METHOD 2032.2

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. Visual inspection criteria are presented in four sections. The first (see 3.1), concerns planar thin film elements (resistors, capacitors, inductors, single-level patterned substrates and multilevel patterned substrates). The second (see 3.2), concerns planar thick film elements (resistors, capacitors, single-level patterned hard substrates, and multilevel patterned hard substrates). The third (see 3.3), concerns nonplanar elements (ceramic chip capacitors, tantalum chip capacitors, parallel plate chip capacitors, chip resistors, inductors, and transformers). The fourth (see 3.4) concerns surface acoustic wave (SAW) elements. The inspection criteria contained in each section 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. Unmounted element inspection shall be conducted in a 100,000 (0.5 ☒m or greater) particles/cubic foot controlled environment (class 8 of ISO 14644-1), except that the maximum allowable relative humidity shall not exceed 65 percent. Mounted element inspection shall be conducted in a 100,000 (0.5 ☒m or greater) controlled environment (class 8 of ISO 14644-1) for class H and a 100 (0.5 ☒m or greater) controlled environment (class 5 of ISO 14644-1) for class K. During the time interval between final pre-seal inspection and preparation for sealing, mounted elements shall be placed in a controlled environment (see 3.i (7)). 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, rectangularly 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 is one that has 1,000 or fewer (0.5 ⊠m or greater) particles/cubic foot in a controlled environment in accordance with the requirements of ISO 14644-1 for a class 6 clean environment, except that 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.

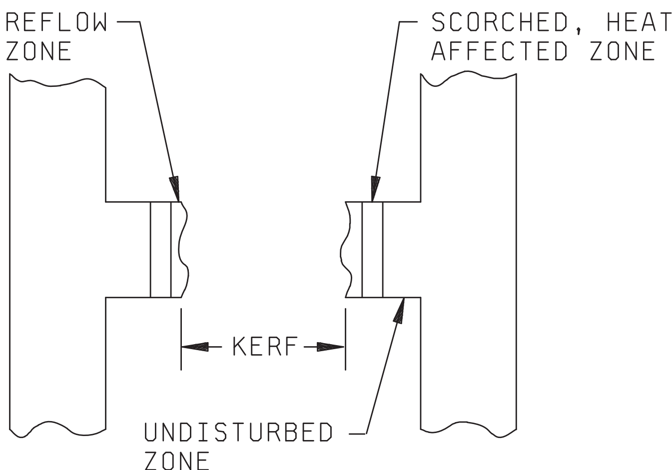
(11) Detritus is fragments of original or trim-modified resistor or conductor material.

(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 nonforeign 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 nontearing 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 it 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 tearing defect, 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 tearing defect 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 nonuniform deposition of metallization or by nonuniform 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..

3.1 Thin film element inspection. Inspection for visual defects described in this section shall be conducted on each planar 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.

Class H	Class K
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.	
a. A scratch or probe mark in the metallization, excluding bonding pads, that both exposes under-lying material anywhere along its length and leaves less than 50 percent of the original metallization width undisturbed (see 2032-1h). NOTE: These criteria do not apply to capacitors (see 3.1.1.1e). NOTE: Underlying material does not have to be exposed along the full length of the scratch.	a. Same as Class H.

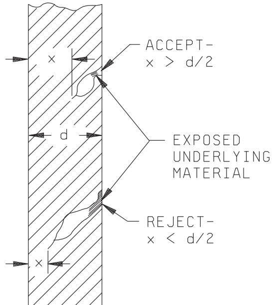


FIGURE 2032-1h. Class H metallization scratch criteria.

Class H	Class K
3.1.1.1 b. Scratch 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).	3.1.1.1 b. Less than 75 percent (see figure 2032-2k).

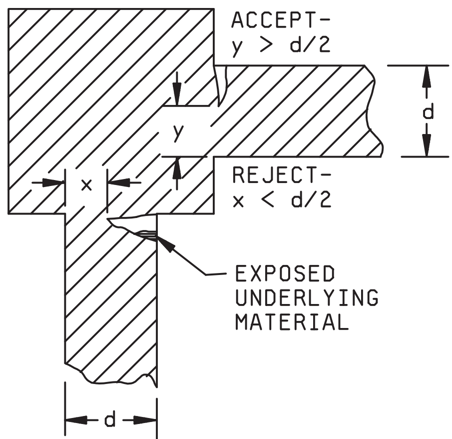


FIGURE 2032-2h. Class H metallization width reduction at bonding pad criteria.

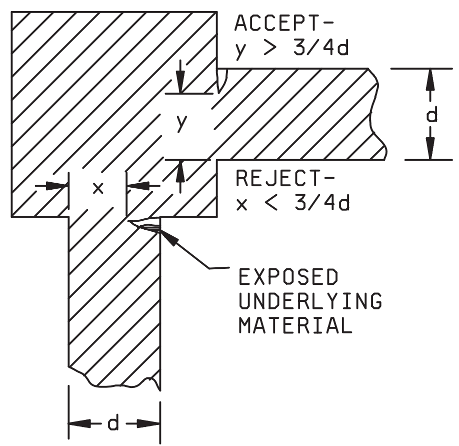


FIGURE 2032-2k. Class K metallization width reduction at bonding pad criteria.

Class H	Class K
3.1.1.1 c. Scratch that completely crosses a Metallization path and damages the surface of the surrounding passivation, glassivation, or substrate on either side.	c. Same as class H.
d. Scratches or probe marks in the bonding pad area that expose underlying material over greater than 25 percent of the original unglassivated metallization area.	d. Same as class H.
e .For capacitors only, a scratch in the metallization, other than in the bonding pad area, that exposes the dielectric material.	e. Same as class H.

Class H | Class K

3.1.1.2 Metallization voids.

Class H

a. Void(s) in the metallization, excluding bonding pads, that leaves less than 50 percent of the original metallization width undisturbed (see figure 2032-3h).

Class K

a. Same as Class H

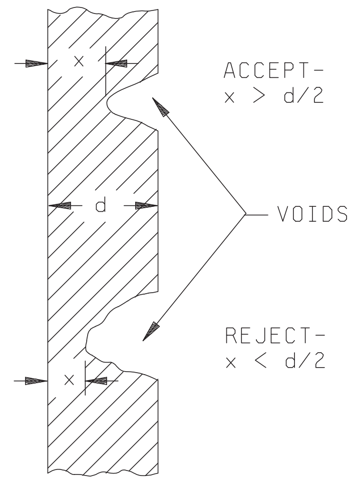


FIGURE 2032-3h. Class H metallization void criteria.

Class H

b. Void(s) in the bonding pad area that reduces the metallization path width, where it enters the bonding pad, to less than 50 percent of its original metallization width. If two or more metallization paths enter a bonding pad, each shall be considered separately.
NOTE: Figures 2032-2h and 2032-2k illustrate metallization width reduction at bonding pad criteria for scratches. Void criteria are similar.

Class K

b. Less than 75 percent

Class H	Class K
3.1.1.2 c. Void(s) 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.	3.1.1.2 c. Same as class H.
d. For capacitors only, void(s) in metallization, other than in the bonding pad area, that reduces the metallization to an extent greater than an area equivalent to 25 percent of the capacitor metallization.	d. Same as class H.
e. For interdigitated capacitors only, void(s) in the metallization that leaves less than 50 percent of the original metallization width undisturbed (see figure 2032-4h).	e. Less than 75 percent (see figure 2032-4k).

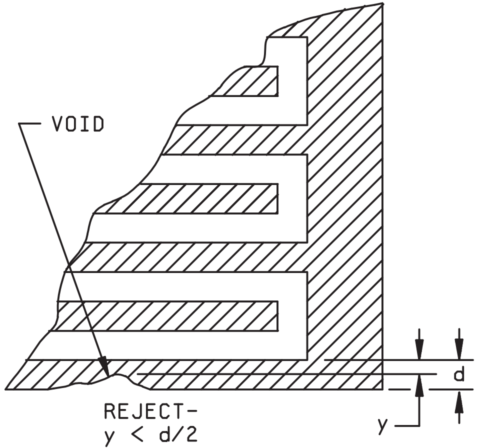


FIGURE 2032-4h. Class H interdigitated capacitor metallization void criterion.

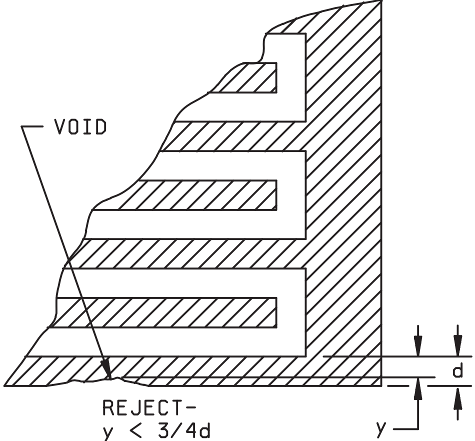


FIGURE 2032-4k. Class K interdigitated capacitor metallization void criterion.

Class H	Class K
3.1.1.3 Metallization corrosion.	
a. Any metallization corrosion.	a. Same as class H. 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.
3.1.1.4 Metallization adherence.	
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.
3.1.1.5 Metallization protrusion.	
a. Protrusion of metallization that reduces the original separation between adjacent operating metallization by greater than 50 percent (see figure 2032-5h).	a. Same as class H.

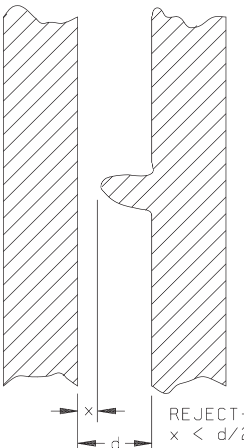


FIGURE 2032-5h. Class H operating metallization protrusion criterion.

Class H	Class K
3.1.1.5 b. For interdigitated capacitors only, protrusion of metallization that reduces the original separation by greater than 50 percent (see figure 2032-6h).	3.1.1.5 b. Same as class H.

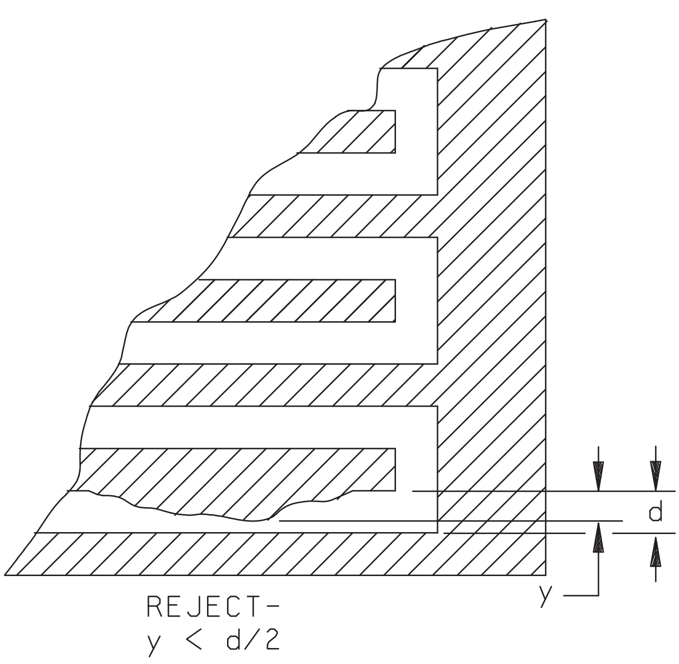


FIGURE 2032-6h. Class H interdigitated capacitor metallization protrusion criterion.

3.1.1.6 Metallization alignment.

Class H	Class K
a. A contact window that has less than 50 percent of its area covered by metallization.	a. Less than 75 percent.

Class H	Class K
3.1.1.6 b. A contact window that has less than a continuous 40 percent of its perimeter covered by metallization (see figure 2032-7h). NOTE: When, by design, metallization is completely contained in a contact window, or does not cover the entire contact perimeter, 3.1.1.6a, area coverage, or 3.1.1.6b, perimeter coverage, can be deleted as applicable provided that the design criteria are satisfied.	3.1.1.6 b. 50 percent of its perimeter (see figure 2032-7k).

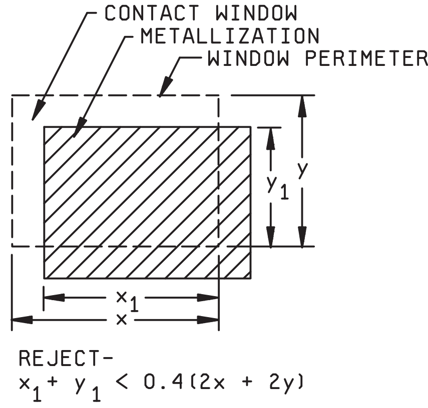


FIGURE 2032-7h. Class H metallization alignment criteria.

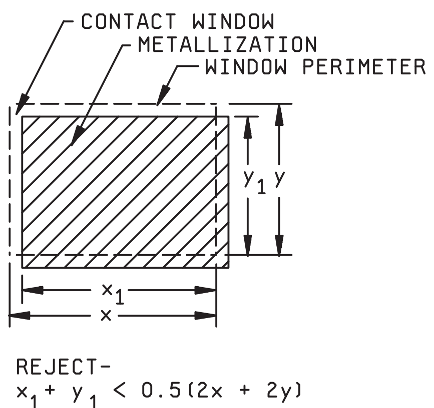


FIGURE 2032-7k. Class K metallization alignment criteria.

Class H	Class K
c. A metallization path not intended to cover a contact window that is separated from the window by less than 0.1 mil unless by design.	c. Same as Class H.
3.1.1.7 Metallization bumps or indentations.	
a. For capacitors only, a bump or indentation in the overlaying metallization.	a. Same as class H.

Class H	Class K
3.1.1.8 Metallized through-hole defects, "high magnification". No element shall be acceptable that exhibits:	
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.
3.1.1.9 Wrap-around connection defects, "high magnification". No element shall be acceptable that exhibits:	
a. Unmetallized area in the edges of wrap-around connections greater than 50 percent of the largest dimension of the edge metallization (see figure 2032-8h).	a. Same as class H.

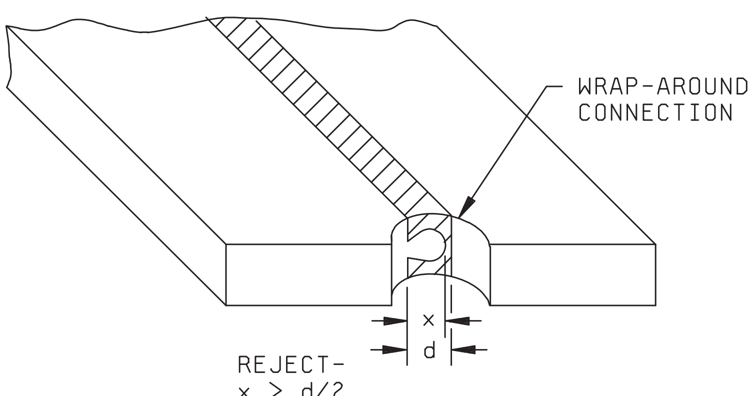


FIGURE 2032-8h. Class H wrap-around connection unmetallized area criterion.

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

a. A complete void through the via.

b. Any lifting, peeling, or blistering of the via metallization.

c. Via fill less than 75% of the total surface area of the via plug and less than 75% of the substrate thickness.

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.

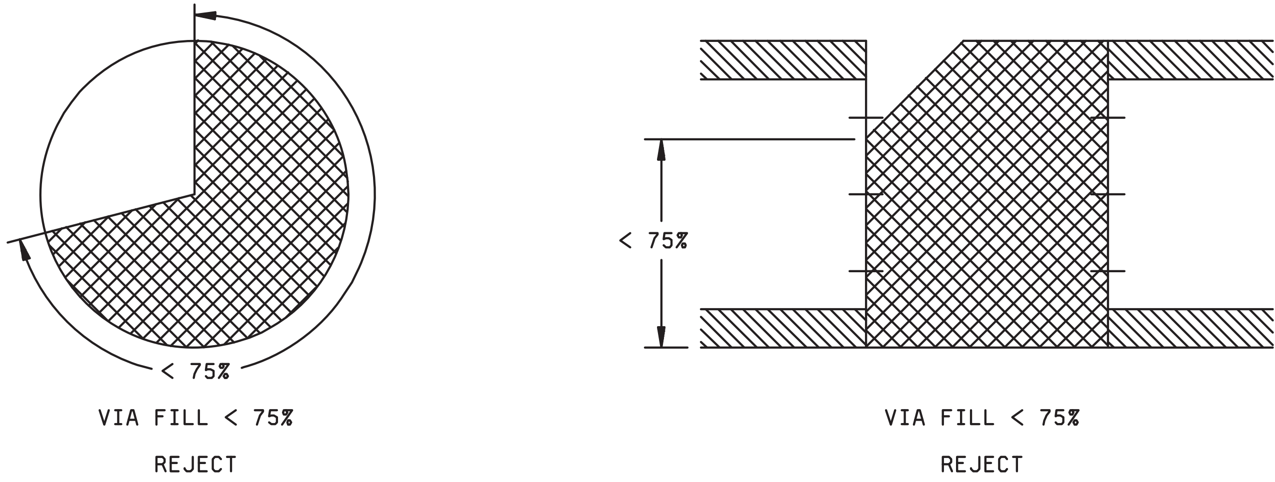


FIGURE 2032-8Bh. Classes H and K via plug fill criteria

Class H	Class K
3.1.2 Passivation defects "high magnification". No element shall be acceptable that exhibits:	
a. Either multiple lines (color fringing) or a complete absence of passivation visible at the edge and continuing under the metallization (see figure 2032-8Ah). 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.

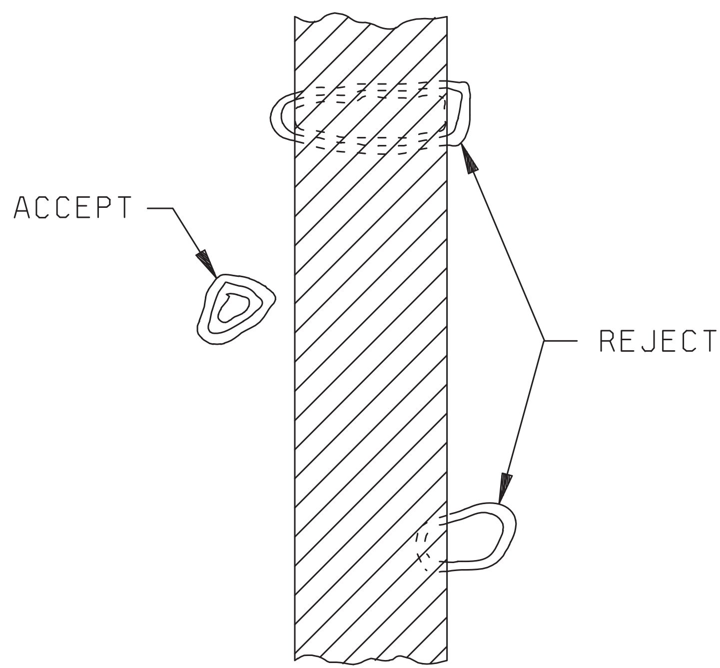


FIGURE 2032-8Ah. Class H passivation defect criteria.

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

NOTE: Criteria of 3.1.3 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 2032-9h).

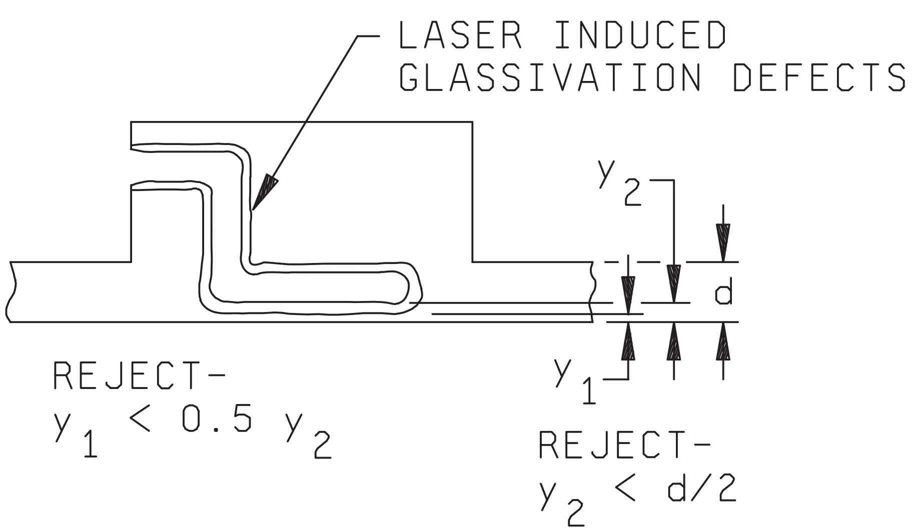


FIGURE 2032-9h. Class H laser trimmed glassivation defect criteria.

Class H	Class K
a. Glass crazing or damage that prohibits the detection of visual criteria contained herein.	a. Same as class H.

		Class H			Class K
3.1.3	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.	3.1.3	b.	Same as class H.
	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.
	d.	Unglassivated nonactive circuit areas greater than 5.0 mils in any dimension, unless by design.		d.	Same as class H.
	e.	Unglassivated areas at the edge of a bonding pad exposing the conductive substrate.		e.	Same as class H.
	f.	Glassivation covering more than 25 percent of a bonding pad area.		f.	Same as class H.
	g.	Crazing in glassivation over a resistor.		g.	Same as class H.
	h.	Misalignment of the glassivation that results in incomplete coverage of a resistor, unless by design.		h.	Same as class H.
	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.
	j.	Scratches in the glassivation that disturb metallization and bridge metallization paths.		j.	Same as class H.
	k.	Cracks (not crazing) in the glassivation that form a closed loop over adjacent metallization paths.		k.	Same as class H.

Class H	Class K
3.1.4 Substrate defects "high magnification". No element shall be acceptable that exhibits:	
a. Less than 0.1 mil of separation between the operating metallization and the edge of the element unless by design (see figure 2032-10h). NOTE: For elements containing wraparound 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 noncommon conductive surface.	a. Same as Class H.
b. A chipout that extends into the active circuit area (see figure 2032-10h).	b. Same as class H.

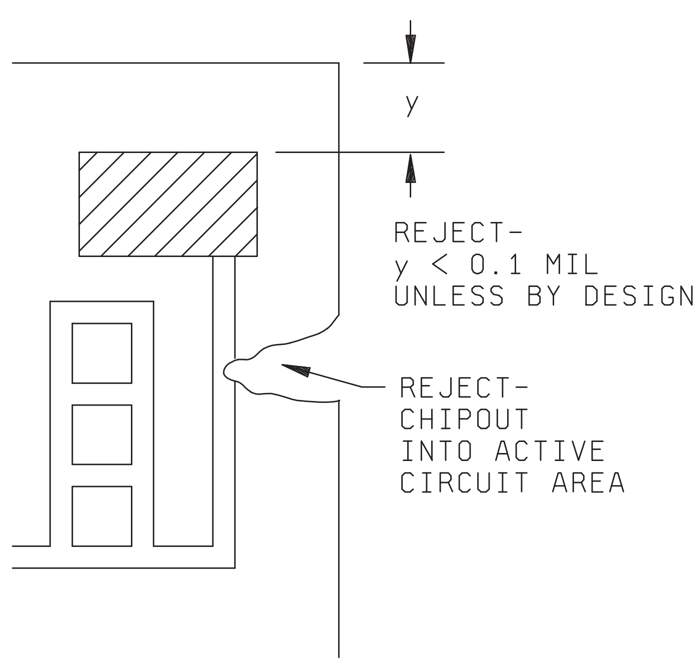


FIGURE 2032-10h. Class H separation and chipout criteria.

	Class H		Class K
3.1.4 c.	Any crack that exceeds 5.0 mils in length (see figure 2032-11h). NOTE: For fused quartz or crystalline substrates, no cracking is allowed.	3.1.4 c.	Same as Class H.
d.	Any crack that does not exhibit 0.1 mil of separation from any active circuit area or operating metallization (see figure 2032-11h).	d.	0.25 mil (see figure 2032-11k).
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 2032-11h).	e.	Same as class H.

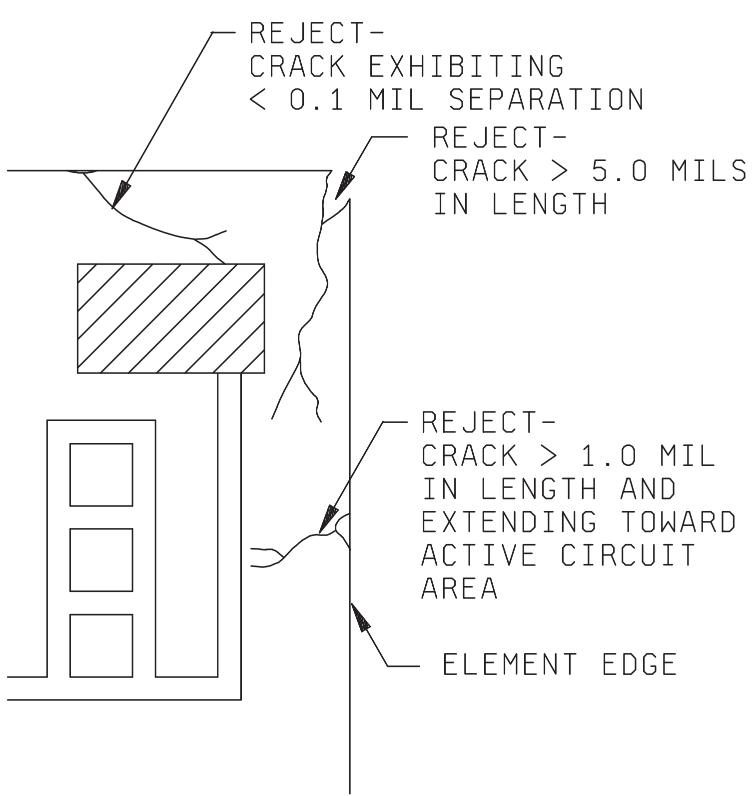


FIGURE 2032-11h. Class H crack criteria.

	Class H		Class K
3.1.4	f. N/A	3.1.4	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 2032-12k).

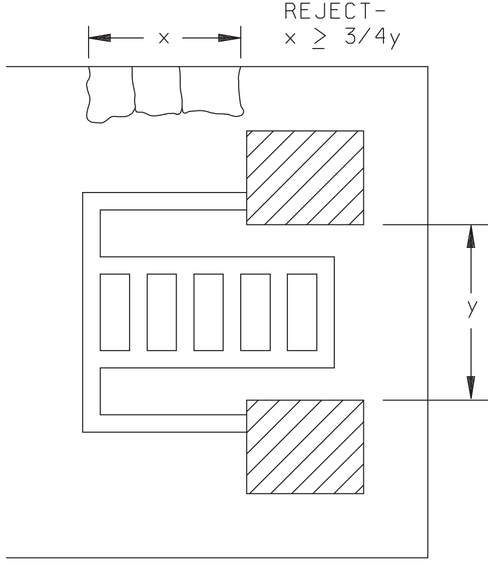


FIGURE 2032-12k. Class K semicircular crack criterion.

Class H	Class K
g. An attached portion of an active circuit area from an adjacent element.	g. Same as class H.
h. Any crack that does not originate at an edge.	h. Same as class H.
i. Holes through the substrate, unless by design.	i. Same as class H.

Class H	Class K
3.1.5 Foreign material defects "low magnification". No element shall be acceptable that exhibits:	
a. For mounted elements, unattached, conductive foreign material on the surface of the elements. For unmounted elements, unattached, conductive foreign material on the surface of the element that is large enough to bridge operating metallization paths, active circuitry, or any combination of these. NOTE: If an element has an insulating layer (such as glassivation or self-passivation) that covers operating metallization paths, active circuitry, or any combination of these, then the presence of unattached, conductive foreign material, that is large enough to bridge these features, is acceptable since the features are protected by the insulating layer. NOTE: All foreign material shall be considered to be unattached unless otherwise verified to be attached. Verification of attachment shall be accomplished by a light touch with an appropriate mechanical device (i.e., needle, probe, pick, etc.), or by a suitable cleaning process approved by the acquiring activity, or by a blow-off with a nominal gas blow (approximately 20 psig). NOTE: Removal of unattached foreign material may be attempted using the techniques for verification of attachment discussed above. NOTE: Semiconductor particles are considered to be foreign material.	a. Same as class H.
b. Attached, conductive foreign material that bridges metallization paths, active circuitry, or any combination of these.	b. Same as class H.
c. Liquid droplets, ink drops, or chemical stains that appear to bridge any unglassivated or unpassivated active circuit areas.	c. Same as class H.
d. Attached foreign material that covers greater than 25 percent of a bonding pad area.	d. Same as class H.

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

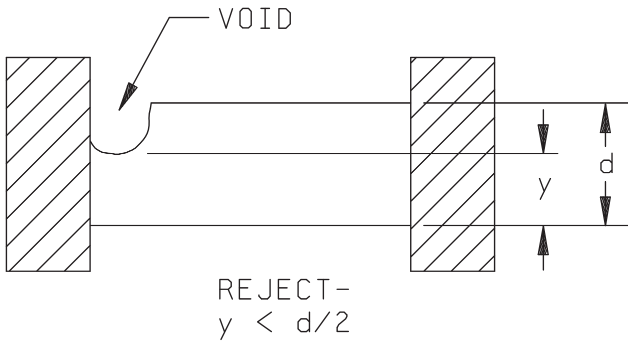


FIGURE 2032-13h. Class H film resistor width reduction at terminal by voids criterion.

Class H	Class K
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.

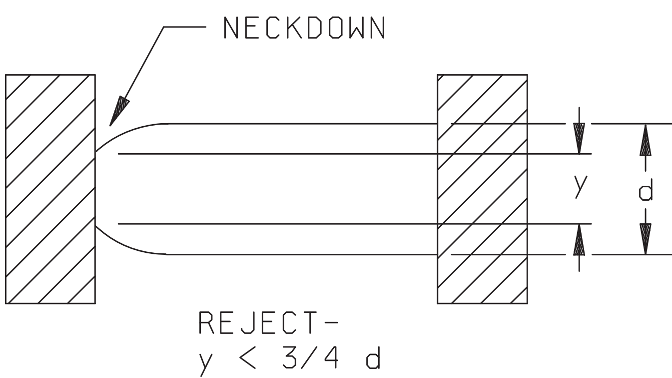


FIGURE 2032-14h. Class H film resistor width reduction at terminal by necking criterion.

Class H			Class K		
3.1.6	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 nonuniform or mottled color anywhere in the resistor, is not cause for rejection.	3.1.6	c.	Same as class H.
	d.	Any resistor film lifting, peeling or blistering.		d.	Same as class H.
	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.

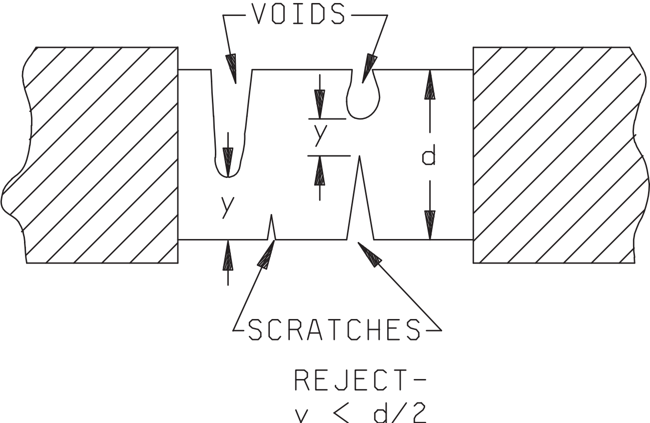


FIGURE 2032-15h. Class H resistor width reduction by voids and scratches criteria.

		Class H			Class K
3.1.6	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).	3.1.6	f.	Same as Class H.

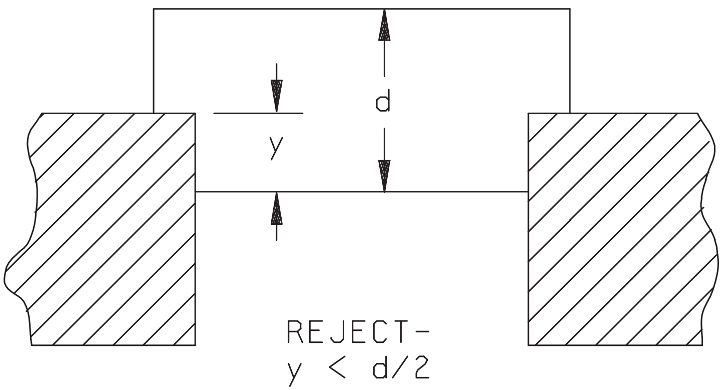


FIGURE 2032-16h. Class H metal/resistor overlap criterion.

	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.

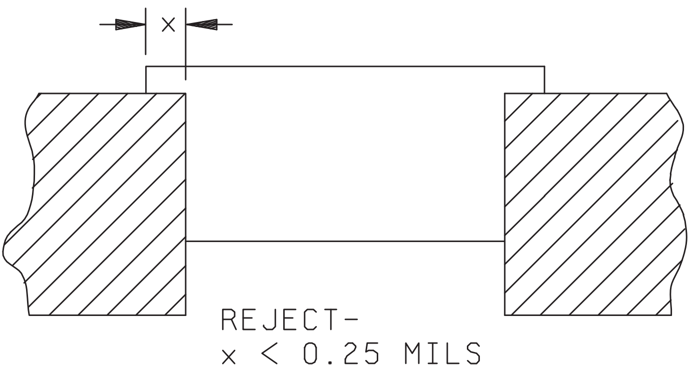


FIGURE 2032-17h. Class H contact overlap criterion.

		Class H			Class K
3.1.6	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).	3.1.6	h.	Same as class H.

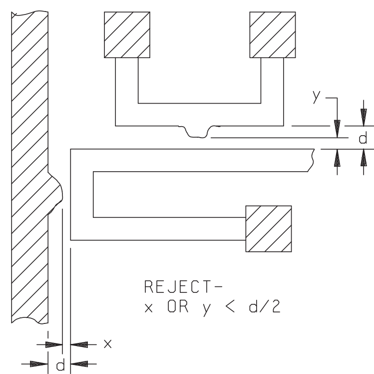


FIGURE 2032-18h. Class H resistor separation criteria.

		Class H			Class K
	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.

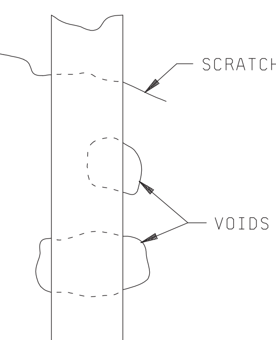
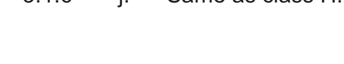


FIGURE 2032-19h. Class H substrate irregularity criterion.

	Class H		Class K
3.1.6 j.	Any increase in resistor width of a block resistor greater than 25 percent of the original resistor width (see figure 2032-20h).	3.1.6 j.	Same as class H.



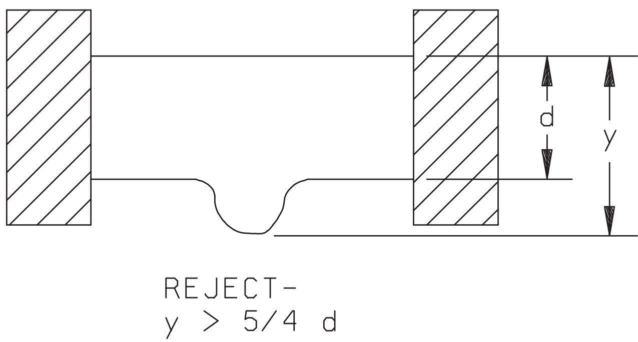


FIGURE 2032-20h. Class H resistor width increase criterion.

	Class H		Class K
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 criteria applies to protrusion of resistor material resulting from a photo-lithographic defect.	k.	Same as class H.

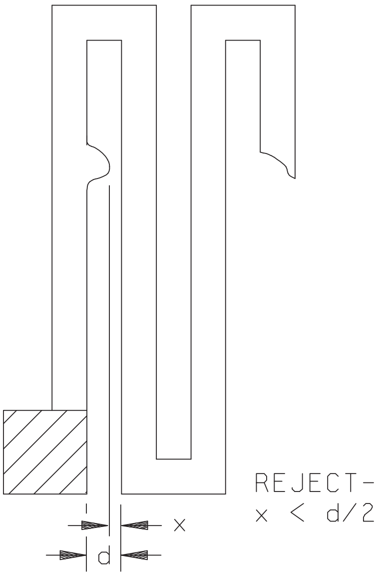


FIGURE 2032-21h. Class H protusion of resistor material criterion.

Class H	Class K
3.1.6 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).	3.1.6 l. Same as class H.

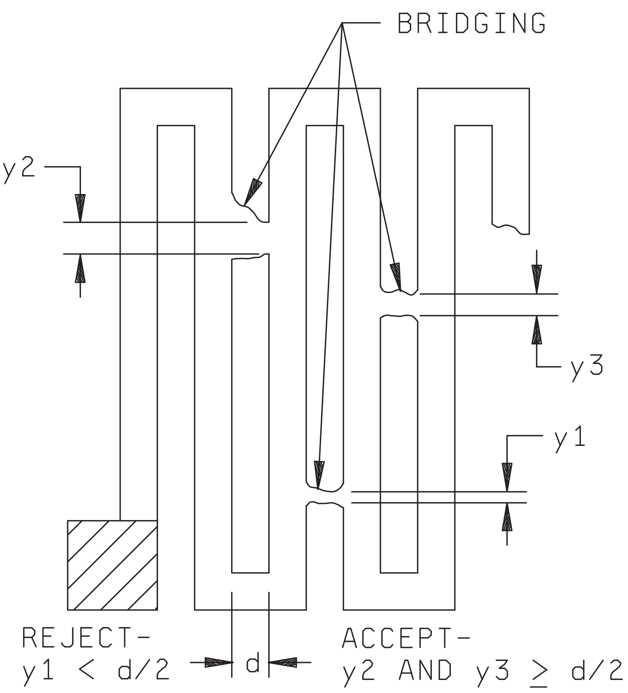


FIGURE 2032-22h. Class H bridging of resistor material criteria.

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
3.1.7	a. A kerf width less than 0.1 mil (see figure 2032-23h). NOTE: This does not apply to edge trimming.	3.1.7 a. Same as class H.

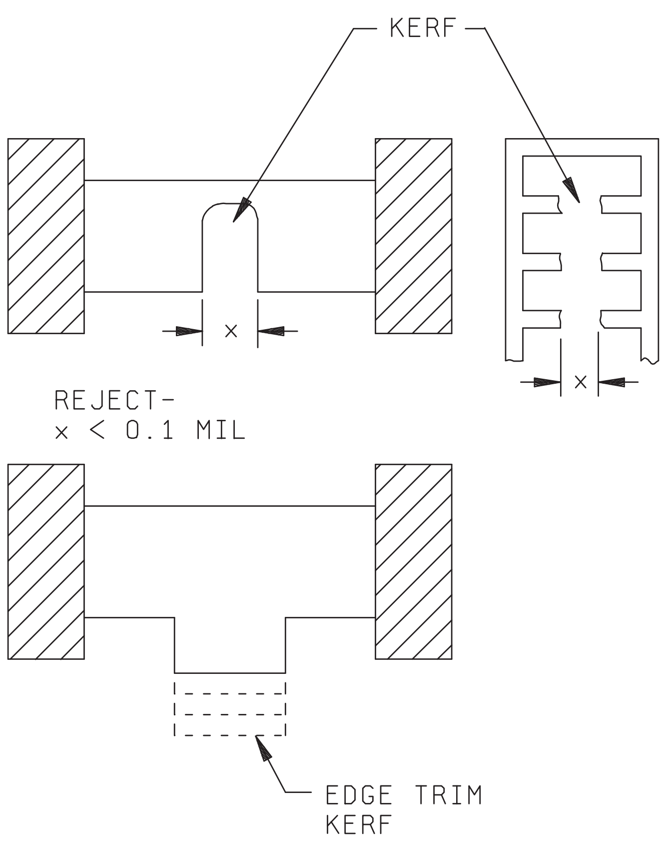


FIGURE 2032-23h. Class H kerf width criteria.

Class H	Class K
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 3.1.5a (see figure 2032-24h). NOTE: This does not apply to edge trimming.	b. Same as class H.

Class H | Class K

3.1.7 b. (Continued.)

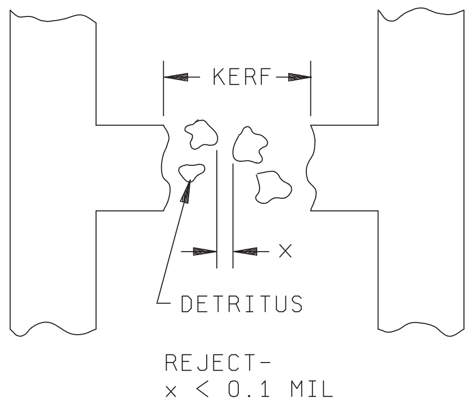


FIGURE 2032-24h. Class H detritus criterion for self-passivating resistor materials.

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 mil in width; otherwise, the element shall be rejected.

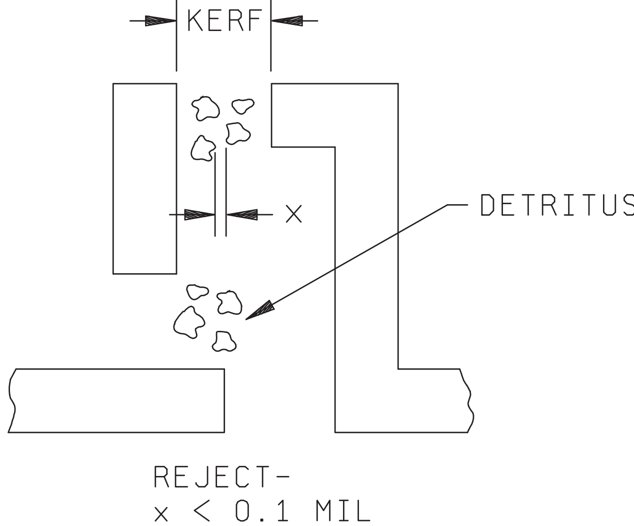


FIGURE 2032-25h. Class H resistor loop element detritus criterion for self-passivating resistor materials.

Class H	Class K
3.1.7 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.	3.1.7 c. Same as class H.

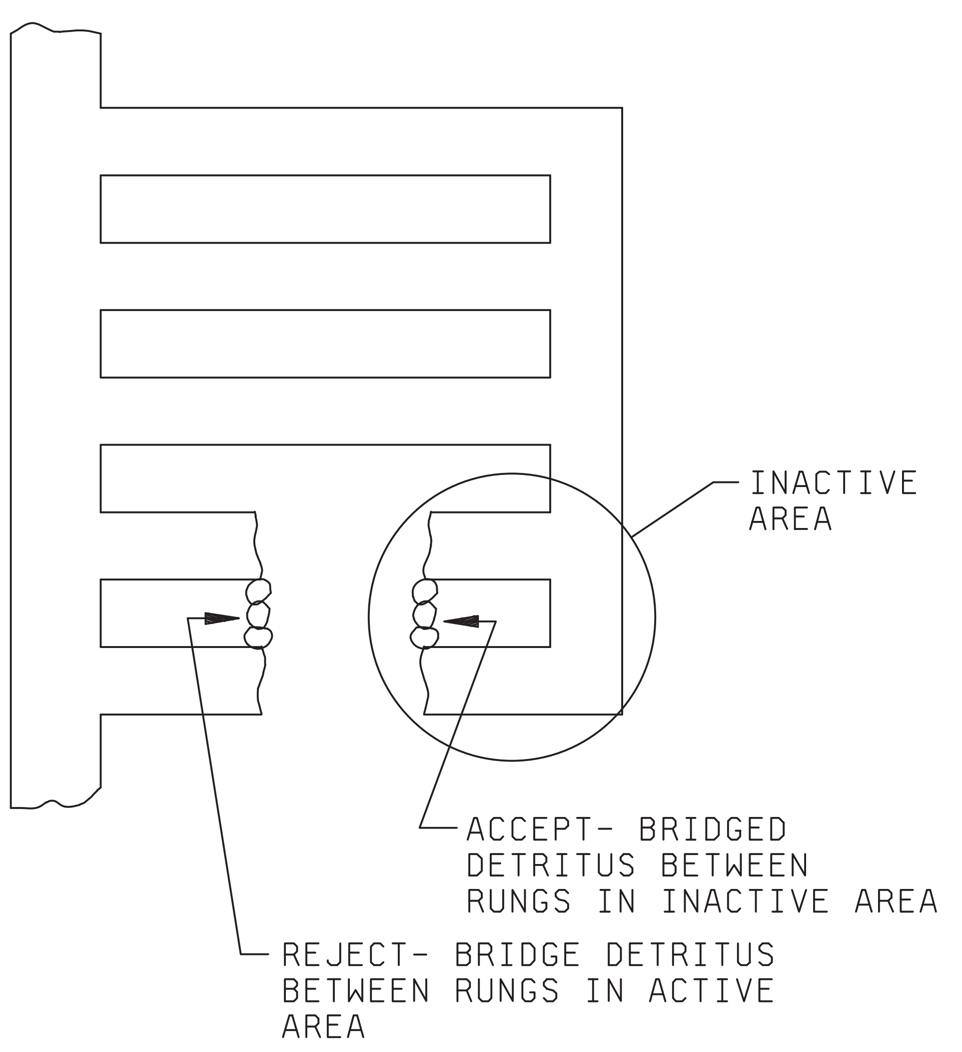


FIGURE 2032-26h. Bridging of detritus between rungs in the active area of a resistor ladder structure criterion.

	Class H		Class K
3.1.7 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.	3.1.7 d.	Same as class H.

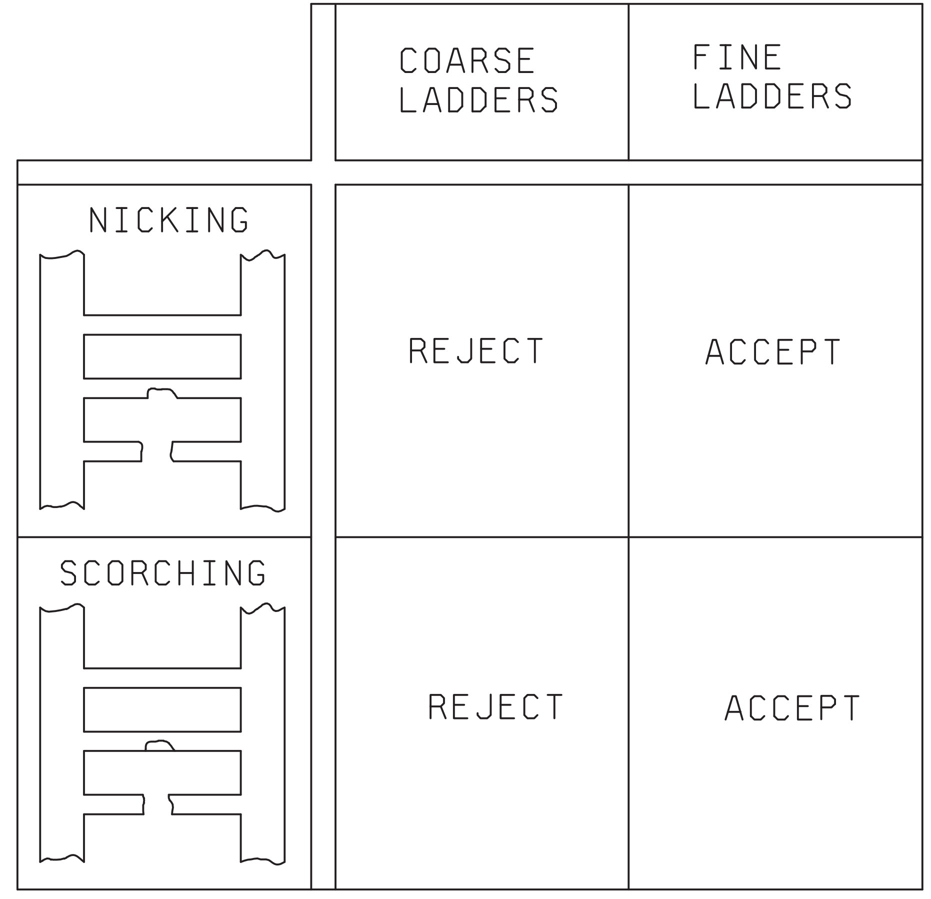


FIGURE 2032-27h. Class H resistor ladder structure nicking and scorching criteria exceptions.

Class H | Class K

3.1.7 d. (Continued.)
NOTE: This criteria does not apply to the second rung of a resistor loop since the second rung is inactive. This criteria 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.

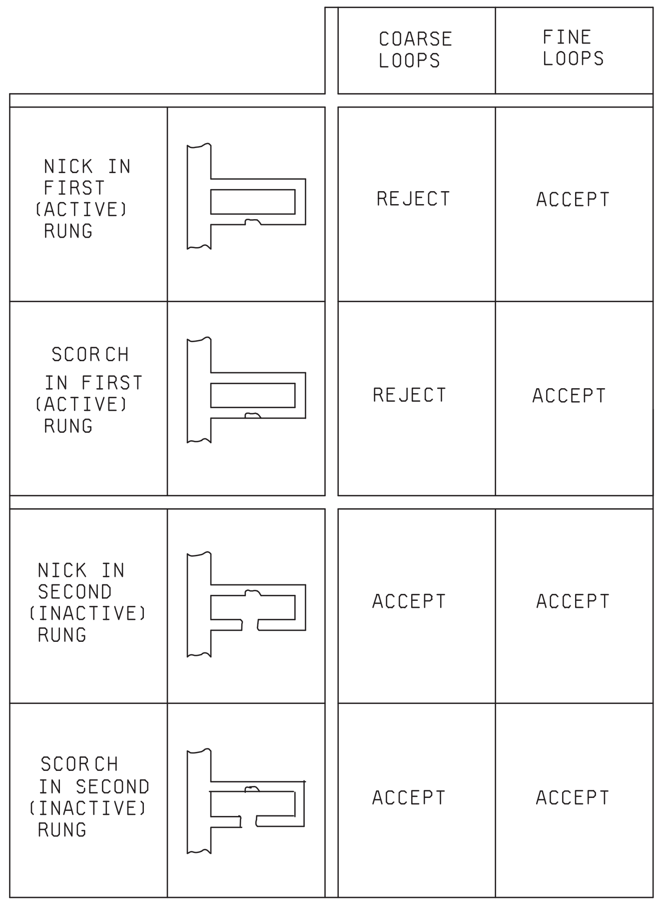


FIGURE 2032-28h. Class H resistor loop nicking and scorching criteria exceptions.

		Class H	Class K
3.1.7	d.	(Continued.) NOTE: This criterion does not apply to the last rung of a resistor ladder if the last rung is inactive (see figure 2032-29h).	

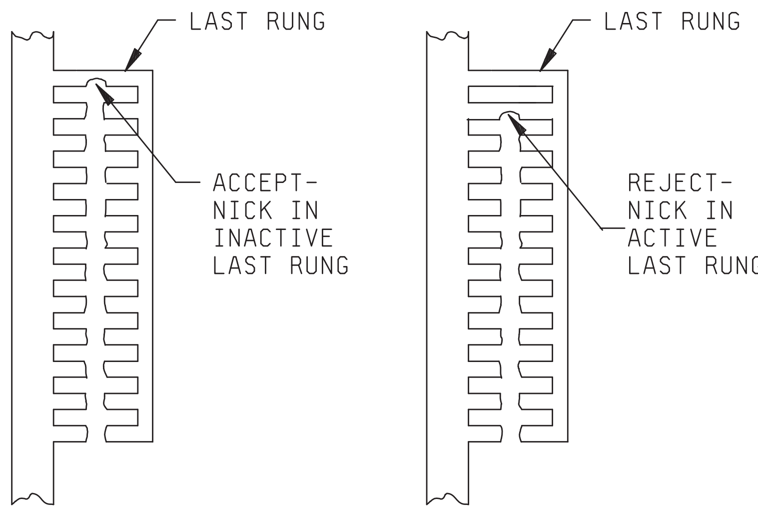


FIGURE 2032-29h. Class H laser nicking criteria exception for the last rung of a resistor ladder.

		Class H	Class K
	e.	A kerf or scorch which extends into a resistor ladder sidebar (see figure 2032-30h).	e. Same as class H.

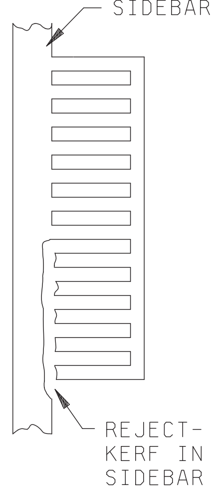


FIGURE 2032-30h. Class H resistor ladder sidebar trim criterion.

Class H	Class K
3.1.7 f. Kerf or scorch misalignment (see figure 2032-31h).	3.1.7 f. Same as class H.

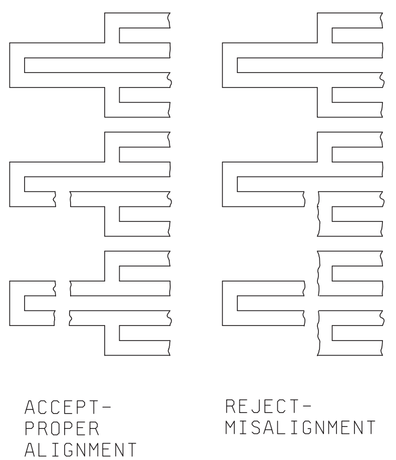


FIGURE 2032-31h. Class H laser trim misalignment criteria.

Class H	Class K
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.

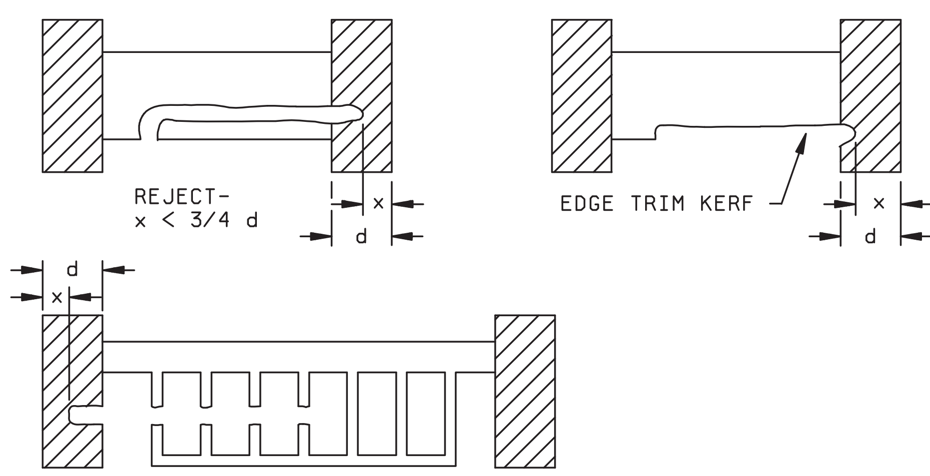


FIGURE 2032-32h. Class H laser trim kerf extension into metallization criteria.

Class H	Class K
3.1.7 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).	3.1.7 h. Same as class H.

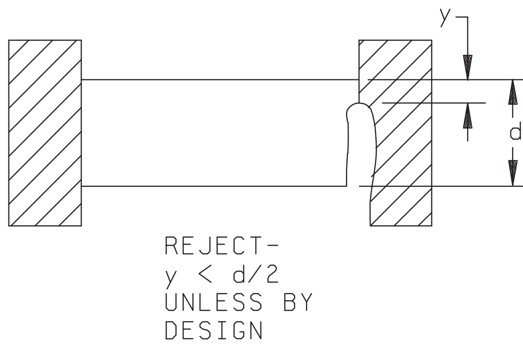


FIGURE 2032-33h. Class H resistor width reduction at metallization interface criteria.

Class H	Class K
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.

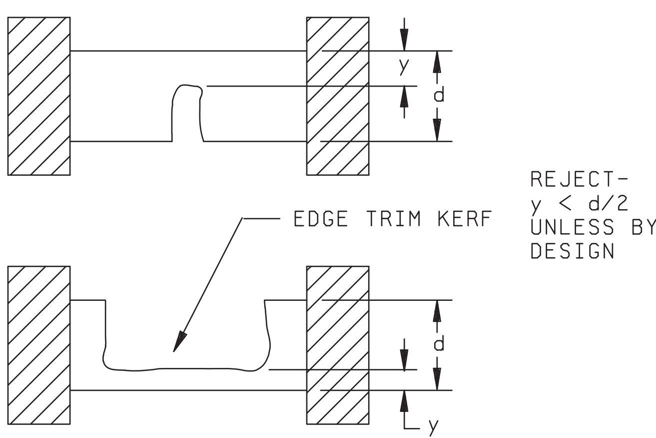


FIGURE 2032-34h. Class H resistor width reduction by trimming criteria.

Class H	Class K
3.1.7 j. A 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 criteria. PRECAUTIONARY NOTE: The maximum allowable current density requirement shall not be exceeded.	3.1.7 j. Same as class H.

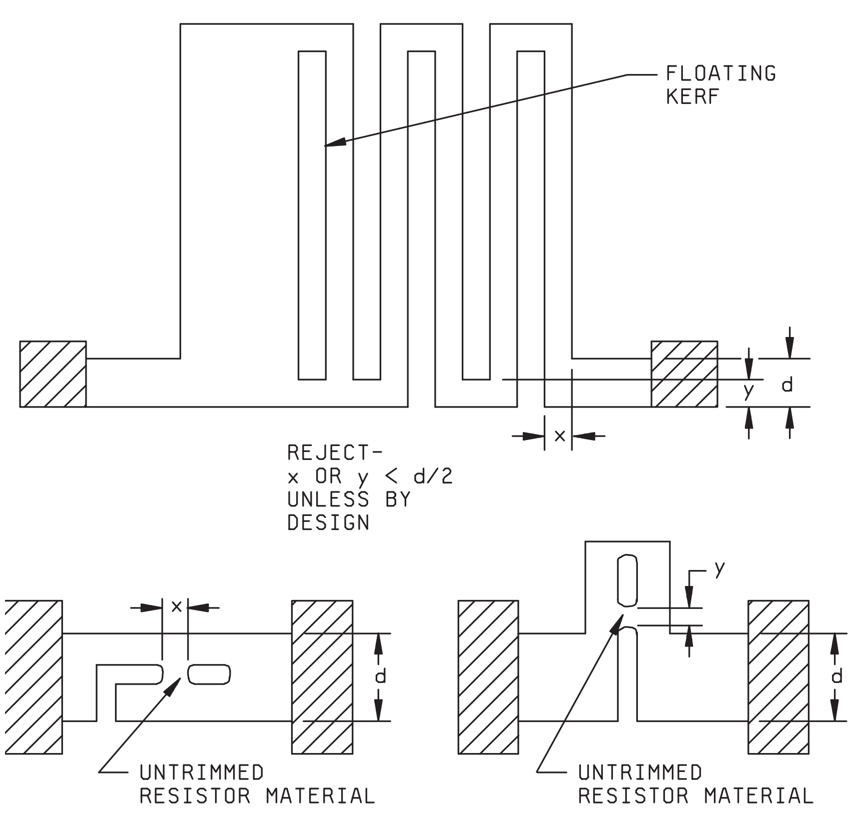


FIGURE 2032-35h. Class H resistor width reduction and untrimmed resistor material criteria.

Class H	Class K
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.

Class H	Class K

3.1.7 k. (Continued.)

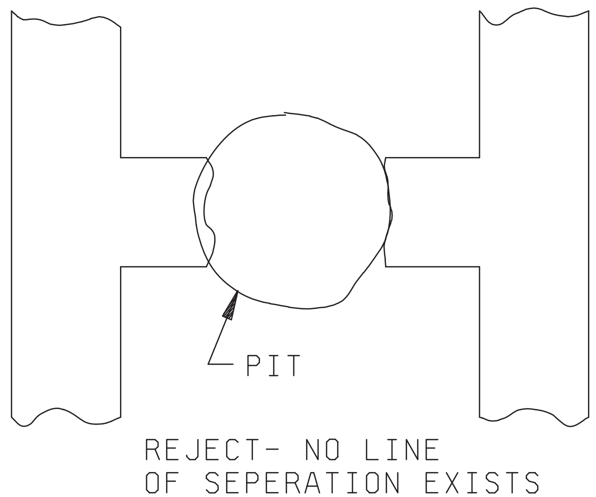


FIGURE 2032-36h. Class H laser trim pitting criterion.

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

Class H	Class K
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.

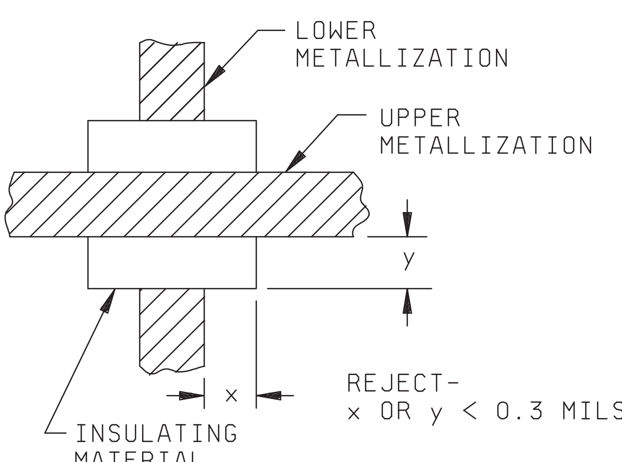
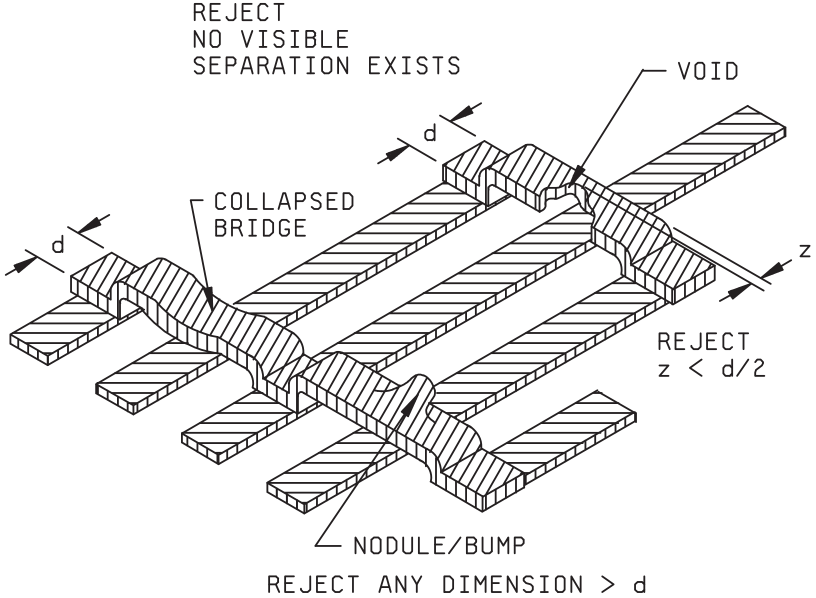


FIGURE 2032-37h. Class H insulating material extension criteria.

		Class H			Class K
3.1.8	b.	Voids in the insulating material.	3.1.8	b.	Same as class H.
	c.	A bump or indentation in the upper (overlaying) metallization. NOTE: This criteria is not applicable to coupling (air) bridges.		c.	Same as class H.
	d.	Scratch that completely crosses the metallization and damages the insulating material surface on either side.		d.	Same as class H.

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

	Class H		Class K
a.	A void in the coupling (air) bridge metallization that leaves less than 50 percent of the original metallization width undisturbed. (See figure 2032-37Ah).	a.	Same as class H.
b.	Nodules or bumps that are greater, in any dimension, than the original coupling (air) bridge metallization width. (See figure 2032-37Ah).	b.	Same as class H.
c.	Coupling (air) bridge that contacts under-lying operating metallization. (See figure 2032-37Ah).	c.	Same as class H.
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.
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 2032-37Ah).	e.	Same as class H.
f.	Coupling (air) bridge metallization overhang over adjacent operating metallization, not intended by design, that does not exhibit a visible separation. (See figure 2032-37Ah).	f.	Same as class H.
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.



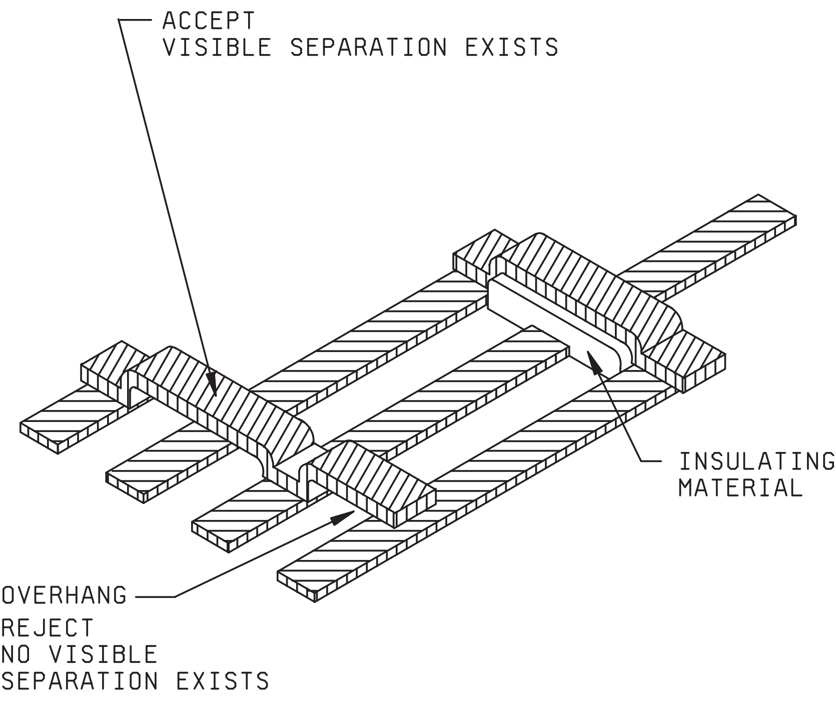


FIGURE 2032-37Ah. Class H and class K coupling (air) bridge criteria.

3.2 Planar thick film element inspection. Inspection for visual defects described in this section shall be conducted on each planar thick film passive element. All inspection shall be performed at "low magnification" within the range of 10X to 60X magnification for both class H and class K.

Class H	Class K
3.2.1 Operating metallization defects "low magnification". No element shall be acceptable that exhibits: NOTE: The metallization defect criteria contained in this section apply to operating metallization only.	
3.2.1.1 Metallization scratches	
a. A scratch or probe mark 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 figure 2032-38h). NOTE: Underlying material does not have to be exposed along the full length of the scratch. NOTE: This criteria does not apply to capacitors.	a. Same as Class H.

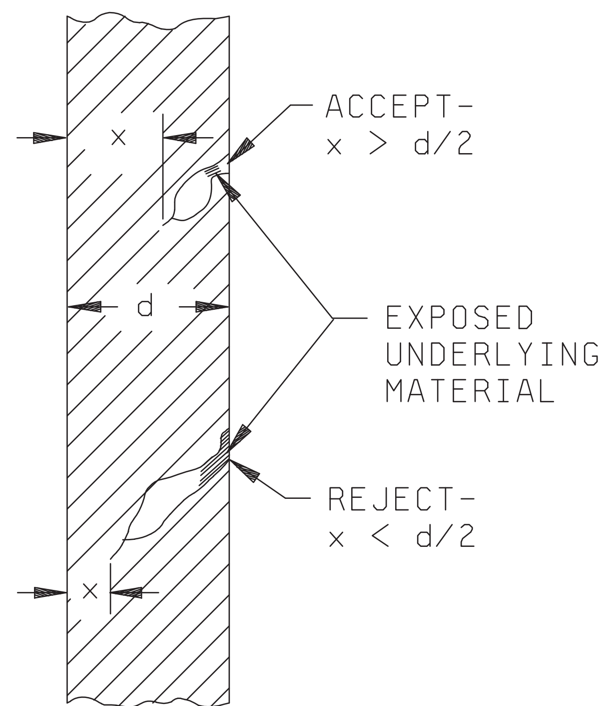


FIGURE 2032-38h. Class H metallization scratch criteria.

	Class H		Class K
3.2.1.1 b.	Scratch in the bonding pad area that both exposes underlying material and reduces the metallization path width, where it enters the bonding pad, to less than 50 percent its original metallization width. If two or more metallization paths enter a bonding pad, each shall be considered separately (see figure 2032-39h).	3.2.1.1 b.	Less than 75 percent (see figure 2032-39k).

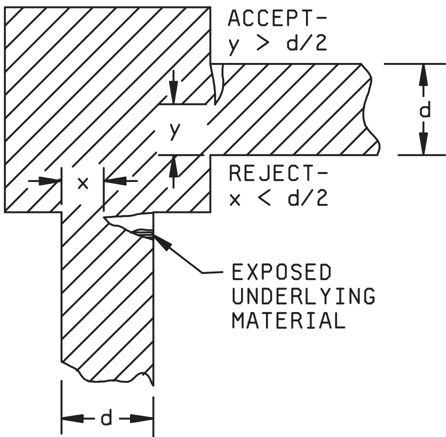


FIGURE 2032-39h. Class H metallization width reduction at bonding pad criteria.

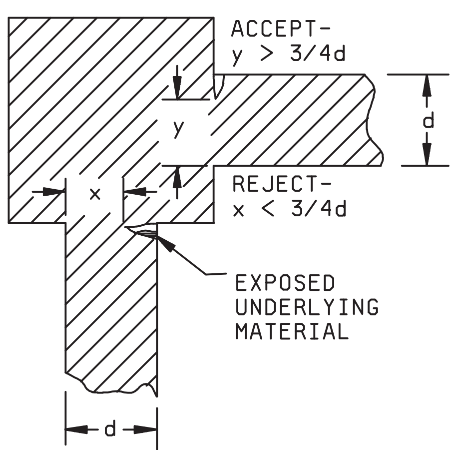


FIGURE 2032-39k. Class K metallization width reduction at bonding pad criteria.

	Class H		Class K
c.	Scratch or probe marks in the bonding pad area that expose underlying material over more than 25 percent of the original metallization area.	c.	Same as class H

Class H	Class K

3.2.1.2 Metallization voids.

Class H	Class K
a. Void(s) in the metallization, excluding bonding pads, that leaves less than 50 percent of the original metallization width undisturbed (see figure 2032-40h).	a. Same as Class H.

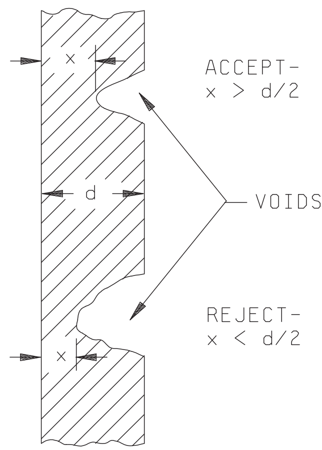


FIGURE 2032-40h. Class H metallization void criteria.

Class H	Class K
b. Void(s) in the bonding pad area that reduces the metallization path width, where it enters the bonding pad, to less than 50 percent of its original metallization width. If two or more metallization paths enter a bonding pad, each shall be considered separately. NOTE: Figures 2032-39h and 2032-39k illustrate metallization width reduction at bonding pad criteria for scratches. Void criteria are similar.	b. Less than 75 percent.
c. Void(s) in the bonding pad area that expose underlying material over more than 25 percent of the original 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.	c. Same as class H.

Class H	Class K
3.2.1.3 Metallization corrosion.	
a. Any metallization corrosion.	a. Same as class H.
3.2.1.4 Metallization adherence.	
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 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.
3.2.1.5 Metallization protrusion.	
a. More than 50 percent reduction of the original design separation, between any protruding metallization and adjacent metallization paths (see figure 2032-41h).	a. Same as class H.

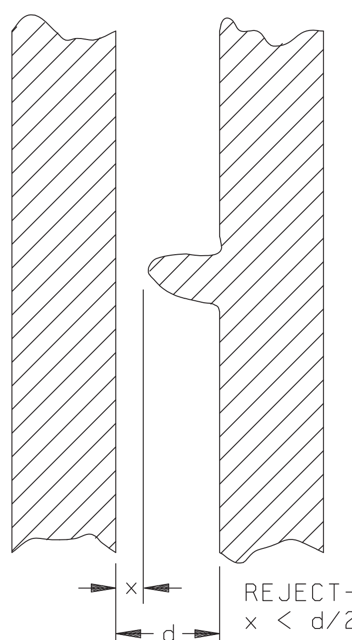


FIGURE 2032-41h. Class H metallization protrusion criterion.

Class H	Class K
3.2.1.6 Metallization overlap.	
a. Contact overlap between the upper and lower metallizations that is less than 50 percent of the designed contact overlap area (see figure 2032-42h). NOTE: The overlap area is that area in which the upper metallization actually contacts the lower metallization.	a. Same as class H.

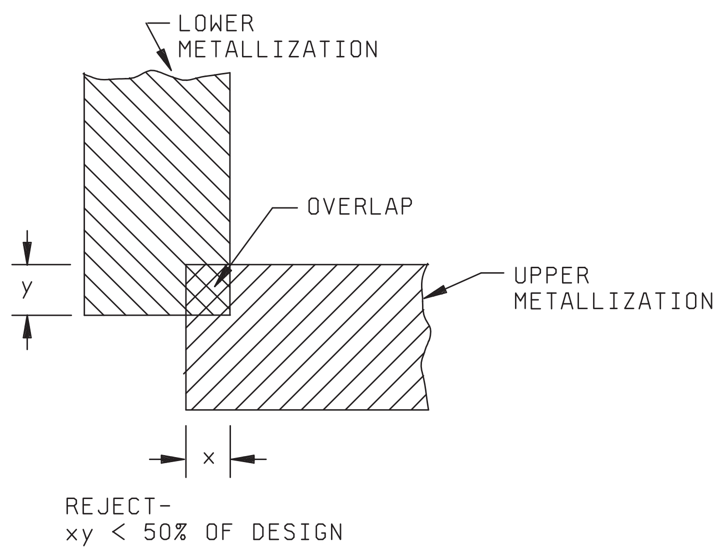


FIGURE 2032-42h. Class H metallization overlap criterion.

Class H	Class K
3.2.1.7 Metallized through-hole defects, "low magnification". No element shall be acceptable that exhibits:	
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.
3.2.1.8 Wrap-around connection defects, "low magnification". No element shall be acceptable that exhibits:	
a. Unmetallized area in the edges of wrap-around connections greater than 50 percent of the largest dimension of the edge metallization (see figure 2032-43Ah).	a. Same as class H.

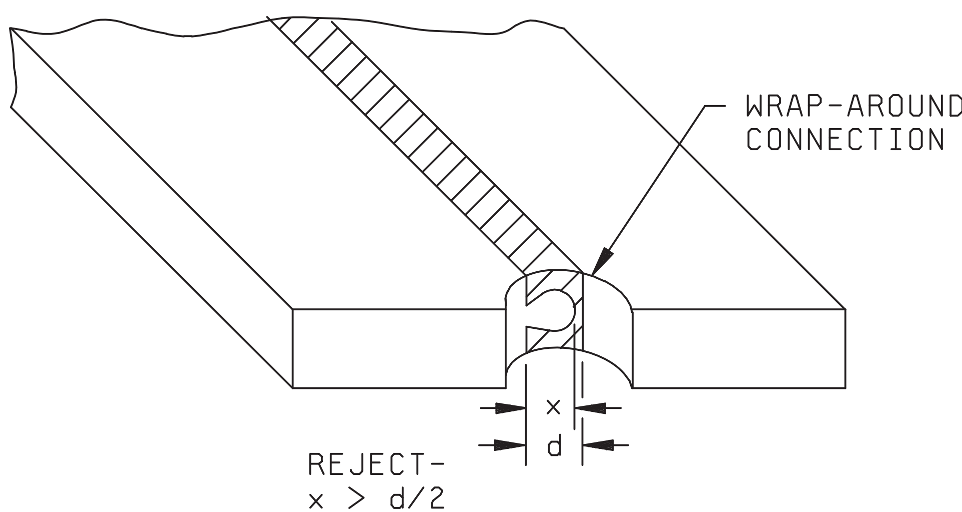


FIGURE 2032-43Ah. Class H wrap-around connection unmetallized area criterion.

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

a. A complete void through the via.

b. Any lifting, peeling, or blistering of the via metallization.

c. Via fill less than 75% of the total surface area of the via plug and less than 75% of the substrate thickness.

NOTE: These are minimum requirements. Via flatness and other requirements shall be in accordance with the applicable detail drawings.

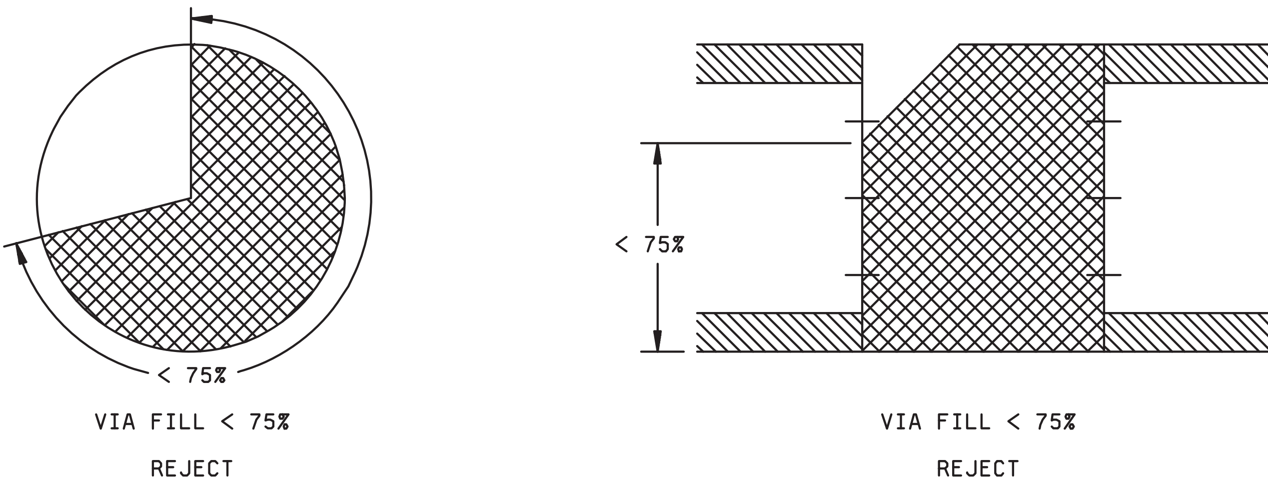


FIGURE 2032-43Bh. Classes H and K via fill criteria.

Class H	Class K

3.2.2 Substrate defects, "low magnification".
No element shall be acceptable that exhibits:

Class H	Class K
a. Less than 1.0 mil separation between the operating metallization and the edge of the element unless by design (see figure 2032-43h). NOTE: This criterion does not apply to substrates designed for wraparound conductors.	a. Same as class H.
b. A chipout that extends into the active circuit area (see figure 2032-43h).	b. Same as class H.

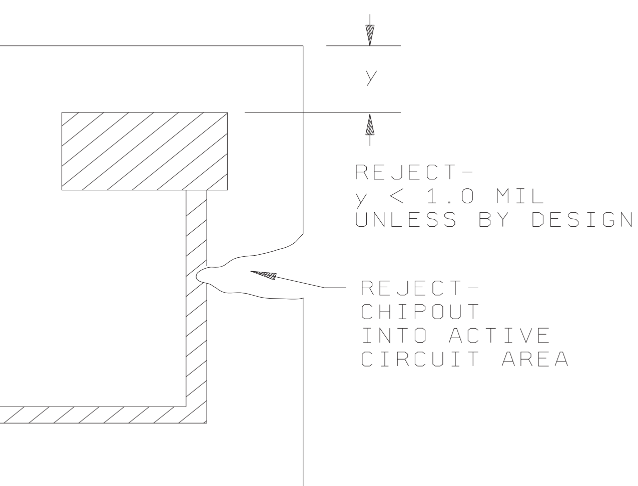


FIGURE 2032-43h. Class H separation and chipout criteria.

Class H	Class K
c. Any crack that exceeds 5.0 mils in length (see figure 2032-44h). NOTE: For fused quart or crystalline substrates, no cracking is allowed.	c. Same as Class H.
d. Any crack that does not exhibit 1.0 mil of separation from any active circuit area or operating metallization (see figure 2032-44h).	d. Same as class H.

<u>Class H</u>

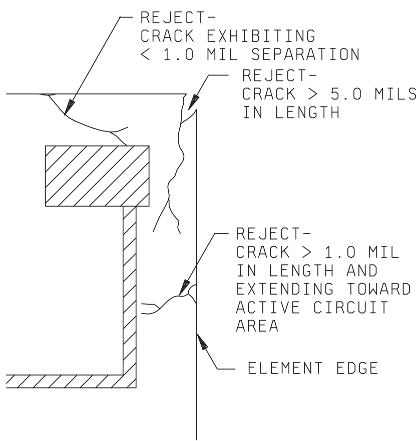


FIGURE 2032-44h. <u>Class H additional crack criteria</u>.

3.2.2 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 2032-44h).

f. N/A

<u>Class K</u>

3.2.2 e. Same as class H.

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 2032-45k).

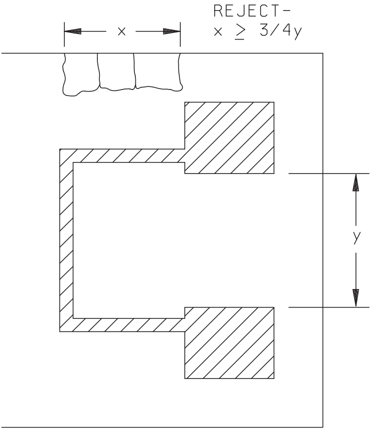


FIGURE 2032-45k. <u>Class K semicircular crack criterion</u>.

Class H		Class K
3.2.2 g.	An attached portion of a circuit area from an adjacent element.	3.2.2 g. Same as class H.
h.	Any crack that does not originate at an edge.	h. Same as class H.
i.	Holes through the substrate, unless by design.	i. Same as class H.
j.	Patterned substrates having a section broken out around a substrate mounting hole (intended for substrate-to-post attachment) that is greater than 25 percent of the mounting hole circumference.	j. Same as class H.

Class H	Class K
3.2.3 Thick film resistor defects, "low magnification". No element shall be acceptable that exhibits:	
a. A reduction of the resistor at the terminal due to voids to less than 50 percent of the original resistor width (see figure 2032-46h).	a. Same as Class H.

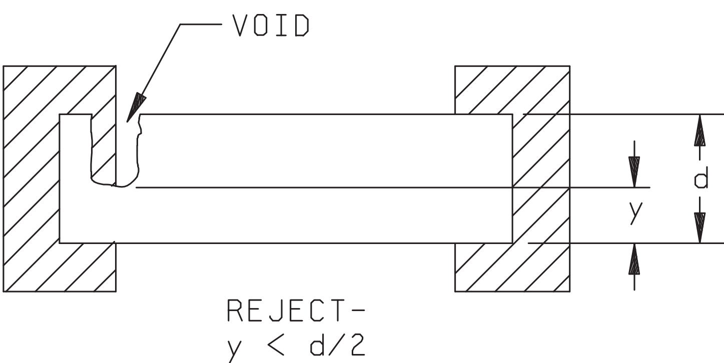


FIGURE 2032-46h. Class H resistor width reduction at terminal caused by voids criterion.

Class H	Class K
b. Reduction of the resistor at the terminal, due to neckdown less than 50 percent, to of the original resistor width (see figure 2032-47h).	b. Same as Class H.

Class H	Class K

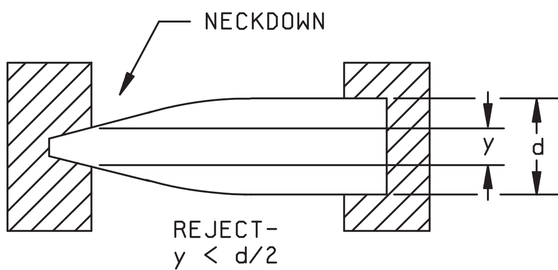


FIGURE 2032-47h. Class H resistor width reduction at terminal by neckdown criterion.

Class H			Class K		
3.2.3	c.	Any resistor film lifting, peeling, or blistering.	3.2.3	c.	Same as class H.
	d.	Crack in the resistor greater than 1.0 mil in length. NOTE: Irregularities such as fissures in resistor material that are created during firing, and that do not expose the underlying material, are not considered to be cracks.		d.	Same as class H.
	e.	Evidence of resistor repair by overprinting or any other means.		e.	Same as class H.
	f.	Separation between any two resistors that is less than 50 percent of the original separation.		f.	Same as class H.
	g.	Separation between any resistor and conductor combination that is less than 50 percent of the original separation.		g.	Same as class H.
	h.	Increase in resistor width greater than 25 percent of the original design width.		h.	Same as class H.
	i.	Resistor that is closer than 1.0 mil to the edge of the substrate.		i.	Same as class H.

		Class H			Class K
3.2.3	j.	Reduction of resistor width resulting from voids, scratches, or chipouts, or a combination of these, that leaves less than 50 percent of the narrowest resistor width (see figure 2032-48h). PRECAUTIONARY NOTE: The maximum allowable current density requirement shall not be exceeded.	3.2.3	j.	Same as class H.

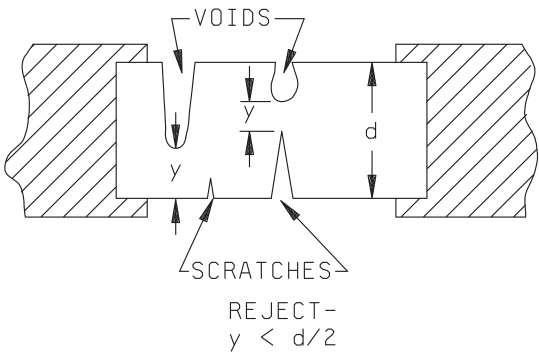


FIGURE 2032-48h. Class H resistor width reduction criteria.

		Class H			Class K
	k.	Contact overlap between the metallization and the resistor in which the actual width dimension "y" is less than 50 percent of the original resistor width (see figure 2032-49h).		k.	Less than 75 percent (see figure 2032-49k).

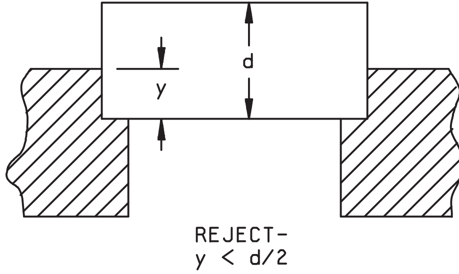


FIGURE 2032-49h. Class H resistor overlap criterion.

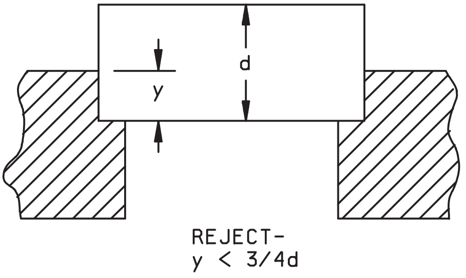


FIGURE 2032-49k. Class K resistor overlap criterion.

	Class H		Class K
3.2.3 l.	Contact overlap between the metallization and the resistor in which the length dimension "x" is less than 3.0 mils (see figure 2032-50h).	3.2.3 l.	Same as class H.

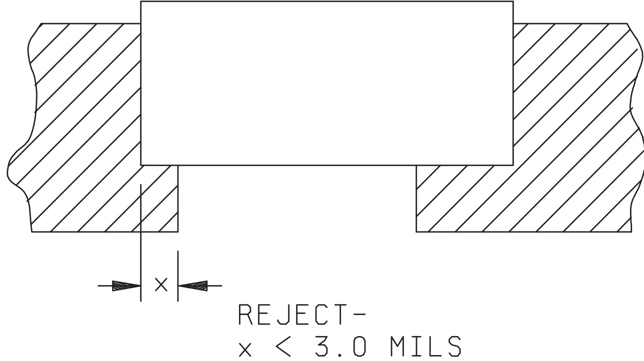


FIGURE 2032-50h. Resistor overlap criterion.

	Class H		Class K
m.	Voids or misalignment of glassivation that results in less than 90 percent coverage of the resistor area, unless by design.	m.	Same as class H.
n.	Crazing of glassivation over a resistor.	n.	Same as class H.
o.	Glassivation scratches, lifting, or peeling that expose any portion of a resistor.	o.	Same as class H.

Class H	Class K
3.2.4 Trimmed thick film resistor defects, "low magnification". No element shall be acceptable that exhibits: NOTE: The trim defect criteria contained in this section apply to active resistor areas only.	
a. A kerf width less than 0.5 mil (see figure 2032-51h). NOTE: This does not apply to edge trimming.	a. Same as class H.

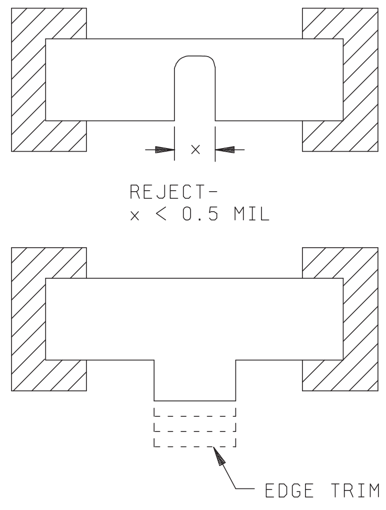


FIGURE 2032-51h. Class H kerf width criteria.

Class H	Class K
b. A kerf containing detritus.	b. Same as class H.
c. A kerf which extends into metallization and leave less than 75 percent of the metallization width undisturbed (see figure 2032-52h). NOTE: Opening a metallization link by design is acceptable.	c. Same as class H.

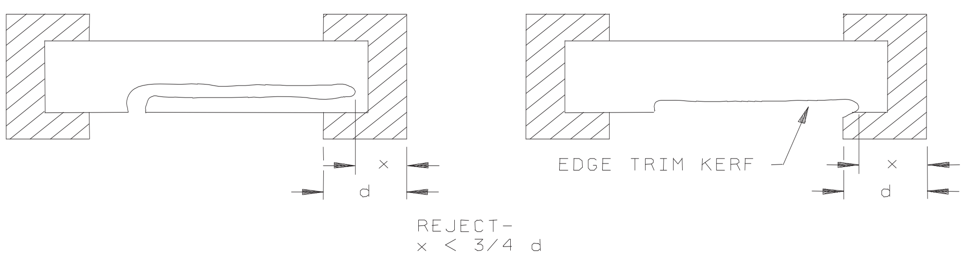


FIGURE 2032-52h. Class H laser trim kerf extension into metallization criteria.

	Class H		Class K
3.2.4	d. A kerf that leaves less than 50 percent of the original width of a resistor, unless by design (see figure 2032-52Ah). PRECAUTIONARY NOTE: The maximum allowable current density requirement shall not be exceeded.	3.2.4	d. Same as class H.

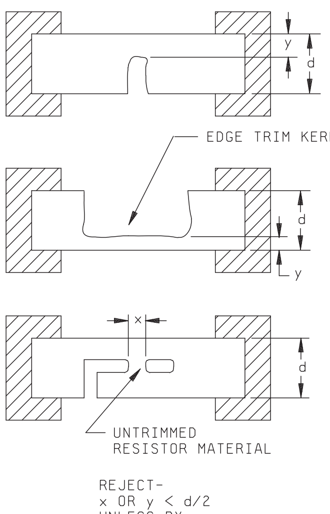


FIGURE 2032-52Ah. Class H resistor width reduction and untrimmed resistor material criteria.

e. A trim that does not originate from the edge of the resistor. — e. Same as class H.

3.2.5 Multilevel thick film defects, "low magnification". No element shall be acceptable that exhibits:

a. Any insulating material that does not extend beyond the width of the upper and lower metallization by 3.0 mils minimum (see figure 2032-53h). — a. Same as class H.

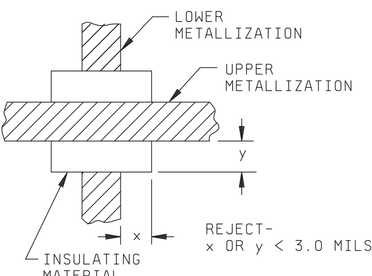


FIGURE 2032-53h. Class H dielectric extension criteria.

	Class H		Class K
3.2.5	b. Voids in the insulating material that expose underlying metallization.	3.2.5	b. Same as class H.
	c. Vias that are less than 50 percent of the original design area.		c. Same as class H.
	d. Scratch that completely crosses the metallization and damages the insulating material surface on either side.		d. Same as class H.

3.2.6 All thick film capacitors and those overlay capacitors used in GaAs microwave devices,"low magnification". No element shall be acceptable that exhibits:

a. Scratches that expose an underlying material.

b. Any peeling or lifting of the metallization.

c. Excess top metal which extend beyond the capacitor bottom metal.

d. Voids in the capacitor bottom metal which extend under the capacitor top metal.

e. Voids in the top metallization which leaves less than 75% of the metallization area undisturbed.

3.3 Nonplanar element inspection. Inspection for visual defects described in this section shall be conducted on each nonplanar passive element. The "low magnification" inspection shall be within the range of 10X to 60X.

Class H	Class K
3.3.1 General nonplanar element defects, "low magnification". No element shall be acceptable that exhibits:	
a. Peeling or lifting of any metallization.	a. Same as class H.
b. Protrusion between metallization terminals that leaves less than 5.0 mils separation (see figure 2032-54h).	b. Same as class H.

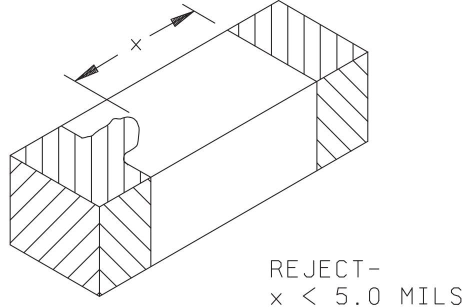


FIGURE 2032-54h. Class H metallization protrusion criterion.

Class H	Class K
3.3.1 c. Lifting, blistering, or peeling of insulation.	3.3.1 c. Same as class H.
d. Voids in metallized terminals that expose underlying material over greater than 25 percent of any side of the metallized terminal area.	d. Same as class H.

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

Class H	Class K
a. For mounted elements, unattached, conductive foreign material on the surface of the element. For unmounted elements, unattached, conductive foreign material on the surface of the element that is large enough to bridge operating metallization path, active circuitry, or any combination of these. NOTE: If an element has an insulating layer (such as glassivation) that covers operating metallization paths, active circuitry, or any combination of these, then the presence of unattached conductive foreign material that is large enough to bridge these features is acceptable since the features are protected by the insulating layer. NOTE: All foreign material shall be considered to be unattached unless otherwise verified to be attached. Verification of attachment shall be accomplished by a light touch with an appropriate mechanical device (i.e., needle, probe, pick, etc.) by a suitable cleaning process approved by the acquiring activity, or by a blow-off with a nominal gas blow (approximately 20 psig). NOTE: Semiconductor particles are considered to be foreign material. NOTE: Removal of unattached foreign material may be attempted using the techniques for verification of attachment discussed above.	a. Same as class H.
b. Attached, conductive foreign material that bridges metallization paths, active circuitry, or any combination of these.	b. Same as class H.
c. Liquid droplets, inkdrops, or any chemical stain that appear to bridge any unglassivated active circuit areas.	c. Same as class H.
d. Attached foreign material that covers more than 25 percent of a bonding pad area.	d. Same as class H.

Class H	Class K
3.3.3 Ceramic chip capacitor defects "low magnification". No element shall be acceptable that exhibits:	
a. Crack, chip or void in the body that exposes metal plates, (see figure 2032-55h).	a. Same as class H.

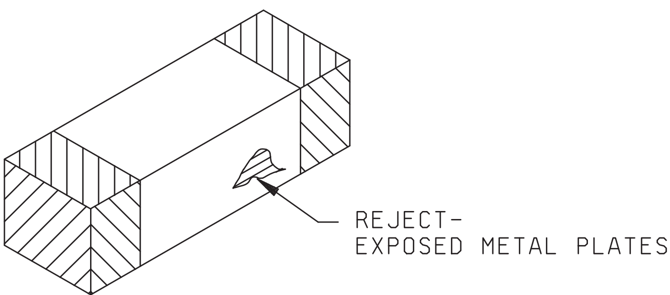


FIGURE 2032-55h. Class H metal plate exposure criteria.

Class H	Class K
b. Crack that is greater than 50 percent of the width of the unmetallized sides, top, or bottom, or that extends around a corner (see figure 2032-56h).	b. Crack. NOTE: No cracks are allowed.

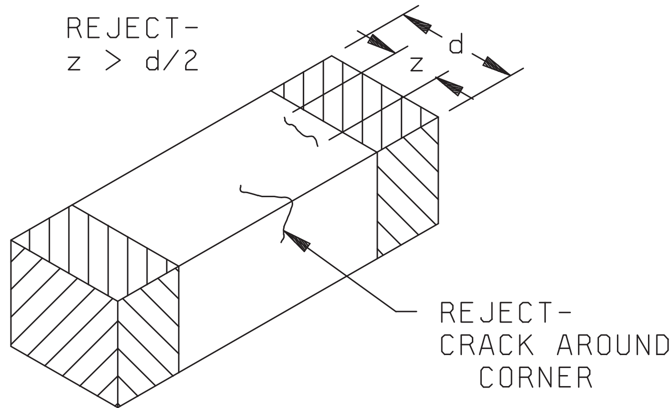


FIGURE 2032-56h. Class H crack criteria.

Class H	Class K
3.3.3 c. Evidence of separation (delamination) of metal plates or cracks along the plane of the metal plates (see figure 2032-57h). NOTE: Narrow grooves or channel less than 1.0 mil wide that exhibit a glass-like appearance and do not expose metal plates are acceptable.	3.2.3 c. Delamination. NOTE: No delamination is allowed.

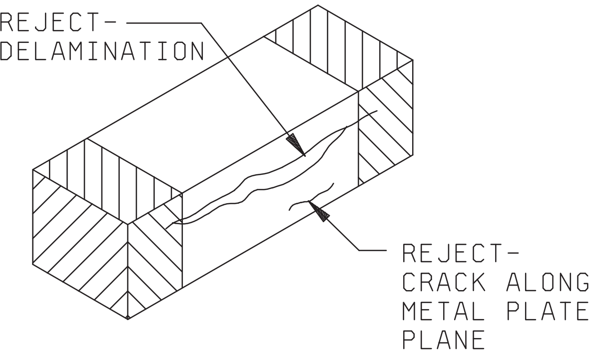


FIGURE 2032-57h. Class H delamination criteria.

Class H	Class K
d. Crack or void in the metallization that exposes metal plates, or voids that are greater than 25 percent of the area of the metallized terminal (see figure 2032-58h).	d. Same as class H.

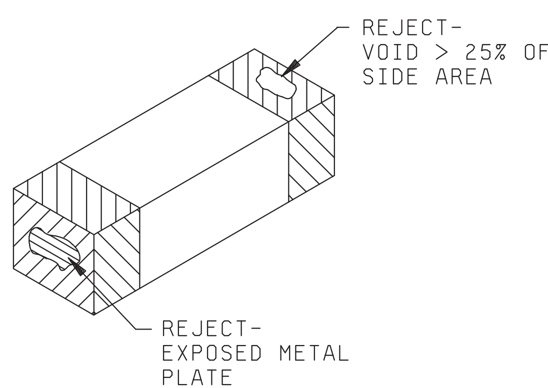


FIGURE 2032-58h. Class H termination defect criteria.

Class H	Class K
3.3.3 e. Void in the metallized edges of the element that are greater than 10 percent of the metallized edge dimension, or bare corners of metallized terminals (see figure 2032-59h). NOTE: This criteria ia applicable to solder attached elements only.	3.3.3 e. Same as class H.

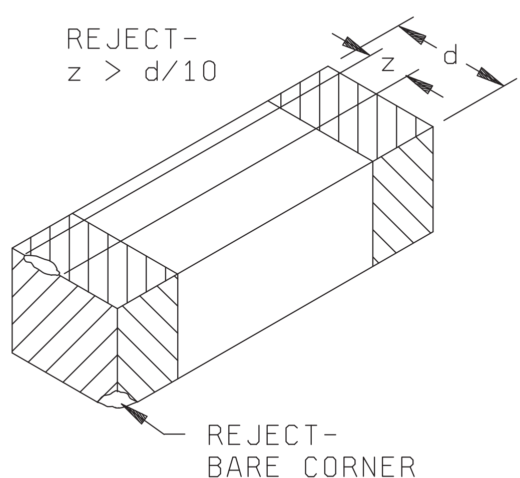


FIGURE 2032-59h. Class H metallized edge defect criteria.

Class H	Class K
f. Attached foreign material on the body that covers an area greater than 5.0 mils square on any side.	f. Same as class H.

3.3.4 Tantalum chip capacitor defects, "low magnification." No element shall be acceptable that exhibits:

Class H	Class K
a. Flaking or peeling of the encapsulant that exposes any underlying material.	a. Same as class H.
b. A metallized terminal that is less than 90 percent free of encapsulant material.	b. Same as class H.
c. Less than 50 percent continuous metallized terminal weld area without cracks. For capacitors with riser wires, a riser wire connection with less than 25 percent continuous weld area.	c. Same as class H.
d. Metallized terminal containing residue from the welding operation that is not firmly attached metallurgically to the anode cap.	d. Same as class H.

Class H			Class K		
3.3.4	e.	Metallized terminal not aligned as shown in the applicable drawing.	3.3.4	e.	Same as class H.
	f.	Encapsulant preventing the metallized terminal from resting on the substrate bonding pads when the capacitor is in the bonding position except where the metallized terminal electrical contact is made by alternate means.		f.	Same as class H.
	g.	Lifting, blistering or peeling of metallized terminal encapsulant.		g.	Same as class H.

3.3.5 Parallel plate chip capacitor defects, "low magnification". No element shall be acceptable that exhibits:

	a.	Metallization that extends greater than 50 percent around the edge of the capacitor (see figure 2032-60h).		a.	Same as class H.

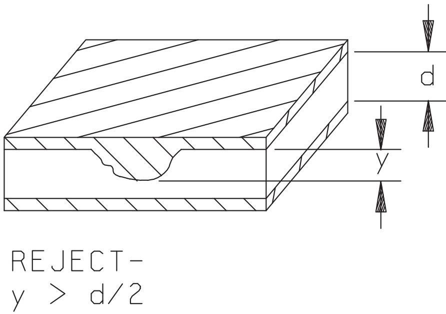


FIGURE 2032-60h. Class H metallization extension criterion.

3.3.5	b.	Evidence of cracks in the dielectric body (see figure 2032-61h).	3.3.5	b.	Same as class H.

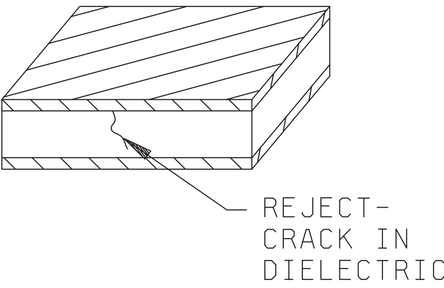


FIGURE 2032-61h. Class H crack in dielectric criterion.

Class H	Class K
3.3.6 Inductor and transformer defects, "low magnification". No element shall be acceptable that exhibits:	
a. Peeling, lifting or blistering of winding metallization or insulation.	a. Same as class H.
b. Evidence of shorts between adjacent turns or windings.	b. Same as class H.
c. Cracks or exposure of bare magnetic core material. Exposed bare magnetic core material is acceptable if by design.	c. Same as class H.
d. Pits or voids in the core insulation greater than 5.0 mils area that expose the magnetic core material.	d. Same as class H.
e. Separation less than 5.0 mils between wire termination points of the same or adjacent windings.	e. Same as class H.
f. Missing polarity identification unless by design.	f. Same as class H.
g. Operating metallization and multilevel thick film defects as described in 3.2.1 and 3.2.5 herein.	g. Same as class H.
3.3.7 Chip resistor defects, "low magnification". No element shall be acceptable that exhibits:	
a. Reduction of the resistor width resulting from voids, bubbles, nicks, or scratches, or a combination of these, that leaves less than 50 percent of the narrowest resistor width (see figure 2032-62h).	a. Same as class H.

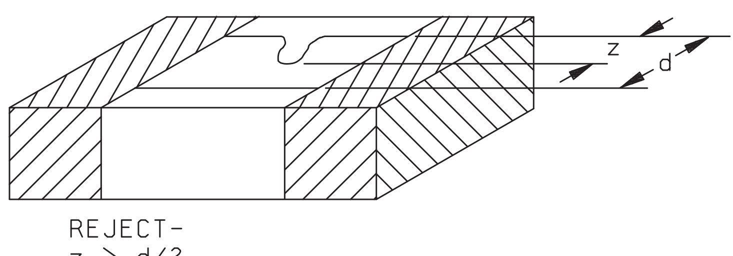


FIGURE 2032-62h. Class H resistor width reduction criterion.

		Class H			Class K
3.3.7	b.	A kerf that leaves less than 50 percent of the original width of the resistor unless by design.	3.3.7	b.	Same as class H.
	c.	Metallized termination width less than 10.0 mils unless by design (see figure 2032-63h).		c.	Same as class H.

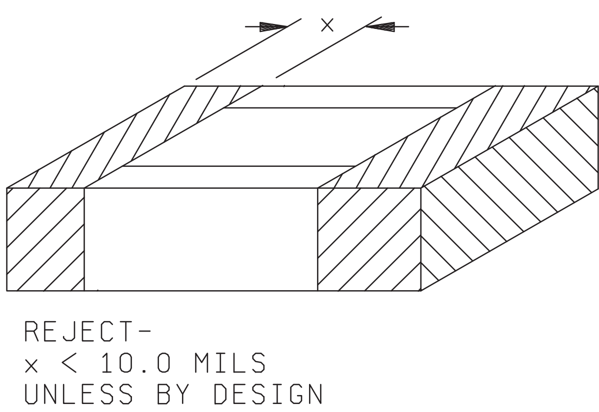


FIGURE 2032-63h. Class H termination width criterion.

		Class H			Class K
	d.	A crack, chipout or void in the substrate greater than 3.0 mils in any direction (see figure 2032-64h).		d.	Same as class H.

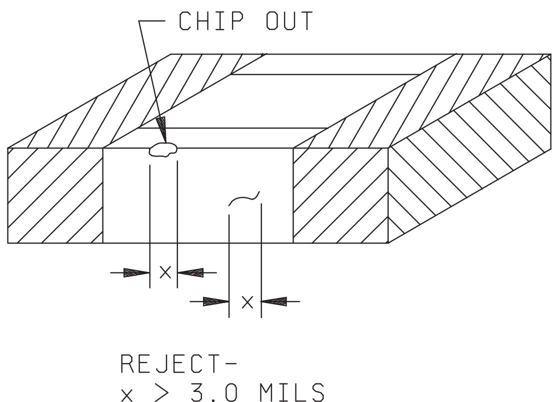


FIGURE 2032-64h. Class H substrate defect criteria.

Class H	Class K
3.3.7 e. 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 2032-65h).	3.3.7 e. Same as class H.

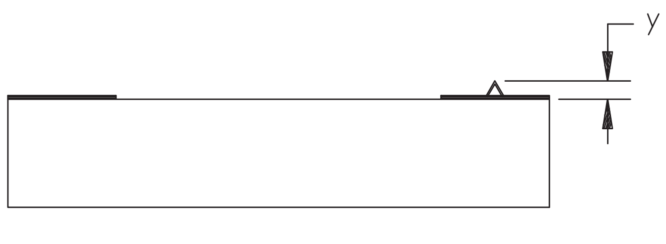


FIGURE 2032-65h. Class H termination material buildup criteria.

Class H	Class K
f. Termination material splattered throughout the resistor (see figure 2032-66h).	f. Same as class H.

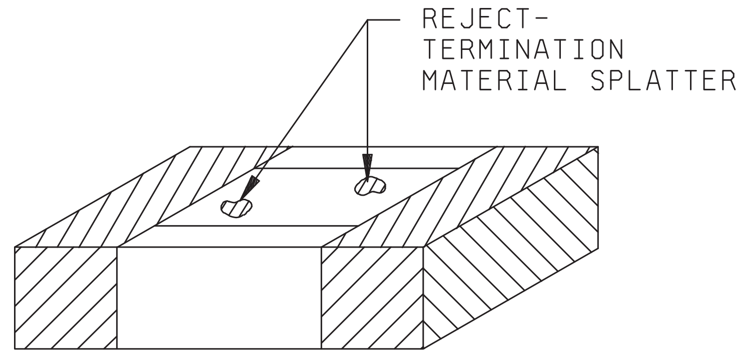


FIGURE 2032-66h. Class H termination material splatter criteria.

3.4 Surface acoustic wave (SAW) element inspection. Inspection for visual defects described in this section shall be conducted on each SAW element. When inspection is performed prior to mounting, then SAW elements may be inspected using backlighting. All inspection shall be performed at "low magnification" within the range of 10X to 60X for both class H and class K.

3.4.1 Defect control. The manufacturer shall perform an audit on a weekly basis for the presence of process related defects which impact SAW device performance (e.g., metallization voids, metallization scratches, metallization bridging, or crystal material pits/scratches/chipouts). This audit may be satisfied during routine internal visual inspection. If the presence of process related defects are discovered, the manufacturer shall monitor for a defect pattern to be used for the improvement of process controls. The manufacturer shall document the results of his investigation and corrective action to eliminate trends. The intent of this procedure is to require monitoring of process related defects which affect SAW device performance but do not cause reliability degradation leading to eventual failure of device function.

Class H	Class K
3.4.2 Operating metallization defects "low magnification." No element shall be acceptable that exhibits:	
3.4.2.1 Metallization corrosion.	
a. Any metallization corrosion.	a. Same as class H.
3.4.2.2 Metallization adherence.	
a. Any metallization lifting, peeling or blistering.	a. Same as class H.
3.4.3 Substrate material defects "low magnification". No element shall be acceptable that exhibits:	
a. Any crack that exceeds 5.0 mils in length.	a. Same as class H.
b. Any crack that is within 0.1 mil of any active circuit area or operating metallization.	b. Same as class H.
c. Any crack exceeding 1.0 mil in length extending from the element edge directly toward the active circuit area or operating metallization.	c. Same as class H.

Class H	Class K
3.4.4 Foreign material defects "low magnification". No element shall be acceptable that exhibits:	
a. For mounted and unmounted elements, unattached conductive foreign material on the surface of the element that is large enough to bridge operating metallization paths. NOTE: All foreign material shall be considered to be unattached unless otherwise verified to be attached. Verification of attachment shall be accomplished by a light touch with a mechanical device (i.e., needle, probe, pick, etc.) or by a suitable cleaning process approved by the acquiring activity, or by a nominal gas blow (approximately 20 psig). Removal of unattached foreign material may be attempted using the techniques for verification of attachment discussed above.	a. Same as class H.
b. Liquid droplets, ink drops, or chemical stains that appear to bridge unglassivated metallization.	b. Same as class H.
c. Attached foreign material that covers greater than 25 percent of a bonding pad area.	c. Same as class H.

4. SUMMARY. The following details shall be specified in the applicable acquisition document:

a. Class H or class K visual requirements.

b. Where applicable, any conflicts with element design, topology or construction (see 3).

c. Where applicable, gauges, drawings and photographs that are to be used as standards for operator comparison (see 2).

d. Where applicable, magnifications other than those specified (see 3).