods sections • AAR/ Blue tag references Added: • GM standards defect definitions • Specification linked to SPI standard for molded parts • Specific section for laser etched graphics • MSA acceptance guidelines table