* METHOD 2032.3

VISUAL INSPECTION OF PASSIVE ELEMENTS

1. PURPOSE. The purpose of this test is to inspect passive elements used for microelectronic applications, including RF/microwave, for the visual defects described herein. This test can be performed at the unmounted element level, or prior to sealing or encapsulation, on a 100 percent inspection basis, to detect and eliminate elements with visual defects that could lead to failure in normal application. It may also be performed on a sample inspection basis at the unmounted element level, or prior to sealing or encapsulation, to determine the effectiveness of the manufacturer's quality control and handling procedures for passive elements. The inspection criteria define the visual requirements for class H and class K elements (classes of passive elements refer to screening requirements of MIL-PRF-38534).

2. APPARATUS. The apparatus for this test shall include optical equipment capable of the specified magnification(s) and any visual standards (drawings, photographs, etc.) necessary to perform effective inspection and to enable the operator to make objective decisions as to the acceptability of the element being inspected. Adequate fixturing shall be provided for handling elements during inspection to promote efficient operation without inflicting damage to them.

3. PROCEDURE.

a. General. The element shall be inspected in a suitable sequence of observations within the specified magnification ranges to determine compliance with class H or class K visual requirements. If a specified visual inspection requirement is in conflict with element design, topology or construction, it shall be documented and specifically approved by the acquiring activity. Inspection for all of the visual defect criteria in this test shall be performed on all elements to which they are applicable. Where a criterion is intended for a specific element type, process, or technology, it has been so indicated.

b. Sequence of inspection. The order in which criteria are presented is not a required order of inspection and may be varied at the discretion of the manufacturer.

c. Inspection control. In all cases, inspections prior to the final pre-seal inspection shall be performed under the same quality program that is required at final pre-seal inspection. Care shall be exercised after unmounted element inspection to prevent any handling induced defects from occurring and to insure that defects created during such handling will be detected and rejected at final pre-seal inspection. If an element is electrostatic discharge (ESD) sensitive, then appropriate precautions shall be taken.

d. Inspection environment. Inspection of unmounted elements shall be conducted in a Class 8 controlled environment (see paragraph 3.i (7)), except that the maximum allowable relative humidity shall not exceed 65 percent. Final pre-seal visual inspection shall be conducted in a Class 8 controlled environment for class H and a Class 5 controlled environment for class K. During the time interval between final pre-seal visual inspection and preparation for sealing, mounted elements shall be placed in a Class 6 controlled environment. Both mounted and unmounted elements shall be in covered containers when transported from one controlled environment to another.

e. Magnification. "High magnification" inspection shall be performed perpendicular to the element with illumination normal to the element surface. Other angles at which the inspection can be performed, and at which the element can be illuminated, may be used at the option of the manufacturer if the visual presentation is the same as used in the originally specified conditions. "Low magnification" inspection shall be performed with either a monocular, binocular, or stereo microscope with the element under suitable illumination, tilted at an angle not greater than 30° from the perpendicular. The magnification ranges to be used for inspection are specified at the start of each section and are called out at the start of each major criteria grouping.

f. Reinspection. When inspection for product acceptance or quality verification of the visual requirements herein is conducted subsequent to the manufacturer's successful inspection, the additional inspection shall be performed at the magnification specified herein, unless a specific magnification is required by the acquisition document.

g. Exclusions. Where conditional exclusions have been allowed, specific instruction as to the location and conditions for which the exclusion can be applied shall be documented in the assembly drawing.

h. Format and conventions. For ease of understanding and comparison, visual criteria are presented side-by-side in a columnar format. Class H criterion are presented in the left column and class K criterion are presented in the right column. When there are differences, the applicable parts of the class H criterion are underlined, for ease of comparison and clarity, and the differences only are shown in the class K column. When there are similarities, the phrase "same as class H" is used with no underlining of the class H criterion. If a requirement is not applicable to either product class, this is indicated by "N/A." A note in the class H column is applicable to class K unless otherwise specified in the class K column. A note in the class K column is applicable to class K only. Two kinds of notes are used herein, regular notes (NOTE:) and precautionary notes (PRECAUTIONARY NOTE:). A regular note is a integral part of a criterion. A precautionary note is not an integral part of the criterion but serves to alert the user to a requirement of the General Specification for Hybrids, MIL-PRF-38534. The phrases "except by design," "intended by design," "by design," or "unless otherwise specified by design" require that the element drawing be referenced to determine intent. For inspections performed at 100X, the criteria of "0.1 mil of passivation, separation, or metal" is satisfied by a "line of passivation, separation, or metal." Reference herein to "that exhibits" is satisfied when the visual image or visual appearance of the element under examination indicates a specific condition is present that does not require confirmation by any other method of testing. When other methods of test are used to confirm that a defect does not exist, they shall be approved by the acquiring activity. In the figures, cross-hatched areas represent metallization, blank areas represent resistor material and shaded areas represent exposed underlying material. The letters "x", "y", or "z" represent the dimension of interest and the letter "d" represents the original dimension. Most figures show the reject condition only.

i. Definitions:

(1) Active circuit area is all functional circuitry, operating metallization, or any connected combinations of these. In the case of resistors, it includes all resistor material that forms a continuous path between two metallized areas (usually bonding pads).

(2) Block resistor is a solid, rectangular shaped resistor, which, for purposes of trimming, is designed to be much wider than would be dictated by power density requirements and shall be identified in the approved manufacturer's precap visual implementation document.

(3) Bonding pad is a metallized area (usually located along the periphery of the element) at which an electrical connection is to be made by the user of the element.

(4) Bridging is complete connection between circuit features not intended to be connected.

(5) Conductive substrate is one that can conduct electricity. Copper or doped silicon, for example, are conductive substrates. Alumina and quartz, for example, are nonconductive (insulating) substrates.

(6) Contact window is an opening (usually square) through the oxide (or insulating) layer for the purpose of allowing contact by deposited material to the substrate.

(7) Controlled environment (Clean Room) is one that maintains the humidity and particle count in the working atmosphere below specified limits, as defined by ISO 14644-1. A Class 5 controlled environment has no more than100 (0.5 μm or greater) particles/cubic foot of air, a Class 6 controlled environment has no more than 1,000 (0.5 μm or greater) particles/cubic foot of air, and a Class 8 controlled environment has no more than 100,000 (0.5 μm or greater) particles/cubic foot of air. The maximum allowable relative humidity shall not exceed 65 percent.

(8) Corrosion is the gradual wearing away of metal, usually by chemical action, with the subsequent production of a corrosion product.

(9) Crazing is the presence of numerous, minute, interconnected surface cracks.

(10) Crossover is the transverse crossing of metallization paths, without mutual electrical contact, achieved by the deposition of an insulating layer between the metallization paths in the area of crossing.

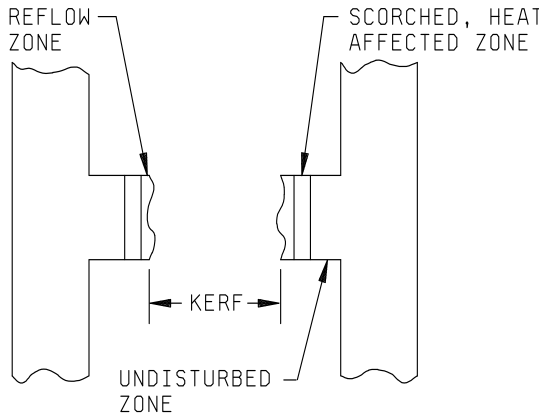
(11) Detritus is fragments of original or trim-modified resistor or conductor material.

(12) Dielectric is an insulating material that does not conduct electricity but may be able to sustain an electric field. It can be used in crossovers, as a passivation or a glassivation, or in capacitors.

(13) Foreign material is any material that is foreign to the element or any non-foreign material that is displaced from its original or intended position in the element. It is considered attached when it cannot be removed by a nominal gas blow (approximately 20 psig) or by an approved cleaning process. Conductive foreign material is any substance that appears opaque under those conditions of lighting and magnification used in routine visual inspection. Particles are considered to be embedded in glassivation when there is evidence of color fringing around the periphery of the particle.

(14) Glassivation is the top layer(s) of transparent insulating material that covers the active circuit area, including metallization, but not bonding pads. Crazing is the presence of numerous minute cracks in the glassivation. Cracks are fissures in the glassivation layer resulting from stress release or poor adhesion. The cracks can form loops over metallized areas.

(15) Kerf is the clear area in a trimmed resistor resulting from the removal of resistor material by the trimming operation. In laser trimming, the Kerf is bounded by the reflow zone (which is characterized by adherent, melted resistor material), the scorched heat-affected zone (which is characterized by discoloration of the resistor film without alteration of its physical form), and the undisturbed zone.



(16) Mar is a surface disturbance such as an indentation or a buff mark.

(17) Metallization, multilevel (conductors) is alternate layers of metallization, or other material used for interconnection, that are isolated from each other by a grown or deposited insulating material. The term "overlaying metallization" refers to any metallization layer on top of the insulating material.

(18) Metallization, multilayered (conductors) is two or more layers of metallization, or other material used for interconnection, that are not isolated from each other by a grown or deposited insulating material. The term "underlying metallization" refers to any metallization layer below the top layer of metallization.

(19) Metallization, operating (conductors) is all metallization (gold, aluminum, or other material) used for interconnection. Bonding pads are considered to be operating metallization. Alignment markers, test patterns, and identification markings are not considered to be operating metallization.

(20) Narrowest resistor width is the narrowest portion of a given resistor prior to trimming; however, the narrowest resistor width for a block resistor may be specified in the approved manufacturer's design documentation.

(21) Neck-down is tapering of a resistor line at a metallization interface. Resistor material taper is typically equal on both sides of the line and is less abrupt than a void.

(22) Nicking (partial cut) is incomplete or inadvertent trimming of a resistor adjacent to the one being trimmed or of the next ladder rung of the same resistor.

(23) Nonplanar element is one that is essentially three-dimensional.

(24) Original separation is the separation dimension or space that is intended by design.

(25) Original width is the width dimension that is intended by design.

(26) Oxide defect is an irregularly shaped defect in the oxide characterized by two or three colored fringes at its edges.

(27) Passivation is the silicon oxide, silicon nitride, or other insulating material, that is grown or deposited directly on the element prior to the deposition of metal.

(28) Passivation step is a change in thickness of the passivation layer by design.

(29) Passive elements are planar resistors, capacitors, inductors, and patterned substrates (both single-layer and multilayer), and nonplanar chip capacitors, chip resistors, chip inductors, and transformers.

(30) Patterned substrate is a substrate on which conductors and components, such as resistors or capacitors, are formed using thick or thin film manufacturing techniques.

(31) Planar element is one that is essentially two-dimensional with all points in a common plane.

(32) Protrusion is a jutting-out of a circuit feature. Protrusion is typically caused by a photolithographic or screening defect.

(33) Resistor ladder is a resistor structure resembling a ladder in appearance that can be trimmed in incremental steps. A coarse ladder structure is one in which trimming of a rung results in a large incremental resistance change (one that can cause an out-of-tolerance condition to occur). A fine ladder structure is one in which trimming of a rung results in a small incremental resistance change (one that can not cause an out-of-tolerance condition to occur).

(34) Resistor ladder rung is that portion of a resistor ladder structure intended to be laser trimmed to result in an incremental change in resistance.

(35) Resistor loop is a resistor structure resembling a loop in appearance that can be trimmed. A coarse loop structure is one in which trimming results in a large resistance change (one that can cause an out-of-tolerance condition to occur). A fine loop structure is one in which trimming results in a small resistance change (one that cannot cause an out-of-tolerance condition to occur).

(36) Resistor material, self-passivating is one on which a conformal insulating layer can be thermally grown (such as tantalum nitride on which tantalum pentoxide is grown).

(37) Scorching is discoloration of laser trimmed thin film resistor material without alteration of its physical form.

(38) Scratch, metallization is any cut, including probe marks, in the surface of the metallization. A mar on the metallization surface is not considered to be a scratch.

(39) Scratch, resistor is any cut in the resistor film. A mar on the resistor surface is not considered to be a scratch.

(40) Sidebar is that portion of a resistor ladder structure to which rungs are attached. Sidebars are not intended to be laser trimmed.

(41) Substrate is the supporting structural material into or upon which, or both, functional circuits are formed.

(42) Surface Acoustic Wave (SAW) element is a planar element fabricated typically using thin film manufacturing techniques on various substrate materials. Size varies as a function of frequency and design features include interdigitated fingers.

(43) Terminal is a metal area used to provide an electrical access point to functional circuitry.

(44) Thick film is conductive, resistive or dielectric material screen printed onto a substrate and fired at temperature to fuse into its final form.

(45) Thin film is conductive, resistive or dielectric material, usually less than 50,000Å in thickness that is deposited onto a substrate by vacuum evaporation, sputtering, or other means.

(46) Underlying material is any layer of material below the top-layer metallization. This includes metallization, resistor, passivation or insulating layers, or the substrate itself.

(47) Via is an opening in the insulating material in which a vertical conductive electrical connection from one metallization layer to another is made.

(48) Vitrification is conversion into glass or a glassy substance by heat and fusion.

(49) Void, metallization is any missing metallization where the underlying material is visible (exposed). Voids typically are caused by photolithographic, screen, or mask related defects, not by scratches.

(50) Void, resistor is any missing resistor material where the underlying material is visible (exposed). Voids typically are caused by photolithographic, screen, or mask related defects, not by scratches.

(51) Wraparound conductor is one which extends around the edge of the substrate by design.

(52) Coupling (air) bridge is a raised layer of metallization used for interconnection that is isolated from the surface of the element by an air gap or other insulating material.

(53) Pit is a depression produced in a substrate surface typically by non-uniform deposition of metallization or by non-uniform processing such as excessively powered laser trim pulses.

(54) Substrate, hard is the inorganic, rigid material into or upon which or both, functional circuits are formed. Typical materials are alumina and silicon.

(55) Blister, metallization is a hollow bump that can be flattened.

(56) Nodule, metallization is a solid bump that cannot be flattened.

(57) Substrate plug via is a cylinder-like volume in the substrate material filled with conductive material which makes electrical connection from contact areas on the top surface to the back surface of the substrate.

(58) Whisker is a spontaneous columnar or cylindrical filament, usually of monocrystalline metal, emanating from the surface of a finish. Whiskers are not to be confused with dendrites. Whiskers have the following characteristics:

a. An aspect ratio (length/width) greater than 2.
b. Can be kinked, bent, or twisted.
c. Usually have a uniform cross-sectional shape.
d. May have striations along the length of the column and/or rings around the circumference of the column.
e. Length of 10 microns or more. Features less than 10 microns may be deemed important for research but are not considered significant for this test method.

(59) Dendrites are fern-like growths on the surface of a material. They can form as a result of electromigration of an ionic species produced during solidification.

(60) Probe marks are scratches on the bond pads made by probes during electrical measurements.

3.1. Thin film resistor element planar inspection (Including patterned substrates, discrete resistor elements, or other planar thin film element inspection). Inspection for visual defects described in this section shall be conducted on each thin film passive element. The "high magnification" inspection shall be within the range of 100X to 200X for both class H and class K. The "low magnification" inspection shall be within the range of 30X to 60X for both class H and class K. When inspection is performed prior to mounting, then elements utilizing ceramic or glass type substrates, without backside metallization, shall be inspected using backlighting for conditions of hair-line voiding or bridging. Patterned substrates that have geometries of 2.0 mils or greater shall be inspected at 10X to 60X magnification.

3.1.1. Operating metallization defects "high magnification". No element shall be acceptable that exhibits:

NOTE: The metallization defect criteria contained in this section apply to operating metallization only.

3.1.1.1. Metallization scratches and voids. No element shall be acceptable that exhibits:

Class H	Class K	Figures
a. A scratch, probe mark, or void in the metallization, excluding bonding pads, that both exposes underlying material anywhere along its length and leaves less than 50 percent of the original metallization width undisturbed (see 2032-1h). NOTE: Underlying material does not have to be exposed along the full length of the scratch.	a. Same as Class H.	FIGURE 2032-1h
b. Scratch, probe mark, or void in the bonding pad area that both exposes underlying material and reduces the metallization path width, where it enters the bonding pad, and leaves less than 50 percent of its original metallization width. If two or more metallization paths enter a bonding pad, each shall be considered separately (see figure 2032-2h).	b. Less than 75 percent (see figure 2032-2k).	FIGURE 2032-2h FIGURE 2032-2k
c. Scratch that completely crosses the metallization path and damages the surface of the surrounding passivation, glassivation, or substrate on either side.	c. Same as Class H.	No figure supplied.
d. Scratches, probe marks, or voids in the bonding pad area that expose underlying material over greater than 25 percent of the original unglassivated metallization area. NOTE: For RF/microwave elements on nonconductive substrates, a void created in the bonding pad area as a result of wire bond removal for performance optimization or tuning, is not rejectable provided that the void remains entirely visible.	d. Same as Class H.	No figure supplied.

3.1.1.2. Metallization corrosion. No element shall be acceptable that exhibits:

Class H	Class K	Figures
a. Any metallization corrosion. NOTE: Metallization having any localized discolored area shall be closely examined and rejected unless it is demonstrated to be a harmless film, glassivation interface, or other obscuring effect.	a. Same as class H.	No figure supplied.

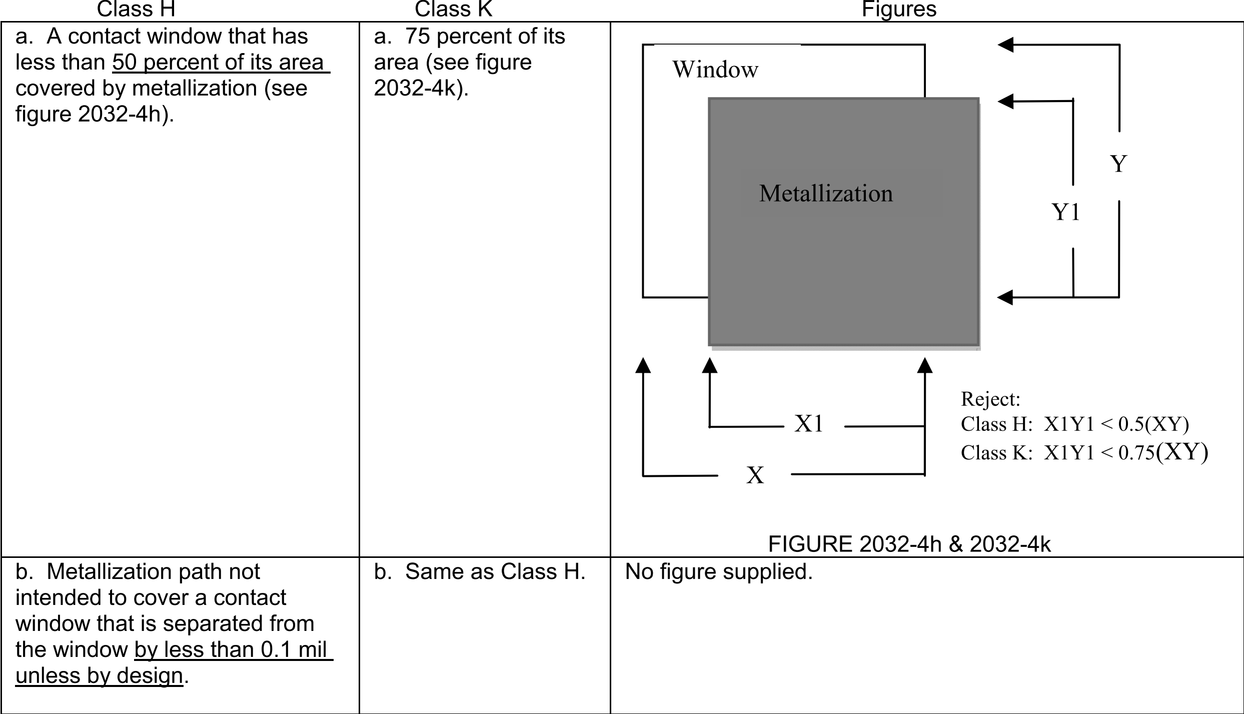
3.1.1.3 Metallization adherence. No element shall be acceptable that exhibits:

Class H	Class K	Figures
a. Any metallization lifting, peeling, or blistering. NOTE: Nodules are acceptable. In order to determine if a bump in the metallization is a blister or a nodule, attempt to flatten the bump with a nonmetallic instrument. If the bump flattens, then it is a blister. NOTE: These criteria are not applicable to undercutting or separation induced anomalies (for example, metallization lifting due to scribe and break or diamond sawing) since these are not indicative of adhesion problems.	a. Same as Class H.	No figure supplied.

3.1.1.4. Metallization protrusion. No element shall be acceptable that exhibits:

Class H	Class K	Figures
a. Protrusion of metallization that reduces the original separation between adjacent operating metallization by greater than 50 percent (see figure 2032-3h).	a. Same as class H.	FIGURE 2032-3h

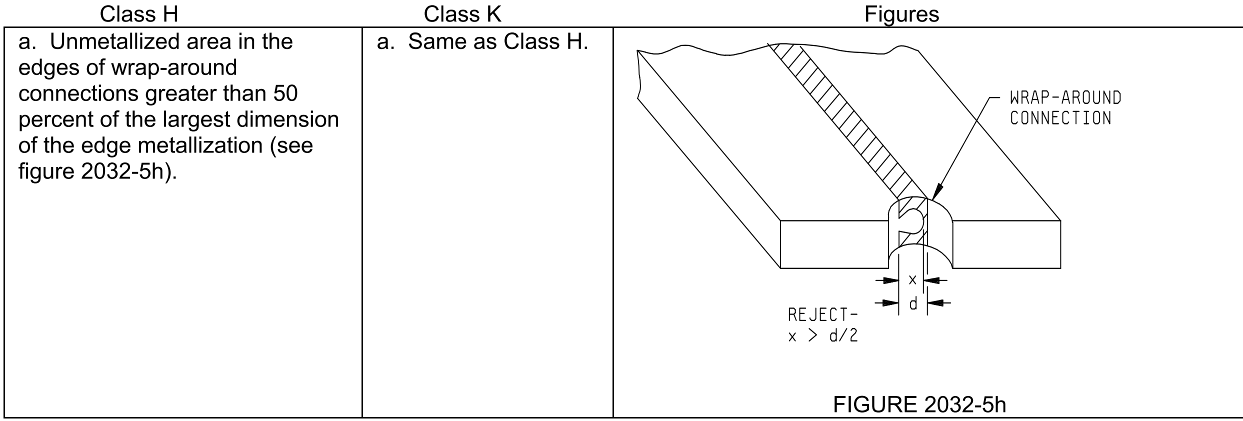
3.1.1.5. Metallization alignment. No element shall be acceptable that exhibits:

Class H	Class K	Figures
a. A contact window that has less than 50 percent of its area covered by metallization (see figure 2032-4h).	a. 75 percent of its area (see figure 2032-4k).	 FIGURE 2032-4h & 2032-4k
b. Metallization path not intended to cover a contact window that is separated from the window by less than 0.1 mil unless by design.	b. Same as Class H.	No figure supplied.

3.1.1.6. Metallized through-hole defects, "high magnification". No element shall be acceptable that exhibits:

Class H	Class K	Figures
a. Through-hole metallization that is not vertically continuous or that does not cover at least a continuous 50 percent of the inside, circumferential surface area unless by design.	a. Same as Class H.	No figure supplied.

3.1.1.7. Wrap-around connection defects, "high magnification". No element shall be acceptable that exhibits:

Class H	Class K	Figures
a. Unmetallized area in the edges of wrap-around connections greater than 50 percent of the largest dimension of the edge metallization (see figure 2032-5h).	a. Same as Class H.	 FIGURE 2032-5h

3.1.1.8. Substrate plug via defects, "low magnification". When inspected from each side of the substrate, no element shall be acceptable that exhibits:

NOTE: These are minimum requirements. Via flatness and other requirements shall be in accordance with the applicable detail drawings. The via fill may consist of thick film metallization.

Class H	Class K	Figures
a. A complete void through the via.	a. Same as Class H.	See figure 2032-6h.
b. Any lifting, peeling, or blistering of the via metallization.	b. Same as Class H.	See figure 2032-6h.
c. Via fill less than 75% of the total surface area of the via plug and less than 75% of the substrate thickness.	c. Same as Class H.	See figure 2032-6h.

< 75%

VIA FILL < 75%

REJECT

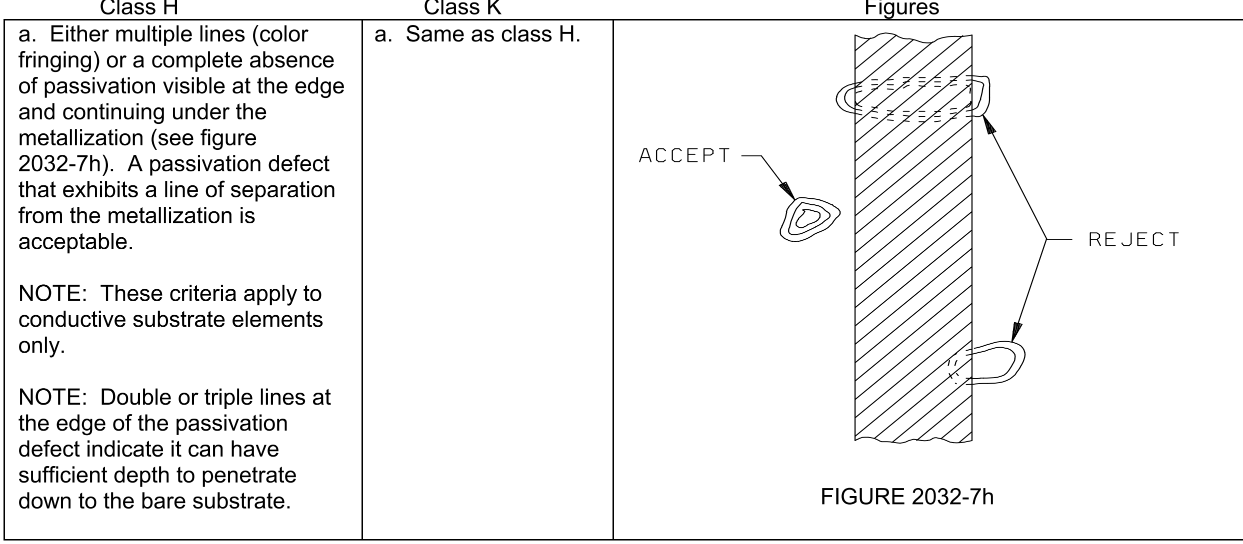
< 75%

VIA FILL < 75%

REJECT

FIGURE 2032-6h. Classes H and K via plug fill criteria.

3.1.2. Passivation defects "high magnification". No element shall be acceptable that exhibits:

Class H	Class K	Figures
a. Either multiple lines (color fringing) or a complete absence of passivation visible at the edge and continuing under the metallization (see figure 2032-7h). A passivation defect that exhibits a line of separation from the metallization is acceptable. NOTE: These criteria apply to conductive substrate elements only. NOTE: Double or triple lines at the edge of the passivation defect indicate it can have sufficient depth to penetrate down to the bare substrate.	a. Same as class H.	 FIGURE 2032-7h

3.1.3. Glassivation defects, "high magnification". No device shall be acceptable that exhibits:

Class H	Class K	Figures
a. Glass crazing or damage that prohibits the detection of visual criteria contained herein.	a. Same as Class H.	No figure supplied.
b. Any lifting or peeling of the glassivation. NOTE: Lifting or peeling of the glassivation is acceptable when it does not extend more than 1.0 mil from the designed periphery of the glassivation, provided that the only exposure of metallization is of adjacent bonding pads or of metallization leading from those pads.	b. Same as Class H.	No figure supplied.
c. A void in the glassivation that exposes two or more adjacent operating metallization paths, excluding bonding pad cutouts, unless by design.	c. Same as Class H.	No figure supplied.
d. Unglassivated non-active circuit areas greater than 5.0 mils in any dimension, unless by design.	d. Same as Class H.	No figure supplied.
e. Unglassivated areas at the edge of a bonding pad exposing the conductive substrate.	e. Same as Class H.	No figure supplied.

3.1.3. Glassivation defects, "high magnification" - Continued.

Class H	Class K	Figures
f. Glassivation covering more than 25 percent of a bonding pad area.	f. Same as Class H.	No figure supplied.
g. Crazing in glassivation over a resistor.	g. Same as Class H.	No figure supplied.
h. Misalignment of the glassivation that results in incomplete coverage of a resistor, unless by design.	h. Same as Class H.	No figure supplied.
i. Glassivation scratches or voids that expose any portion of a resistor or fusible link except for polycrystalline silicon links where the glassivation is opened by design.	i. Same as Class H.	No figure supplied.
j. Scratches in the glassivation that disturb metallization and bridge metallization paths.	j. Same as Class H.	No figure supplied.
k. Cracks (not crazing) in the glassivation that form a closed loop over adjacent metallization paths.	k. Same as Class H.	No figure supplied.
NOTE: Criteria of 3.1.3a-k can be excluded when the defects are due to laser trimming. In this case, the defects outside the kerf due to laser trimming shall not be more than one half the remaining resistor width, and shall leave a primary resistor path free of glassivation defects, equal to or greater than 50 percent of the narrowest resistor width, (see figure 2032-8h).	NOTE: Same as Class H.	LASER INDUCED GLASSIVATION DEFECTS y_2 d y_1 REJECT- $y_1 < 0.5\ y_2$ REJECT- $y_2 < d/2$ FIGURE 2032-8h

3.1.4. Substrate defects "high magnification". No element shall be acceptable that exhibits:

Class H	Class K	Figures
a. Less than 0.1 mil of separation between the operating metallization and the edge of the element unless by design (see figure 2032-9h). NOTE: For elements containing wrap-around conductors or for bonding pads of RF/microwave elements that are coincident with the element edge (as documented on the design drawing), this criteria does not apply. When bond pad metallization is coincident with the element edge, a minimum separation of 1.0 mil shall exist between the bonding pad metallization at the element edge and any non-common conductive surface.	a. Same as Class H.	y REJECT- y < 0.1 MIL UNLESS BY DESIGN REJECT- CHIPOUT INTO ACTIVE CIRCUIT AREA FIGURE 2032-9h
b. A chipout that extends into the active circuit area (see figure 2032-9h).	b. Same as class H.	See figure 2032-9h.
c. Any crack that exceeds 3.0 mils in length (see figure 2032-10h). NOTE: For fused quartz or glass substrates, no cracking is allowed.	c. Same as Class H.	Reject: Crack > 3 .0 mils Reject: Crack >1.0 mil and extending towards active area Reject: Crack < 0.1 mil from active circuit area. FIGURE 2032-10h
d. Any crack that does not exhibit 0.1 mil of separation from any active circuit area or operating metallization (see figure 2032-10h).	d. 0.25 mil (see figure 2032-10h).	See figure 2032-10h.
e. Any crack exceeding 1.0 mil in length extending from the element edge directly towards the active circuit area or operating metallization (see figure 2032-10h).	e. Same as class H.	See figure 2032-10h.

3.1.4. Substrate defects "high magnification" - Continued.

Class H	Class K	Figures
f. Not applicable.	f. Semicircular crack or combination of cracks along the element edge whose total length is equal to or greater than 75 percent of the narrowest separation between any two bonding pads (see figure 2032-11k).	REJECT- x ≥ 3/4y FIGURE 2032-11k
g. An attached portion of an active circuit area from an adjacent element.	g. Same as Class H.	No figure supplied.
h. Any crack that does not originate at an edge.	h. Same as Class H.	No figure supplied.
i. Holes through the substrate, unless by design.	i. Same as Class H.	No figure supplied.

3.1.5 Foreign material defects "low magnification". No element shall be acceptable that exhibits:

Class H	Class K	Figures
a. For mounted and unmounted elements, unattached foreign material on the surface of the element. NOTE: All foreign material shall be considered to be unattached unless otherwise verified to be attached. Verification of attachments of foreign material whose longest dimensions are greater than 75 percent of the closest unglassivated conductive spacing shall be accomplished by a light touch with an appropriate mechanical device (i.e., needle, probe, pick, etc.). Verification of attachments of smaller material can be satisfied by suitable cleaning process approved by the acquiring or qualifying activity. All foreign material or particles may be removed, if possible, with a nominal gas blow (approximately 20 psig). NOTE: Semiconductor particles are considered to be foreign material.	a. Same as class H.	No figure supplied.

3.1.5 Foreign material defects "low magnification" - Continued.

Class H	Class K	Figures
b. Attached foreign material that bridges metallization paths, two package leads, lead to package metallization, functional circuit elements, junctions, or any combination thereof.	b. Same as class H.	No figure supplied.
c. Liquid droplets, ink drops, or chemical stains that appear to bridge any unglassivated or unpassivated active circuit areas.	c. Same as class H.	No figure supplied.
d. Attached foreign material that covers greater than 25 percent of a bonding pad area.	d. Same as class H.	No figure supplied.
e. Termination material splattered throughout the resistor, substrate, passivation, or glassivation (see figure 2032-12h). Reject for termination material greater than 10 mils in any direction. Reject for 5 or more areas between 3 and 10 mils in any direction.	d. Same as class H.	Termination Material FIGURE 2032-12h

3.1.6 Thin film resistor defects, "high magnification". No element shall be acceptable that exhibits:

Class H	Class K	Figures
a. Voids at the terminal that reduces the resistor width to less than 50 percent of the original resistor width (see figure 2032-13h).	a. Same as Class H.	FIGURE 2032-13h
b. Neckdown at the terminal that reduces the resistor width to less than 75 percent of the original resistor width (see figure 2032-14h).	b. Same as Class H.	FIGURE 2032-14h
c. Any sharp (clearly defined) color change within 0.1 mil of the terminal. NOTE: A sharp color change close to the terminal usually indicates an abrupt reduction of resistor film thickness. This color change usually occurs in a straight line parallel to the terminal. A gradual color change, or a non-uniform or mottled color anywhere in the resistor, is not cause for rejection.	c. Same as Class H.	No figure supplied.

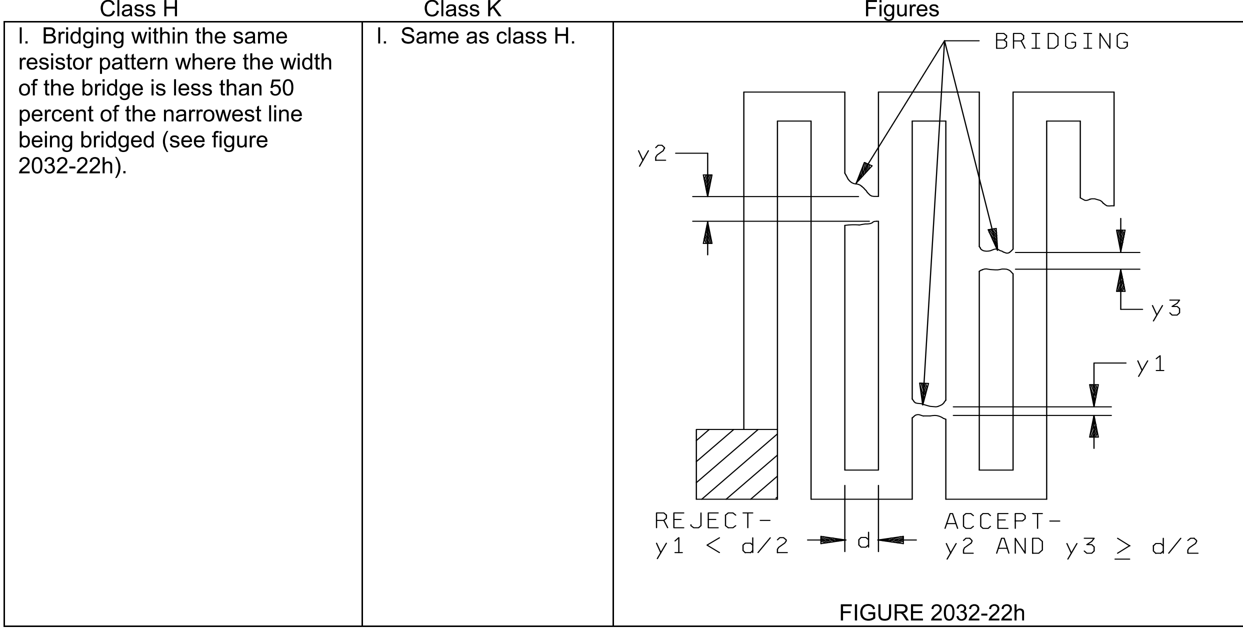
3.1.6 Thin film resistor defects, "high magnification" - Continued.

Class H	Class K	Figures
d. Any resistor film lifting, peeling or blistering.	d. Same as class H.	No figure supplied.
e. Reduction of resistor width, resulting from voids, scratches, or a laser trim kerf or a combination of these, that leaves less than 50 percent of the narrowest resistor width (see figure 2032-15h). PRECAUTIONARY NOTE: The maximum allowable current density requirement shall not be exceeded.	e. Same as class H.	 FIGURE 2032-15h
f. Contact overlap between the metallization and the resistor in which the width dimension "y" is less than 50 percent of the original resistor width (see figure 2032-16h).	f. Same as Class H.	 FIGURE 2032-16h
g. Contact overlap between the metallization and the resistor in which the length dimension "x" is less than 0.25 mil (see figure 2032-17h).	g. Same as class H.	 FIGURE 2032-17h
h. More than a 50 percent reduction of the original separation, between any two different resistors, or a resistor and metallization not associated with it (see figure 2032-18h).	h. Same as class H.	 FIGURE 2032-18h

3.1.6. Thin film resistor defects, "high magnification" - Continued.

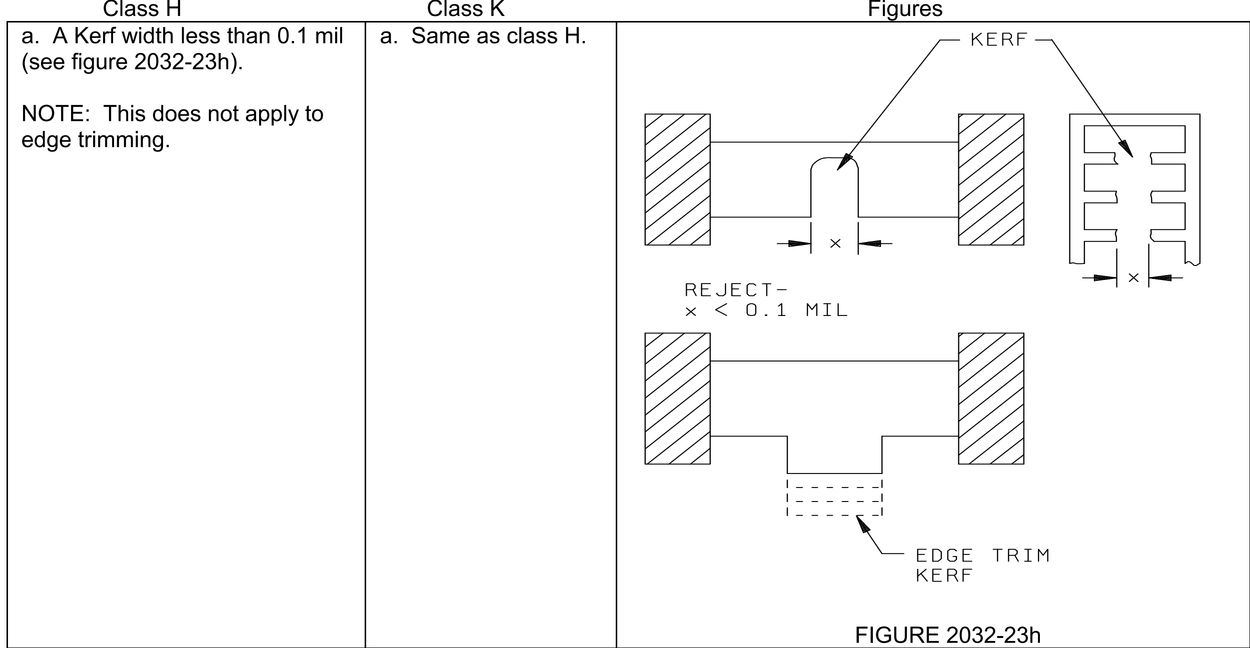
Class H	Class K	Figures
i. Any resistor that crosses a substrate irregularity (such as a void or scratch) (see figure 2032-19h). NOTE: This criterion is applicable to conductive substrates only.	i. Same as class H.	FIGURE 2032-19h
j. Any increase in resistor width of a block resistor greater than 25 percent of the original resistor width (see figure 2032-20h).	j. Same as class H.	FIGURE 2032-20h
k. Protruding resistor material within the same resistor structure that reduces the original separation to less than 50 percent (see figure 2032-21h). NOTE: This criterion applies to protrusion of resistor material resulting from a photo-lithographic defect.	k. Same as class H.	FIGURE 2032-21h

3.1.6 Thin film resistor defects, "high magnification" - Continued.

Class H	Class K	Figures
l. Bridging within the same resistor pattern where the width of the bridge is less than 50 percent of the narrowest line being bridged (see figure 2032-22h).	l. Same as class H.	 FIGURE 2032-22h

3.1.7 Laser trimmed thin film resistor defects, "high magnification". No element shall be acceptable that exhibits:

NOTE: The laser trim defect criteria contained in this section apply to active resistor areas only.

Class H	Class K	Figures
a. A Kerf width less than 0.1 mil (see figure 2032-23h). NOTE: This does not apply to edge trimming.	a. Same as class H.	 FIGURE 2032-23h

3.1.7 Laser trimmed thin film resistor defects, "high magnification" - Continued.

Class H	Class K	Figures
b. A Kerf containing particles of detritus. NOTE: For resistor materials that are self-passivating (such as tantalum nitride), detritus in the Kerf is allowed provided that a clear path of at least 0.1 mil in width exists in the Kerf. Such detritus shall be attached. Verification of attachment shall be accomplished using the techniques described in 3.1.5 (see figure 2032-24h). NOTE: This does not apply to edge trimming.	b. Same as class H.	 FIGURE 2032-24h
NOTE: In the case of a resistor loop made with self-passivating resistor material which is similar in configuration to the one shown in figure 2032-25h, there shall be at least one Kerf that contains a clear path of at least 0.1 mils in width, otherwise, the element shall be rejected.	Same as class H.	 FIGURE 2032-25h
c. Bridging of detritus between rungs in the active area of a resistor ladder structure (see figure 2032-26h). NOTE: Bridging of detritus in inactive areas is acceptable.	c. Same as class H.	 FIGURE 2032-26h

3.1.7 Laser trimmed thin film resistor defects, "high magnification" - Continued.

Class H	Class K	Figures
d. No nicking or scorching is allowed except as permitted below. NOTE: This does not apply to rungs in a fine resistor ladder structure (see figure 2032-27h). NOTE: See 3.i.(33) for a definition of coarse and fine resistor ladder structures. The element drawing must be referenced to determine if a given resistor ladder structure is coarse or fine.	d. Same as class H.	COARSE LADDERS / FINE LADDERS NICKING: REJECT / ACCEPT SCORCHING: REJECT / ACCEPT FIGURE 2032-27h
d. (Continued.) NOTE: This criterion does not apply to the second rung of a resistor loop since the second rung is inactive. This criterion does not apply to a fine loop or to a resistor structure that is comprised of fine loops (see figure 2032-28h). NOTE: See 3.i.(35) for a definition of coarse and fine resistor loop structures. The element drawing must be referenced to determine if a given resistor loop structure is coarse or fine.	d. Same as Class H.	COARSE LOOPS / FINE LOOPS NICK IN FIRST (ACTIVE) RUNG: REJECT / ACCEPT SCORCH IN FIRST (ACTIVE) RUNG: REJECT / ACCEPT NICK IN SECOND (INACTIVE) RUNG: ACCEPT / ACCEPT SCORCH IN SECOND (INACTIVE) RUNG: ACCEPT / ACCEPT FIGURE 2032-28h

3.1.7. Laser trimmed thin film resistor defects, "high magnification" - Continued.

Class H	Class K	Figures
d. (Continued.) NOTE: This criterion does not apply to the last rung of a resistor coarse ladder if the last rung is inactive (see figure 2032-29h).	d. Same as class H.	LAST RUNG ACCEPT- NICK IN INACTIVE LAST RUNG LAST RUNG REJECT- NICK IN ACTIVE LAST RUNG FIGURE 2032-29h
e. A Kerf or scorch which extends into a resistor ladder sidebar is acceptable as long as there is 50% of the line undisturbed (see figure 2032-30h).	e. 75% for class K (see figure 2032-30k).	X D Laser Trim Reject: Class H: $X < 0.5D$ Class K: $X < 0.75D$ FIGURE 2032-30h & 2032-30k
f. Kerf or scorch misalignment which extends into resistor loop (see figure 2032-31h).	f. Same as class H.	ACCEPT- PROPER ALIGNMENT REJECT- MISALIGNMENT FIGURE 2032-31h

3.1.7 Laser trimmed thin film resistor defects, "high magnification" - Continued.

Class H	Class K	Figures
g. A Kerf which extends into metallization and leaves less than 75 percent of the metallization width undisturbed (see figure 2032-32h). NOTE: Opening a metallization link by design is acceptable.	g. Same as class H.	REJECT- x < 3/4 d EDGE TRIM KERF FIGURE 2032-32h
h. A Kerf in a resistor, at the interface of the resistor material with the metallization, that leaves less than 50 percent of the original resistor width, unless by design. PRECAUTIONARY NOTE: The maximum allowable current density requirement shall not be exceeded. (see figure 2032-33h).	h. Same as class H.	REJECT- y < d/2 UNLESS BY DESIGN FIGURE 2032-33h
i. A Kerf in a resistor that leaves less than 50 percent of the original resistor width, unless by design. PRECAUTIONARY NOTE: The maximum allowable current density requirement shall not be exceeded (see figure 2032-34h).	i. Same as class H.	EDGE TRIM KERF REJECT- y < d/2 UNLESS BY DESIGN FIGURE 2032-34h

3.1.7. Laser trimmed thin film resistor defects, "high magnification" - Continued.

Class H	Class K	Figures
j. A floating Kerf in a resistor that leaves less than 50 percent of the narrowest resistor width unless by design (see figure 2032-35h). NOTE: A floating Kerf (one that is completely contained within the resistor) must meet this criterion. PRECAUTIONARY NOTE: The maximum allowable current density requirement shall not be exceeded.	j. Same as class H.	FIGURE 2032-35h
k. Pits into the silicon dioxide of conductive substrate elements in the Kerf which does not show a line of separation between the pit and the resistor material (see figure 2032-36h).	k. Same as class H.	FIGURE 2032-36h

3.1.8. Multilevel thin film defects, "high magnification". No element shall be acceptable that exhibits:

Class H	Class K	Figures
a. Insulating material that does not extend beyond the width of the upper and lower metallization by 0.3 mil minimum (see figure 2032-37h).	a. Same as class H.	FIGURE 2032-37h
b. Voids in the insulating material.	b. Same as class H.	No figure supplied.
c. A bump or indentation in the upper (overlaying) metallization at the intersection of the upper and lower metallization (see figure 2032-38h). NOTE: This criteria is not applicable to coupling (air) bridges. NOTE: There could be a problem with the insulating material.	c. Same as class H.	FIGURE 2032-38h
d. Scratch that completely crosses the metallization and damages the insulating material surface on either side (see figure 2032-39h).	d. Same as class H.	FIGURE 2032-39h

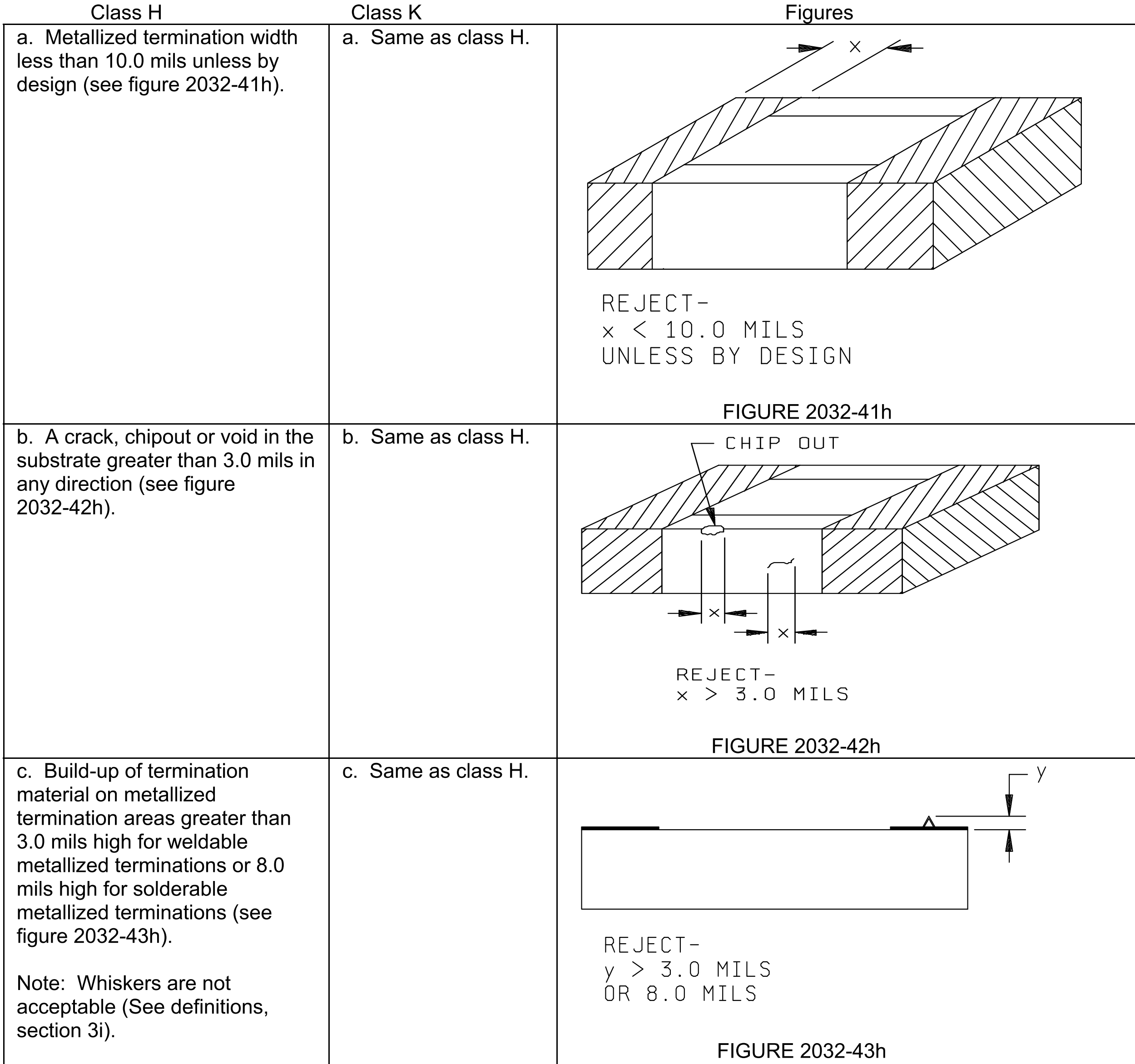
3.1.9 Coupling (air) bridge defects, "high magnification". No element shall be acceptable that exhibits:

Class H	Class K	Figures
a. A void in the coupling (air) bridge metallization that leaves less than 50 percent of the original metallization width undisturbed. (See figure 2032-40h).	a. Same as class H.	 FIGURE 2032-40h
b. Nodules or bumps that are greater, in any dimension, than the original coupling (air) bridge metallization width. (See figure 2032-40h).	b. Same as class H.	See figure 2032-40h.
c. Coupling (air) bridge that contacts underlying operating metallization. (See figure 2032-40h).	c. Same as class H.	See figure 2032-40h.
d. Attached, conductive foreign material that is greater, in any dimension, than 50 percent of the original coupling (air) bridge metallization width.	d. Same as class H.	No figure supplied.
e. No visible separation between the coupling (air) bridge and the underlying operating metallization. NOTE: This criterion is not applicable when an insulating material is used between the coupling (air) bridge and the underlying metallization. (See figure 2032-40h).	e. Same as class H.	See figure 2032-40h.
f. Coupling (air) bridge metallization overhang over adjacent operating metallization, not intended by design, that does not exhibit a visible separation. (See figure 2032-40h).	f. Same as class H.	See figure 2032-40h.

3.1.9 <u>Coupling (air) bridge defects, "high magnification"</u> - Continued.

Class H	Class K	Figures
g. Mechanical damage to a coupling (air) bridge that results in depression (lowering) of coupling (air) bridge metallization over underlying operating metallization.	g. Same as class H.	No figure supplied.

3.1.10. <u>Additional criteria for thin film nonplanar resistor defects "low magnification"</u>. The thin film resistor element planar inspection criteria, also applies to thin film nonplanar resistors. The "low magnification" inspection shall be within the range of 10X to 60X. No element shall be acceptable that exhibits:

Class H	Class K	Figures
a. Metallized termination width less than 10.0 mils unless by design (see figure 2032-41h).	a. Same as class H.	 FIGURE 2032-41h
b. A crack, chipout or void in the substrate greater than 3.0 mils in any direction (see figure 2032-42h).	b. Same as class H.	 FIGURE 2032-42h
c. Build-up of termination material on metallized termination areas greater than 3.0 mils high for weldable metallized terminations or 8.0 mils high for solderable metallized terminations (see figure 2032-43h). Note: Whiskers are not acceptable (See definitions, section 3i).	c. Same as class H.	 FIGURE 2032-43h