



## Glossary

### **Acceptable Quality Level (AQL)**

The maximum number of defects per every 100 units considered satisfactory as a process average.

### **Active Components**

Electronic components such as semiconductors, transistors, and diodes that can operate on an applied electrical signal and change its basic characteristics (e.g., switching, amplification, rectification).

### **Active Trim**

Trimming of a circuit element (usually a resistor) in a circuit that is electrically activated and operating to obtain a specified functional output for the circuit (see Functional Trimming).

### **Alignment Holes (or Tooling Holes)**

Holes specifically designed for registration of a substrate. These holes can be located virtually anywhere on the substrate, although locations are often standardized.

### **Alloy**

A mixture of two or more metals combined to achieve properties, such as a lower melting point or greater strength, that the individual metals do not possess.

### **Alumina**

Aluminum oxide ( $Al_2O_3$ ). Alumina substrates are made of formulations that are primarily (91 to 99.6%) alumina.

### **Artwork**

The accurately scaled configurations or patterns produced to enable manufacturing of the product; photographic films which are created to produce working thick-film screens and thin film masks.

### **As-Fired**

Values of thick-film resistors or smoothness of ceramic substrates as they come out of the firing furnace prior to trimming and polishing.

### **ASIC**

A custom-made circuit used for a specific application.

**Aspect Ratio**

The ratio between the length of a film resistor and its width, equal to the number of squares of the resistor.

**Assembly**

A film circuit with discrete components attached.

**Assembly Drawing**

A drawing or depiction showing all the components and interconnections mounted or soldered to the film circuit in their proper position.

**Aqueous Cleaning**

A cleaning technique that uses water as the primary cleaning fluid.

**Aqueous Flux**

An organic-chemical soldering flux that is soluble in water.

**Bake Out**

Subjecting an unsealed hybrid circuit package to an elevated temperature to "bake out" moisture and unwanted gases prior to final sealing.

**Ball Bond**

An attachment formed when an interconnecting wire with a ball-shaped end is deformed by thermo-compression against a metallized pad. The bond is also designated a "Nailhead Bond" from the appearance of the flattened ball.

**Ball Grid Array (BGA)**

A leadless surface-mountable package in which solder ball interconnects cover the bottom surface of the package in a checkboard fashion. BGAs are reflow soldered to PCBs using a mass reflow process.

**Blind Via**

A via hole extending only to one surface of a printed circuit board.

**Blister**

A localized swelling and separation between any of the layers of a laminated base material, or between base material and conductive foil. It is a form of delamination.

**Bond**

An interconnection that performs a permanent electrical and/or mechanical function.

**Bond Strength**

In wire bonding, the pull force at rupture of the bond interface measured in the unit of a gram-force.

**Bonding Die**

Attaching the semiconductor chip to the substrate, either with an epoxy, eutectic or solder alloy.

**Burn-In**

The process of stressing a device electrically (usually at an elevated temperature) for an adequate period of time to cause failure of marginal devices.

**Camber**

The amount a substrate is warped.

**Capillary Action**

The effect of surface tension that draws a liquid into a small opening and can impel molten solder to flow against gravity between closely-spaced solid surfaces.

**Centrifuge**

Tests the integrity of bonds in a hybrid circuit. The centrifuge spins the circuit at a high rate of speed to impart a high G loading in the interconnecting wire bonds and bonded elements.

**Ceramic**

Inorganic nonmetallic material such as Alumina, Beryllia, Steatite, or Sterite, whose final characteristics are produced by subjection to high temperatures, often used in microelectronics as parts of components, substrate, or package.

**Chip**

The uncased and normally leadless form of an electronic component part, either passive or active, discrete or integrated.

**Chip and Wire**

A hybrid technology employing face-up bonded chip devices exclusively, interconnected to the substrate conventionally by flying wires.

**Chip Carrier**

A special type of enclosure or package used to house semiconductors

**Circuit**

The interconnection of a number of electrical elements and /or devices that perform a desired electrical function.

**Co-Firing**

Processing more than one type of the thick-film paste through the firing cycle at the same time—usually refers to conductors and resistors.

**Components**

Active or passive elements, devices, integrated circuits, or functional circuits, which are built for attachment to a circuit board or substrate carrier.

**Conductive Epoxy**

An epoxy material (polymer resin) that has been made conductive by the addition of a metal powder, usually gold or silver.

**Conductivity**

The ability of a material to conduct electricity; the reciprocal of resistivity.

**Conductor Spacing**

The distance between adjacent conductor film edges, usually measured in mils or thousandths of an inch.

**Conductor Width**

The width of individual conductors in a conductive film pattern, usually measured in mils or thousandths of an inch.

**Conformal Coating**

A thin nonconductive coating, either plastic (e.g., poly-p-xylylene) or inorganic, applied to a circuit for environmental and/or mechanical protection.

**Continuous Belt Furnace**

A firing furnace that has a continuous belt that carries the unfired substrates through the firing cycle.

**Crossover**

Transverse crossing of metallization paths without mutual electrical contact and achieved by the deposition of an insulating layer between the conducting paths at the area of crossing. Equivalent to jumpers.

**Crosstalk**

Signals from one line leaking into another nearby conductor because of capacitance or inductive coupling or both (e.g. owing to capacitance of a thick-film crossover).

**Curing**

A change in the physical properties of a material via chemical reaction or by reaction to temperature-time profile.

**Curing Time**

The time needed to properly cure a thermosetting plastic material.

**Cut and Strip**

An essentially obsolete method of producing artwork using a two-ply laminated plastic sheet that cuts and strips off the unwanted portion of the opaque layer from the translucent layer, leaving the designed art work configuration.

**Definition**

The sharpness of a screen-printed pattern—the exactness with which a pattern is printed.

**Delamination**

A separation between plies within the base material, or between the base material and the conductive foil, or both.

**Dendritic Growth**

The metallic growth between pads in the presence of moisture and an electrical bias.

**Dielectric**

Materials that do not conduct electricity and that are used to make capacitors, to insulate conductors (as in crossover and multi-layered circuits), and to encapsulate circuits.

**Dielectric Constant**

Describes a material's ability to store charge when used as a capacitor, and its value can be derived from a simplified capacitor model. It is the ratio of the charge that would be stored with free space (i.e., vacuum) as the dielectric to that stored with the material as the dielectric.

**Dielectric Layer**

A layer of dielectric material between two conductor plates.

**Dual in Line Pack (DIP)**

A package having two rows of leads extending at right angles from the base and having standard spacings between lead and between rows of leads.

**Encapsulate**

Sealing up or covering an element of circuit for mechanical and environmental protection.

**Environmental Test**

A test or series of tests used to determine the sum of external influences affecting the structural, mechanical, and functional integrity of any given package or assembly.

**Emulsion**

A stable mixture of two or more immiscible liquids held in a suspension by small percentages of emulsifiers.

**Epoxy**

A thermosetting polymer containing the oxirane group.

**Eutectic**

The minimum melting point of a combination of two or more materials. The eutectic temperature of an alloy is always lower than the melting point of any of its individual constituents. The eutectic temperature is the particular temperature at which the eutectic occurs. When heated, eutectic alloys transform directly from a solid to a liquid and do not show any pasty regions. For example, eutectic solder paste has a composition of 63% tin (Sn) and 37% lead (Pb), and a eutectic temperature of 183°C.

**Failure Rate**

The rate at which devices in a given population can be expected to fail as a function of time (e.g. percent per 1,000 hours of operation).

**Fiducial**

A specific mark incorporated in the circuit artwork and used by machine vision to identify artwork orientation and location.

**Fine Pitch**

Surface mount components with a lead pitch of at least 50 mils. Fine pitch more commonly refers to components with a lead pitch of 25 mils or less. These packages usually require vision assistance for accurate placement.

**Film**

Single or multiple layers or coatings of paste material used to form various elements (resistors, capacitors, inductors) or interconnections and crossovers (conductors, insulators). Thick films are deposited by screen printing.

**Final Seal**

The manufacturing operation that completes the enclosure of the hybrid microcircuit so that further internal processing cannot be performed without de-lidding or disassembling the package.

**Fine Leak**

Used to determine the effectiveness of the seal in microelectronic component packages. If the package seal is damaged or defective, moisture and contaminants can enter the package freely and degrade long-term reliability. A leak in a sealed package less than  $1 \times 10^{-5}$  cm<sup>3</sup>/sec at one atmosphere of differential air pressure are considered fine leak rates.

**Fire**

The term used to describe the act of heating a thick-film circuit so that the resistors, conductors, capacitors, and other integrated elements will be transformed into their final form.

**Fixture**

A device that interfaces the PCB to the process machine center(s).

**Flat Pack**

An integrated circuit package with leads extending from the sides and parallel to the base.

**Flux**

A chemically-active or physically-active formulation capable of cleaning oxides and enabling wetting of metals with solder.

**Functional Trimming**

Trimming of a circuit element (usually resistors) on an operating circuit to set a voltage or current of the output.

**Green**

A term used in ceramic technology meaning unfired (for example, a "green" substrate is one that has been formed, but has not been fired).

**Gross Leak**

A leak in a sealed package greater than  $10^{-5}$  cm<sup>3</sup>/sec at one atmosphere of differential air pressure.

**Header**

The base of a hybrid circuit package that holds the leads.

**Heat Sink**

The supporting member to which electronic components or their substrate or their package bottom are attached. This is usually a heat conductive metal with the ability to rapidly transmit heat from the generating source (component).

**Heat Treating**

A process that uses precise heating and cooling of metals after stamping and forming in order to optimize internal stresses and spring properties.

**Hermetic**

Sealed up so that it is gas tight. The test for hermeticity is to observe leak rates when placed in a vacuum. A plastic encapsulation cannot be hermetic by definition because there is no internal volume of gas to escape.

**Hot Gas Reflow**

A solder reflow process that uses a heated gas, including air, as the mode of heat transfer.

**Hot Spot**

A small area on a circuit that is unable to dissipate the generated heat and therefore operates at an elevated temperature above the surrounding area.

**Hybrid Circuit**

A microcircuit consisting of elements which are a combination of the film circuit type and the semiconductor circuit type or a combination of one or both of these types and may include discrete add-on components.

**Hybrid Microelectronics**

The entire body of electronic art which is connected with or applied to the realization of electronic systems using hybrid circuit technology.

**Infant Mortality (Early Failures)**

The time during which circuits are failing at a decreasing rate (during the first few hundred hours of operation).

**Ink**

Synonymous with "composition" and "paste" when relating to screenable thick-film materials, usually consisting of glass frit, metals, metal oxide, and solvents.

**Insulation Resistance (IR)**

The resistance to current flow when a potential is applied (IR is typically measured in megohms).

**Insulators**

A class of materials that do not conduct electricity and are characterized by high resistivity.

**Kerf**

The slit or channel cut in a resistor during trimming by laser beam or abrasive jet.

**L-Cut**

A trim notch in a film resistor that is created by the cut starting perpendicular to the resistor length and turning 90 degrees to complete the trim parallel to the resistor axis thereby creating an L-shaped cut.

**Laminar Flow**

A constant and directional flow of filtered air across a clean workbench. The flow is usually parallel to the surface of the bench.

**Laminate**

A stack of prepregs with copper foils on either surface after lamination during PCB fabrication.

**Lamination**

A heat and pressure cycle used to consolidate a stack of prepregs into a solid block. The term also refers to the consolidation of a stack of laminates (with circuitry) to form a PCB. Lamination is referred to as the C-stage in PCB fabrication.

**Lands**

Widened conductor areas on the major substrate used as attachment points for wire bonds or the bonding of chip devices.

**Laser Trim**

The adjustment (upward) of a film resistor value by applying intense localized heat from a focused laser source to vaporize material.

**Layout**

The scale depiction (drawing) in two dimensions of all conductors, resistors and other circuit elements to be fabricated as a film substrate.

**LCC**

Leadless Chip Carrier.

**Lead Pitch**

The sum of the lead width and lead spacing. Typically stated as the distance between the center of one lead to the center of an adjacent lead.

**Life Drift**

The change in either absolute level or slope of a circuit element under load. Rated as a percentage change from the original value per 1,000 hours of life.

**Life Test**

Test of a component or circuit under load over the rated life of the device.

**Mask**

The photographic positive (or negative) that serves as the master for making thick-film screens.

**Mesh Size**

The number of openings per inch in a screen. A 325 mesh screen has 325 openings per linear inch, or 105,625 openings per square inch.

**Metallization**

A film pattern (single or multi-layer) of conductive material deposited on a substrate to interconnect electronic components, or the metal film on the bonding area of a substrate which becomes a part of the bond and performs both an electrical and a mechanical function.

**Metal to Glass Seal (or glass-to-metal seal)**

An insulating seal made between a package lead and the metal package by forming a glass bond to oxide layers on both metal parts. In this seal, the glass has a coefficient of expansion that closely matches the metal parts.

**Microcircuit**

A small circuit (hybrid or monolithic) with a relatively high equivalent circuit element density, which is considered a single component on (hybrid) or with (monolithic) a single substrate to perform an electronic circuit function. This excludes print wiring boards, circuit card assemblies, and modules composed exclusively of discrete electronic parts.

**Microelectronics**

The area of electronic technology associated with or applied to the realization of electronic systems from extremely small electronic parts or elements.

**Micron**

One millionth of a meter, and another term for micrometer.

**Migration**

An undesirable phenomenon whereby metal ions, notably silver, are transmitted through another metal, or across an insulated surface, in presence of moisture and an electrical potential.

**MTBF**

Acronym for Mean Time Between Failures applied statistically to reliability studies.

**Multilayer Board**

A substrate that uses more than two layers for conductor routing. Plated via holes are used to connect the internal layers to the outer layers.

**Multilayer Ceramic**

A stack of alternating metallic and ceramic layers with vias interconnecting them.

**Multilayer Ceramic Capacitor**

A Miniature ceramic capacitor manufactured by paralleling several thin layers of ceramic. The assembly is fired after the individual layers have been electroded and assembled.

**Multilayer Substrates**

Substrates that have buried conductors so that complex circuitry can be handled. Assembled using processes similar to those used in multi-layer ceramic capacitors.

**Nominal Resistance Value**

The specified resistance value of the resistor at its rated load.

**Nonconductive Epoxy**

An epoxy material (polymer resin), either without a filler or with a ceramic powder filler added for increasing thermal conductivity and improving thixotropic properties. Nonconductive epoxy adhesives are used in chip to substrate bonds where electrical conductivity to the bottom of the chip is unnecessary or in substrate-to-package bonding.

**Ohms/Square**

The unit of sheet resistance, or more properly, of sheet resistivity.

**Outgassing**

The gaseous emission or de-aeration from a PCB or solder joint.

**Overcoat**

A thin film of insulating material, either plastic or inorganic (e.g., glass or silicon nitride) applied over integral circuit elements for the purposes of mechanical protection and prevention of contamination.

**Overglaze**

A glass coating that is over another component or element, normally for physical protection or electrical isolation purposes.

**Overlap**

The contact area between a film resistor and a film conductor.

**Package**

The container for an electronic component(s) with terminals to provide electrical access to the outside of the container. In addition, the container usually provides environmental protection (hermeticity), and a defined form factor.

**Package Cap**

The cup-like cover that encloses the package in the final sealing operation.

**Package Lid**

A flat cover plate that is used to seal a package cavity.

**Pad**

A metallized area on the surface of an active substrate as an integral portion of the conductive interconnection pattern to which bonds or test probes may be applied.

**Passivation**

The formation of an insulating layer directly over a circuit or circuit element to protect the surface from contaminants, moisture, or particles.

**Passive Components (Elements)**

One of two types of electrical components. A passive component is an electronic component which only receives energy, which it can either dissipate, absorb or store in an electric field or a magnetic field. Passive elements do not need electrical power to operate. Elements such as resistors, capacitors, and inductors are passive components. Active components form the second category of components; they supply energy to a circuit.

**Paste**

Synonymous with "composition" and "ink" when relating to screenable thick-film materials

**Paste Blending**

Mixing a resistor paste of different ohms/square value to create a third value in between those of the two original materials.

**Paste Soldering**

Finely divided particles of solder suspended in a flux paste that forms connections to solderable components. Applied by screening on to a film circuit and reflowing.

**Pattern**

The outline of a collection of circuit conductors and resistors that defines the area to be covered by the material on a film circuit substrate.

**Peak Firing Temperature**

The maximum temperature seen by the resistor or conductor paste in the firing cycle as defined by the firing profile.

**Percent Defective Allowable (PDA)**

The maximum observed percent defective that permits the lot to be accepted after the specified 100% test.

**Pinhole**

Small holes occurring as imperfections which penetrate entirely through film elements, such as metallization films or dielectric films

**Plastic Encapsulation**

Environmental protection of a completed circuitry embedding it in a plastic such as epoxy or silicone.

**Plastic Shell**

A thin plastic cup or box used to enclose an electronic circuit for environmental protection or used as a means to confine the plastic encapsulant used to embed the circuit.

**Potting**

Encapsulating of a circuit in plastic.

**Power Density**

The amount of power dissipated from a film resistor through the substrate. Measured in W/in<sup>2</sup>.

**Power Dissipation**

The dispersion of the heat generated from a film circuit when a current flows through it.

**Prepregs**

Composite materials such as carbon, graphite, or glass fibers that are “pre-impregnated” with resins and then cured. The term “prepreg” is in fact an abbreviation for “pre-impregnated,” which indicates the material has been pre-reinforced.

**Preseal Visual**

The process of visual inspection of a completed hybrid circuit assembly for defects prior to sealing the package.

**Print and Fire**

A term sometimes used to indicate steps in the thick-film process wherein the ink is printed on a substrate and is fired.

**Printing Parameters**

The conditions that affect the screening operation such as off-contact spacing, squeegee speed, squeegee pressure, etc.

**Production Lot**

Hybrid microcircuits manufactured on the same production line(s) by means of the same production’s techniques, materials, controls, and design. The production lot is usually date coded to permit control and traceability required for maintenance of reliability programs.

**Purple Plague**

One of several gold-aluminum compounds formed when bonding gold to aluminum and activated by re-exposure to moisture and elevated temperature (<340 deg. C). Purple plague is purplish in color and is very brittle, potentially leading to time-based failure of the bonds. Its growth is highly enhanced by the presence of silicon to form ternary compounds.

**Reflow**

The application of heat to a surface containing a thin deposit of a low-melting-point metal or alloy (e.g., solder paste), resulting in the melting of the deposit followed by solidification.

**Reflow Soldering**

Soldering technique involving the application of solder prior to the actual joining. To solder, the parts are joined and heated, causing the solder to re-melt, or re-flow.

**Registration**

The alignment of a circuit pattern on a substrate.

**Registration Marks**

The marks used for aligning successive processing masks.

**Resistor Drift**

The change in resistance of a resistor through aging and usually rated as percent change per 1,000 hours.

**Resistor Geometry**

The film resistor outline (see Aspect Ratio).

**Resistor Overlap**

The contact area between a film resistor and a film conductor

**Resistor Paste Calibration**

The characterization of a resistor paste for resistivity, TCR and other parameters by screening and firing a test pattern using the paste and recording the results.

**Schematic**

Diagram in symbolic form of a functional electronic circuit.

**Scored Substrate**

A substrate that has been scribed with a thin cut at the break-lines.

**Screen**

A network of metal or fabric strands, mounted on a frame, and upon which the film circuit patterns and configurations are superimposed by photographic means.

**Screen Deposition**

The laying down of a circuit pattern on a substrate using the silk-screening technique.

**Screening**

The process whereby the desired film circuit patterns are transferred to the surface of the substrate by forcing paste through the open areas of a screen using the wiping action of a soft squeegee.

**Scribe Line**

A series of laser pulses (normally 4-6 mils apart), typically 35-50% of substrate thickness. Allows for multi-up arrays that are easily snapped into single devices after processing. Tolerance after snapping is typically  $\pm 3$  mils.

**Serpentine Cut**

A trim cut in a film resistor that follows a serpentine or wiggly pattern to effectively increase the resistor length and increase resistance.

**Sheet Resistance**

The electrical resistance of a thin sheet of a material with uniform thickness as measured across opposite sides of a unit square pattern. Expressed in ohms/square.

**Silk Screen**

A screen of a closely woven silk mesh stretched over a frame and used to hold an emulsion outlining a circuit pattern and used in screen printing of film circuits. Used generically to describe any screen (stainless-steel or nylon) used for screen printing.

**Solder Dam**

A dielectric composition screened across a conductor to limit molten solder from spreading further onto solderable conductors.

**Solderability**

The ability of a conductor to be wetted by solder and form a strong bond with the solder.

**Soldering**

The process of joining metals by fusion and solidification of an adherent alloy having a melting point below about 400 degrees F.

**Squeegee**

The part of a screen printer that pushes the composition across the screen and through the mesh onto the substrate.

**Stainless Steel Screen**

A stainless steel mesh screen stretched across a frame and used to support a circuit pattern defined by an emulsion bonded to the mesh.

**Step and Repeat**

A process wherein the conductor or resistor pattern is repeated many times in evenly-spaced rows onto a single film or substrate.

**Tantalum Capacitor**

Capacitors that utilize a thin tantalum oxide layer as the dielectric material.

**Temperature Coefficient of Capacitance (TCC)**

The amount of capacitance change in a capacitor over a temperature range. Expressed as the average change over a certain temperature range in ppm/degree C.

**Temperature Coefficient of Resistance (TCR)**

The amount of resistance change in a resistor (or resistor material) with temperature. Expressed as the average change over a certain temperature range in ppm/degree C.

**Temperature Cycling**

An environmental test where the device under test is subjected to several temperature changes from a low temperature to a high temperature over a certain period of time.

**Thermal Conductivity**

The rate with which a material is capable of transferring a given amount of heat.

**Thermal Shock**

A condition whereby devices are subjected alternately to extreme heat and extreme cold; used to screen out processing defects.

**Thermocompression Bonding**

A process involving the use of pressure and temperature to join two materials by inter-diffusion across the boundary.

**Thermocouple**

A sensor made of two dissimilar metals which, when heated, generate a small DC voltage used in temperature measurements.

**Thermoplastic**

Polymer materials that can be repeatedly melted without significant change in their properties.

**Thick Film**

A film deposited by screen printing "paste" and subsequent firing at high temperature to fuse the paste into its final form.

**Thick Film Hybrid Circuit**

A hybrid microcircuit that has components, usually chip devices, added to a thick-film network to perform an electrical function.

**Thick-Film Technology**

The technology whereby electrical networks or elements are formed by applying a coating of semi-liquid paste through a screen or mask in a selective pattern on a supporting substrate material and then fired.

**Thin Film**

A thin film (usually less than 100 nm thickness) is one that the metallic film is deposited onto a substrate by an accretion process such as vacuum evaporation, or pyrolytic decomposition, or sputtering.

**Top Hat Resistors**

Film resistors having a projection on one side allowing a notch to be cut into the center of the projection to form a serpentine resistor and thereby increase resistivity.

**Tracking**

Two similar elements on the same circuit that change values with temperature in close harmony are

said to track well. Tracking of different resistors is measured in ppm/deg C (difference). Tracking is also used in reference to temperature hysteresis performance and potentiometer repeatability.

**Trimming**

Notching a resistor by an abrasive or laser to raise the nominal resistance value.

**Ultrasonic Bonding**

A process involving the use of ultrasonic energy and pressure to join two materials.

**Ultrasonic Cleaning**

A method of cleaning that uses cavitation in fluids caused by applying ultrasonic vibrations to the fluid.

**Vehicle**

A thick film term that refers to organic system in the screenable paste.

**Via**

An opening in the dielectric layer through which a riser passes.

**Void**

A cavity inside the solder joint formed by gases released during reflow or by flux residues entrapped before solidification.

**Wedge Bond**

A bond made with a wedge tool. The term is usually used to differentiate thermo-compression wedge bonds from other thermo-compression bonds (almost all ultrasonic bonds are wedge bonds).

**Wetting**

The spreading of solder along the leads and pad to produce complete and uniform solder coverage.

**Whisker**

A metallic growth, needle-like in size, that appears on the surface of a PCB.

**Wicking**

When used in reference to Solder Wicking, the term describes the capillary movement of molten solder onto a pad or component lead or between metal surfaces, such as strands of wire.

**Wire Bond**

Includes all the constituent compounds of a wire electrical connection between the terminal and the semiconductor die. These components include the wire, metal bonding surfaces, adjacent underlying insulating layer (if present), and substrate.

**Yield**

The ratio of usable components at the end of a manufacturing process to the number of components initially submitted for processing. Can be applied to any input-output stage in processing, and so must be defined and understood.