USEFUL GUIDE TO TECHNICAL TERMS

Use the links below to find definitions of technical terms used in our product guides that will help you understand the application, features and properties of our products.

Thermal Interface Materials

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Laird™

Thermal Interface Materials

Adhesive Strength: The tack or tackiness of a material. A characterization of the adhesive force between a material and another surface, which can be desirable (for gap filler placement), or undesirable (liner release, or ease of rework).

Alumina (Al2O3): A ceramic filler used in thermal interface materials because of its thermal conductivity and dielectric properties.

Ambient Temperature: The temperature of the environment; usually the still air in the immediate proximity of the system.

Apparent or Effective Thermal Conductivity: Thermal conductivity of a material that also takes into consideration contact resistance when measured.

Bake: A temperature condition used during thermal reliability testing. Material is exposed to a specified temperature for an extended and specified amount of time. Example 150°C for 1000hrs.

Bondline Thickness: The thickness of the thermal material as used in an application. The thinner the bondline, the better. In practice, the minimum bondline is limited by the size of the filler used in the material.

Boron Nitride (BN): A ceramic filler used in thermal interface materials because of its excellent thermal conductivity and dielectric properties. Boron nitride also has excellent lubricant properties which makes it ideal in thermally conductive dispensable materials.

Breakdown Voltage: The applied voltage that a material can withstand before passing electrical current through thickness.

Coefficient of Thermal Expansion (CTE): Describes a materials' size change because of change in temperature. CTE is the ratio in which a material expands in accordance with changes in temperature.

Comparative Tracking Index (CTI): The maximum voltage, measured in volts, at which a material withstands 50 drops of contaminated water without tracking (forming a conductive path due to electrical stress, humidity, and contamination).

Compliant: Soft and pliable

Conduction: Transfer of heat through a solid from hot areas to cooler areas. The transport mechanism occurs between neighboring molecules. Liquids and gases conduct heat, but to a much lesser degree.

Convection: Transfer of heat by the mixing action of fluids and gases. In *natural convection* the mixing action is due entirely to temperature differences, resulting in different densities. In *force convection* the mixing action is produced by mechanical means, such as fans or pumps.

Compliance: The ability of a material to conform to another surface; the more compliant a material is, the more it reduces contact resistance.

Compression: The ability of a material to change its external volumes, such as a sponge; air is displaced.

Deflection: The degree to which a material is displaced under an applied force. With deflection, the volume of the material does not change, it merely moves out of the way.

Density: Weight per unit volume. Dispensable materials may be purchased by weight but applied by volume.

Dielectric Properties: The response of a material to electric and magnetic fields. For thermal materials, dielectric properties describe the insulating (or electrically resistive) property of a sheet product.

Dielectric Constant: A measurement of the material's ability to insulate charges from one another. The larger the dielectric constant the more charge can be stored.

Dielectric Strength: The maximum electric field that a material can withstand before it exhibits a breakdown.

Dispensable 1K vs 2K products: Product characteristic that indicates whether or not the product requires mixing and/or curing during installation; One-part (1K) materials typically require no post-application curing, whereas two-part (2K) materials may require mixing prior to applying and time to cure.

Durometer: Equipment used to measure material hardness/softness.

Electrical Resistivity: Property of a material that indicates how strongly the material opposes the flow of an electric current.

Filler: A substance added to increase thermal or electrical performance of the interface material.

Flatness: The flatness of a surface is the degree to which it approximates a "perfect" plane. Although a surface may look flat, there is usually a degree of unevenness; poor flatness introduces higher contact resistance and generally requires a thick thermal interface material (TIM) to maintain proper thermal management.

Flow Rate: The amount of material that flows through a stated orifice per unit time. In this context, flow rate is critical for TIM materials that are dispensed from cartridges, or from pails using a pump. Along with a material property (viscosity), flow rate is affected by the dispensing equipment.

Gap Distance to be Bridged: The physical distance thermal energy must travel to be transferred between two objects; this value is usually measured in inches or millimeters.

Hardness: The resistance of a material to penetration by an indenter in a standard test. Different indenters may be used, and must be specified, for example "Shore 00".

HAST: A temperature and relative humidity condition used during reliability testing. Example: 85°C/85%RH.

Heat Capacity: Measurement of a material's ability to hold heat.

Heat Flow: The movement of thermal energy between physical systems.

Heat Transfer: The exchange of thermal energy between physical systems.

Heat Sink: A medium of high thermal mass that can absorb (sink) heat indefinitely with negligible change in temperature.

Interface: The contact area of two mating surfaces.

Interfacial Resistance: The measure of an interface's resistance to heat flow; also known as thermal contact resistance.

Minimum Bondline Thickness: The thickness of thermal material as used in an application. The thinner the bondline, the better. In practice, the minimum bondline is limited by the size of the material's filler.

Mil: Standard unit of length (thickness) used when describing TIMs (equivalent of one thousandth of an inch).

HOME

Oil-Bleed: A phenomenon in which material components (oil) can migrate to adjacent surfaces within a device (bleed).

Out-Gassing: The release of volatile components from a material under conditions of heat and vacuum. Some volatile components may be prone to condense permanently on nearby surfaces, while others, such as water, only condense temporarily and are typically of less concern to electronic device manufacturers. Condensed volatiles can be electrically insulating, lead to device failures, and fog optical components. Out-gassing is quantified by the ASTM E595 test protocol.

Pressure: A physical force exerted on an object; in thermal management, the pressure between two interfaces is crucial in defining a thermal transfer solution.

Pressure Sensitive Adhesive (PSA): Adhesive available on some products to help enhance the adhesive property of the material.

Pump out: State when a material is forced out or flows out of the interface.

Radiation: Transfer of heat by electromagnetic waves produced by bodies because of their temperature. A hot body radiates heat in all directions. When the energy strikes another body, the part that is absorbed is transformed into heat.

Reinforcement: A layer of material (fiberglass, film, etc.) used to help strengthen a product.

Relative Temperature Index (RTI): The maximum service temperature for a material where the critical properties will not be compromised due to chemical thermal degradation. This is typically rated by UL standard 746B.

REACH: Registration, evaluation, authorization, and restriction of chemical substances.

Recovery: Process during which a material returns to its original state after a force has been applied.

Relaxation: Material's state when not under stress, return to equilibrium.

RoHS: Restriction of Hazardous Substances. RoHS reports are available for all Laird products upon request.

Screen Printable (SP): Material delivered in bulk form that can be applied in a silk screened or stenciled method.

SDS: Safety data sheet. SDS information is available for all Laird products.

Shear-Thinning: A reduction in viscosity with applied shear force. A shear thinning material can exhibit a high viscosity when static and a low viscosity when stirred or pumped.

Shock: A temperature cycle condition used during thermal reliability testing. Material is exposed to high and low temperatures very quickly.

Softness: The ability of the material to easily move aside during the penetration test. Because material can deflect, the test duration is also important, and should be specified. Example of test specification Shore 00, 30 second dwell.

Surface Area: A function of length and width resulting in the complete plane that thermal energy can be transferred into a medium.

Surface Texture: An uneven surface texture has more voids and air pockets, decreasing a material's ability to mate to the surface and transfer thermal energy from one medium to another.

Thermal Conductivity (k): The ability of a material to transfer heat. Thermal conductivity is measured in watts per meter Kelvin (W/mK). The higher the value, the more conductive the material.

Thermal Contact Resistance: The thermal resistance between two mating surfaces (materials).

Thermal Energy: Particles within an object or system are continuously moving. This movement creates heat, which can be transferred from one object to another. Thermal energy can be measured as a temperature.

Thermal Interface Materials (TIM): A material that helps transfer heat away from the component. A TIM is used in electronic devices to improved thermal transfer between two mating surfaces: usually a heat generating component such as a processor and a heat sink.

Thermal Interface Materials TIM 1: Interfaces from the bare die to the lid of the component.

Thermal Interface Materials TIM 2: Interfaces from the lid to the thermal solution, generally a heatsink.

Thermal Resistance (Tr): The inverse of thermal conductivity, thermal resistance is a material's resistance to transfer heat. The lower the value, the better the material performs as a thermal interface.

Thermogravimetric Analysis (TGA): A method of thermal analysis in which changes in physical or chemical properties of materials are measured as a function of temperature.

Thixotropic: A property of a material in which viscosity reduces as force is applied.

Total Thermal Resistance (TTR): TTR is the sum of the material's thermal resistances and the resistance of the two contact resistances at each interface (top and bottom surfaces).

UL: Underwrites Laboratories is an organization that sets standards for different product categories and tests products to make sure they meet the standards. Example: Flammability Rating.

Viscoelastic Material: Material that exhibits both viscous and elastic characteristics when undergoing deformation.

Viscosity: An intrinsic property that describes the resistance of a material to deform or flow. Viscosity can be characterized by different methods that require analytical instrumentation.

Volume Resistivity: A fundamental property of a material that quantifies how strongly it resists electric current. A low resistivity indicates a material that readily allows electric current (0.001) while a high resistivity indicates a resistance to electric current ($1x10_{13}$)

Wet Out: State when a TIM, generally a phase change, grease or dispensable gap filler, flows and coats the topography of the mating surface.

Withstand Voltage/Hi-pot: Non-destructive test that verifies electrical isolation.

Magnetic Ceramic Products

The following glossary of terms is adapted from the Magnetic Materials Producers Association publication SFG-92 and other sources.

Air Core Inductance (L0 [Henry]): The inductance that would be measured if the core had unity permeability and the flux distribution remained unaltered.

Circular mils (c.m. [mils2]): The cross-sectional area of a circular conductor calculated as a square conductor, ie, area in c.m. is D2, where D is the diameter of the wire. See also “Square Mils.”

Coercive Force ([Oe;Amp/m]): The magnetization field strength required to bring the magnetic flux density of a magnetized material to zero. See “Field Strength.”

Common Mode Current: The component of signal current that induces electric and magnetic fields that do not tend to cancel one another. For example, in a circuit with one outgoing signal conductor and one return (“ground”) conductor, the common mode current is the component of the total signal current that flows in the same direction on both conductors. Common mode current is the primary source of EMI in many electronic systems.

Common Mode Type I: On a single-phase Wye bus, the conduction mode in which phase, neutral, and ground currents are in phase. The return current path is through the ground plane and the case.

Common Mode Type II: On a single-phase Wye bus, the conduction mode in which phase and neutral currents are in phase. However, the green wire currents are the return path and therefore 180 degrees out of phase.

Common Mode Voltage: The voltage that drives directed common mode (noise) currents.

Core Constant (C1 [cm-1; mm-1]): The summation of the magnetic path length of each section of the circuit divided by the corresponding area of the same section. See section entitled “Magnetic Design Formulas.” q is a frequently useful ratio in the analysis and prediction of core performance.

Core Constant (C2 [cm-3; mm-3]): The summation of the magnetic path length of each section of the magnetic circuit divided by the square of the corresponding magnetic area of the same section. See section entitled “Magnetic Design Formulas.”

Curie Temperature (Tc [°C]): The transition temperature above which a ferrite loses its ferromagnetic properties. Usually defined as the temperature at which pi falls to 10o of its room temperature value.

Dielectric Withstanding Voltage (DwV [V]): DWV is the voltage level at which the dielectric breaks down, allowing conduction between isolated conductors or between a conductor and the core. Isolation, or Hipot is the ability of a transformer to withstand a specific breakdown voltage between the primary and secondary windings.

Differential Mode: A current conduction mode in which currents, relative to two conductors, are flowing 180 degrees out of phase, with equal magnitude within the conductors.

Differential Mode Current: The intended signal currents that are equal and oppositely directed on pairs of signal and return (“ground”) conductors.

Differential Mode Voltage: The voltage that drives equal and oppositely directed currents to achieve an intended circuit function; the source of differential mode currents.

Disaccommodation (D): The proportional change of permeability after a disturbance of a magnetic material, measured at constant temperature, over a given time interval.

Disaccommodation Factor (DF): The disaccommodation factor is the disaccommodation after magnetic conditioning divided by the permeability of the first measurement times logi○ of the ratio of time interval.

Effective Area (Ae [cm2; mm2]: For a magnetic core of a given geometry, the magnetic cross-sectional area that a hypothetical toroidal core of the same material properties would possess to be the magnetic equivalent to the given core.

Effective Length (le [cm; mm]): For a magnetic core of a given geometry, the magnetic length that a hypothetical toroidal core of the same material properties would possess to be the magnetic equivalent to the given core.

Effective Volume (Ve [cm3; mm3]): For a magnetic core of a given geometry, the magnetic volume that a hypothetical toroidal core of the same material properties would possess to be the magnetic equivalent to the given core.

Field Strength (H [Oe;Amp/m]): The parameter characterizing the amplitude of ac or dc field strength. Field strength is determined by the magnitude of current and geometry of the windings.

FlUX Density (B [Gauss; Tesla]): The corresponding parameter for the induced magnetic field in an area perpendicular to the flux path. Flux density is determined by the field strength and permeability of the medium in which it is measured.

Impedance Z [Ohm]: The impedance of a ferrite may be expressed in terms of its complex permeability: $Z = jroL_s + R_s = jroL_\circ(\mu''_s)$ (ohm)

Incremental Permeability [pA]: The permeability of a magnetic material about a specified operating point and applied H (especially under DC bias). The incremental permeability is expressed as the slope of the B-H characteristic the given operating point.

Inductance Factor (AL): A constant for a given geometrical shape that when multiplied by the square of the number of turns, gives the inductance in nano Henrys. Initial permeability (flux density of less than 10 Gauss) is assumed in the inductance factor.

Insulation Resistance [Ohm]: The insulation properties of the insulating material as measured in Ohms.

Leakage Flux: Leakage flux is the small fraction of the total magnetic flux in a transformer or common mode choke that does not contribute to the magnetic coupling of the windings of the device. In a transformer with a single set of primary and secondary windings, the leakage flux is that portion of flux that is produced by the primary that does not link the secondary. The presence of leakage flux in a transformer or common mode choke is modeled as a small “leakage” inductance in series with each winding. In a multi-winding choke or transformer, leakage inductance is the inductance measured at one winding with all other windings short circuited.

Leakage Inductance (^ [Henry]): That component of inductance that results from non-ideal coupling of flux to a core and/or other windings. As applied to the primary side of a transformer, the quotient of flux not coupled to the secondary winding and the current in the primary winding. As applied to an inductor, the quotient of flux outside the core and the current through the winding. In a multi-winding choke or transformer, leakage inductance is the inductance measured at one winding with all other windings short circuited.

Loss Factor (tan3/h): The phase displacement between the fundamental components of the flux density and the field strength divided by the initial permeability. This term is essentially normalized loss. Note that 1/tan3 equals Q. This term is most useful as an indicator of the useful high Q bandwidth of a material.

Above a specific frequency, depending on the material, loss factor normally undergoes a rapid increase due magnetic resonance. Note that a high Q is not desirable in all applications, especially EMI or filtering.

Loss Tangent: The measure of the loss of a magnetic material at high operating frequencies due to the oscillation of microscopic magnetic regions within the material. The loss tangent is expressed as the ratio of the imaginary permeability component p" to the real permeability of the material.

Magnetic Constant 卅。[Henry/m]): The permeability of free space. The constant ^ has a value of 4n x 10^{-7}.

Magnetic Field Intensity or Magnetizing Force (|H|): The mmf per unit length. H can be considered a measure of the strength or effort that the magnetomotive force applies to a magnetic circuit to establish a magnetic field. H may be expressed as H = Nl/d, where d = the mean length of the magnetic circuit in meters.

Magnetic Hysteresis: In a magnetic material, the irreversible variation of the flux density or magnetization which is associated with the change of magnetic field strength and is independent of the rate of change. Hysteresis results in the square or "open" characteristic of the B-H loop. Because it is irreversible, hysteresis results in lost energy. The amount of energy lost is related to the area within the B-H loop traversed.

Magnetically Soft Material: A magnetic material with a low coercivity.

Magnetomotive Force (MMF [Amp]): The magnetic field which induces a magnetic flux in a magnetic circuit. The total magnetomotive force is the product of turns and current. Also, the product of Magnetic Field and coil length.

Mean Length Turn (MLT [cm; mm]): The average length of a single turn around the toroid. Values in this catalog are given for single layer coils. In multi-layer coils, the length of each successive layer is longer resulting in a longer average turn length.

Parasitic Capacitance (Cp [F]): Unintentional capacitance resulting from close physical proximity of two conductors. The copper comprising the wire is separated by its insulation from the core. The capacitance is proportional to area (wire diameter) and inversely proportional to separation.

Permeability (p): The extent to or ease with which a material can be magnetized, often expressed as the parameter relating the magnetic flux density B induced by an applied magnetic field intensity H, as B = pH. The "absolute" permeability of a given material is expressed as the product of its relative permeability + (a dimensionless constant) and the free space constant K.

Permeability, amplitude (pa): The quotient of the peak value of flux density and peak value of applied field strength at a stated amplitude of either, with no static field present.

Permeability, incremental (pA): This is the permeability derived from the incremental difference of B and H (AB/AH), as given by a small ac signal with a static field, or bias, present. Also, minor loop permeability.

Permeability, effective (^): For a magnetic circuit constructed with an air gap(s), the permeability of a hypothetical homogeneous material which would provide the same reluctance.

Permeability, Free Space (po): The permeability of free space, a constant.

Permeability, initial (^): This is the permeability of an initially de-gaussed core driven with a small signal (2<B<10 Gauss typical) such that the permeability of a minor loop centered on the origin is measured. The drive level is specified as < 10 Gauss and is such that the minor loop is "inside" the major loop.

Note that the (amplitude) permeability initially increases with increasing field strength.

Permeability, Pulse (pP): Under stated conditions, permeability obtained from the ratio of the rate of change in flux density to the rate of change in applied field strength of the pulse field.

Power Loss Density (P [mW/cm3; kw/m3]): The power absorbed by a body of ferromagnetic material and dissipated as heat when the body is subjected to an alternating field, which results in a measurable temperature rise. The total loss is divided by the volume of the body.

Quality Factor (Q): The ratio of energy stored to energy lost (reactance to resistance). For a series LR circuit, Q is roL/R. For a parallel LR circuit, Q is R/roL.

Remanence (Br [Gauss; Tesla]): The flux density remaining in a magnetic material when the applied field strength is reduced to zero.

Resistance: A measure of the degree to which an object opposes the passage of an electrical current resistance defined as:

V
R where V = voltage, I = current. At Oe bins levels resistance is also.

Resistivity (p): The intrinsic property measured in ohm-cm that quantifies a material's opposition to free electron motion. Resistivity is the reciprocal property to conductivity. The resistance of a homogeneous material which can be found by uniform Cross section A and length I.

Rise Time (、 [sec]): Rise time of a square pulse is defined as the shortest time required for the voltage level to change from a “low” state to a “high” state. Time is customarily measured between voltage levels 10% and 90% of the “high” amplitude.

Saturation: The point at which the flux density B in a magnetic material does not increase with further applications of greater magnetization force H. At saturation, the slope of a materials' B-H characteristic curve becomes extremely small, with the instantaneous permeability approaching that of free space (relative permeability = 1.0).

Saturation Flux Density (Bs [Gauss; Tesla]): The maximum intrinsic induction possible in a material. This is the flux level at which additional H-field produces no additional B-field.

Single-Layer Winding: A winding for toroidal cores which will result in the full utilization of the inside circumference of the core without overlapping turns. Both the wire gauge and the thickness of the insulation will affect the number of turns which will fit on a single-layer winding.

Square Mils (mils2): The cross-sectional area of a circular conductor calculated as a circle (i.e., area is nr_2, where r is in mils. See also “Circular Mils.”

Temperature Coefficient (T.C.): The normalized change of the quantity considered (inductance, for instance), divided by the difference in temperature producing it.

Turns Ratio: The ratio of the number of turns on the primary to the number of turns on the secondary.

Volt Second Product (ET [Vs]): The ET product is a parameter used to measure the transformer's ability to maintain and support a pulse signal without saturating the core. It is determined as the product of the voltage applied at the primary and the time required for the magnetizing current to reach 1.5 times its linear value. Values for ET are dependent on the core geometry, core material, and the number of turns on the winding.

Volume Resistivity (p {Ohm-cm}): The resistance measured by means of direct voltage of a body of ferromagnetic material having a constant cross-sectional area where d = length of conductor, r = resistivity, A = cross-section area.

Absorbers

The following glossary of terms is useful for the absorber product line:

Attenuation: A measure of how much wave would be attenuated per unit of travel if it was a plane wave propagating through an infinite expanse of the material. Expressed in dB /cm. It is calculated from material parameters.

Broadband Absorber: A term referring to the attenuation over a large band of frequencies as opposed to narrowband absorption with attenuation over a narrow frequency band.

Cavity resonance: Cavity resonance occurs inside a conductive enclosure when energy is generated at frequencies which correspond to the resonant frequencies of the enclosure. At the cavity resonance frequencies, the resonance can provide a secondary coupling path between the energy source and a victim.

Coupling: Coupling is the undesirable transfer of energy from one medium/system to another one.

Dielectric Loss Tangent Tan δ: The quantitative dissipation of the electrical energy due to different physical processes such as electrical conduction, dielectric relaxation, dielectric resonance. The dielectric loss tangent is the ratio of imaginary portion to the real portion of the complex permittivity.

Dielectric Loss: Measure quantifying a *dielectric* material's inherent dissipation of electromagnetic energy (e.g. by converting it to heat). It is the dissipation of energy through the movement of charges in an alternating electromagnetic field as polarization switches direction. It can be parameterized in terms of either the *loss* angle δ or the corresponding *loss* tangent tan δ.

Dielectric: The electrical insulator that can be polarized by an applied electric field. When a dielectric is placed in an electric field, electric charges do not flow through the material as they do in an electrical conductor but only slightly shifted from their average equilibrium positions, causing dielectric polarization.

Electric Field E: This field surrounds an electric charge, and exerts force on other charges in the field, attracting or repelling them. The electric field is defined mathematically as a vector field that associates to each point in space the (electrostatic or Coulomb) force per unit of charge exerted on an infinitesimal positive test charge at rest at that point. The SI unit for electric field strength is volt per meter (V/m).

Enclosed Space: In these applications, the volume is on the order of a wavelength and the waves are non-propagating (standing waves) and create cavity resonances. Typically at the PCB level.

Far Field: In this region, the EM fields are dominated by radiating fields. The E and H-fields are orthogonal to each other and to the direction of propagation as with plane waves.

Free Space: These applications involve propagating waves where the volume is large relative to the wavelength of energy. Typically, this is a communication application (antenna, radar, etc.).

% IACS: (percent International Annealed Copper Standard) is a method of representing electrical conductivity, where the material's conductivity is expressed as a fraction of the conductivity of pure copper. The higher the %IACS, the more conductive the material. 100% IACS is equal to the volume resistivity of pure copper, 1.72 μΩcm.

Insertion Loss: The loss of signal power resulting from the insertion of a device or material in a transmission line and is usually expressed in decibels (dB). Insertion loss absorbers prevent energy emitted at Point A from interfering at Point B.

Isotropic/Anisotropic: Isotropic materials have uniform electromagnetic properties independent of the electric and magnetic field direction. Anisotropic materials have electromagnetic properties dependent on the field direction.

Loads/Terminations: Lossy slugs of material which are used to terminate energy propagation in a waveguide or coaxial line with minimum impedance discontinuity.

Lossy: Lossy is the ability of a material to attenuate or absorb energy. Lossy is based on either the dielectric or magnetic properties of the material.

Magnetic Field H: A vector field that describes the magnetic influence of electric charges in relative motion and magnetized materials . Magnetic fields are produced by moving electric charges and the intrinsic magnetic moments of elementary particles. Magnetic fields and electric fields are interrelated.

Magnetic field strength is measured in the SI base units of ampere per meter.

Magnetic Loss: A term referring to the various energy dissipation mechanisms taking place when a material is subject to a time-varying external magnetic field $H(t)$. As a consequence of the inherent irreversible nature of magnetization processes, part of the energy injected into the system by the external field is irrevocably transformed into heat.

Microwave: An electromagnetic wave with a wavelength in the range 0.01–0.3 m, frequency from 1 to 30 GHz, shorter than that of a normal radio wave but longer than those of infrared radiation. Microwaves are used in radar, in communications, and for heating in microwave ovens and in various industrial processes.

millimeter wave (mm wave): An electromagnetic wave with a wavelength in the range of 1 to 10 mm, frequency from 30 to 300 GHz. Millimeter waves have high atmospheric attenuation and are absorbed by gases in the atmosphere, which reduces the range and strength of the waves.

Near Field: That region very close to a radiating element (commonly < 1 wavelength) where the relationship between the electric and magnetic fields are complex with strong inductive and capacitive effects from the antenna elements. Typically, near field is at the component level for low frequencies below few GHz.

Network analyzer: A device used for measuring the reflection and transmission frequency response of microwave networks.

NRL Arch: The standard system for measurement of reflection properties of an absorber at high frequencies. It involves bouncing microwaves from a metal plate and determining reflection properties by alternately covering and uncovering the metal plate with the absorber piece under test. The difference in signal level between these two conditions indicates the absorption capability of that absorber.

% Open Area: Refers to the percentage of a vent panel that is open to the movement of airflow.

Parameters: Includes the real and imaginary part of permittivity and permeability as a function of frequency of a material. Parameters are used in modelling software for simulation purposes.

Permeability: Measure of a material's ability to store magnetic energy (μ). It is the degree of magnetization that a material obtains in response to an applied magnetic field.

Permittivity: Measure of materials ability to store electric energy. Often called the dielectric constant (ε). It is a measure of the electric polarizability of a dielectric. A material with high permittivity polarizes more in response to an applied electric field than a material with low permittivity, thereby storing more energy in the electric field. It can depend on the frequency, magnitude, and the direction of the applied field. The SI unit for permittivity is farad per meter (F/m).

Plane Wave: Propagating electromagnetic waves that are equal in magnetic and electric energy. In the far field, all waves propagate as plane waves.

Polarization: The orientation of the electric field of the radiation. Radiation transmitted from a dipole antenna has its electric field parallel to the antenna. The wave travels in a direction perpendicular to the antenna. The electric field of the radiation being transferred is perpendicular to the widest dimension of the rectangle.

Polyurethane: Polymers which are most commonly formed by reacting a di- or tri-isocyanate with a polyol. Since polyurethanes contain two types of monomers, which polymerize one after the other, they are classed as alternating copolymers. Available as soft or hard compact or foam material.

Radar Cross Section: A reference to the level of signal reflected from the radar target. The term RCS pattern refers to the pattern of the reflective signal level of a specific target at a specific frequency as the target is rotated.

Radiating source: The component or area generating an unwanted and disturbing energy/wave.

RAM: Radar absorbent material.

Reflection Coefficient: The ratio of reflected to incident energy.

Reflectivity: Measure how much of the incoming wave is reflected/absorbed toward a reference metal plate (perfect reflector). Attenuation is measured in decibels -20 dB = 99% absorbed (1% reflected).

Resonant frequency: Resonant frequency is the oscillation of a system at its natural or unforced resonance. Resonance occurs when a system is capable of storing and easily transferring energy between different storage modes, such as Kinetic energy or Potential energy as you would find with a simple pendulum. Most systems have one resonant frequency and multiple harmonic frequencies that get progressively lower in amplitude as they move away from the center.

RF: Radio Frequency-frequency of radio waves, commonly 3 kHz-300 GHz.

Sidelobes: side lobes are the lobes of the far field radiation pattern of an antenna that are not the main beam.

Standing Wave: If a wave continuously impinges on a surface (CW or continuous wave) a situation often occurs where the voltage at any given point between the transmitter and receiver is constant. This occurs via phase addition of the incident and reflected waves. This phenomenon is used to determine dielectric and magnetic properties of materials at radar frequencies.

Surface Currents: Traveling and creeping waves which contribute to RCS of an object.

Thermoplastic: Material that becomes pliable or moldable at a certain elevated temperature and solidifies upon cooling. Most thermoplastics have a high molecular weight. The polymer chains associate by intermolecular forces, which weaken rapidly with increased temperature, yielding a viscous liquid. In this state, thermoplastics may be reshaped and are typically used to produce parts by various polymer processing techniques such as injection molding.

Thermoset: Polymer, resin, or plastic that is irreversibly hardened by curing from a soft solid or viscous liquid prepolymer or resin. Curing is induced by heat or suitable radiation and may be promoted by high pressure or mixing with a catalyst. It results in chemical reactions that create extensive cross-linking between polymer chains to produce an infusible and insoluble polymer network.

Victim: A component or area being disturbed by radiating source.

VSWR: Voltage Standing Wave Ratio is the ratio of maximum to minimum of voltage over a single cycle of field variation. Refers to the fact that, with reflections present, fields are periodic (i.e., they vary as a sine wave in intensity.) The greater the level of reflection, the greater the so called VSWR (the greater the ratio of maximum to minimum over a single cycle of field variation).

Waveguide: A device to guide electromagnetic waves with minimal power loss. Waveguide usually is in the form of a rectangular metal tube. The electric field of the radiation being transferred is perpendicular to the widest dimension of the rectangle. A wave guide is useful over a narrow frequency range.

Precision Metals

Absorption: Dissipation of electromagnetic energy (as heat) in passing through a substance.

Absorption Loss [(dB)]: is the ratio of electromagnetic energy entering a substance to that absorbed by the substance.

Alloy: An alloy is a combination one metallic element with one or more other metallic or nonmetallic elements. Alloys have the typical properties of a metal, such as electrical conductivity, ductility, opaqueness, and luster. Alloys are classified by the element with the largest percentage by mass, and further classified by their content of alloying agents. For example, among copper alloys, there are beryllium coppers, titanium coppers, brasses, bronzes, nickel silvers, and many others. Among aluminum alloys, there are different series 1000, 2000, 3000, … Many different systems for classifying alloys exist around the world. In North America, the UNS (Unified Numbering System) is used to assign a unique number each commercial alloy. ASTM, AISI, or SAE specifications are used to define tempers and their required properties. In Asia and Europe respectively, JIS (the Japanese Industrial Standard) and EN (European Norms) are the systems most widely used to classify alloys and provide property specifications for tempers.

Aperture: an opening, hole, or gap in an electronic equipment enclosure through which internal or external electromagnetic fields may couple.

Attenuation [(dB)]: Attenuation is the ratio of energy loss to total energy.

Bend Formability: Often simply called “formability.” Formability is the minimum recommended ratio of inside bend radius to material thickness. Formability recommendations are typically based on 90° bends, and vary with material type and temper. Occasionally, separate recommendations may be found for 180° bends or for very thin materials. Recommendations are based on visual inspection of the outer bend surface, and subjective judgement of how much roughness, thinning, or cracking is considered unacceptable. For bends that will be subjected to significant stress or load cycling, use of the typical minimum recommendations from material suppliers risks premature failure.

Bend: As a noun, bend is a region of sheet metal that has been formed into a cylindrical arc. As a verb, noun means to form sheet metal into a cylindrical arc. This is accomplished by applying the right amount of over-bend (smaller radius and larger angle), such that the elastic spring-back of the material leaves the free-state bend with the desired radius and angle. Types of bending processes include v-bending (a rounded v-shaped punch forces sheet metal into a v-shaped die), wipe-bending (sheet metal is first pinned on one side by a pressure pad, and then bent on the other side by being clamped between punch and die surfaces), and air-bending (no tool present on inside of bend.)

BLS – Board Level Shield: Refers to an enclosure that covers PCB component(s), protecting (shielding) them from outside EMI/RFI and/or containing EMI/RFI that is produced by the enclosed component(s). The most basic BLS are 5-sided folded sheet metal boxes that are soldered to the PCB, which becomes the 6th side of the shield. Dense/complex PCB layouts and challenging shielding/cooling requirements often demand more complex BLS geometries.

Bulk Packaging: Refers to many parts being placed together in boxes or bags.

Burr: A sheet metal burr is metal on a cut edge that protrudes from the sheet metal surface. Burrs can be caused by the punch and die tooling that are used to create the cut edge. The side of the metal that is first hit by the punch is typically rounded by adjacent material being drawn by the punch. Because there is typically only a small clearance designed between punch and die, the metal in the clearance area is drawn down slightly into the opening in the die. Then the punch shears the middle of the thickness, and then breaks through the opposite side of the sheet metal, producing an angle to the cut and possibly a burr.

Brittle: describes material having low ductility. Some people consider materials with elongation < 5% to be brittle.

CAD: Computer Aided Design is technology for design and technical documentation, which replaces manual drafting with an automated process. 2D CAD is used for things like architectural drawings, electrical diagrams, and simple tool layouts; 3D CAD (a.k.a. solid modeling) is used for product and tool designs, and to facilitate Computer Aided Manufacturing (CAM), such as CNC (Computer Numeric Controlled) machining and 3D printing. Parametric modeling (a.k.a. feature based modeling) is the creation of geometry through a series of features that are driven by sets of parameters chosen by the designer. Direct modeling doesn't retain a history of features or parameters. Commonly used CAD software packages include: PTC Creo, Solidworks, Catia, Unigraphics, and others, each having their own native CAD file formats. Sharing CAD files traditionally has involved sharing a neutral file format such as STEP (STandard for the Exchange of Product model data, the neutral format most used to exchange data between CAD systems. The development of STEP started in 1984 as a successor to IGES and others. IGES a.k.a. IGS stands for "Initial Graphics Exchange Specification".)

Carrier: Refers to the portion of sheet metal strip that is used to carry (convey) a sheet metal product through progressive die tooling, and sometimes also through cleaning, heat treatment, and finishing operations. In some cases, the carrier may be a part of the finished product. This is common with fingerstock. In many products, like BLS, the carrier is recycled. The carrier begins when pilot holes are punched in the sheet metal. Pilot holes are used to advance and locate the strip for subsequent operations.

Castellations: Patterns of small notches in the bottom edges of a BLS. Castellations provide venting for differential air pressures that otherwise may develop during the reflow process, provide gaps in the BLS solder joint for other circuits to pass through, and may help with BLS placement accuracy by giving excess solder a place to go and by providing more solder menisci to keep the BLS from floating off center on the solder traces.

Coin, Coining: Coining, as it relates to sheet metal, is a stamping process. To coin sheet metal is to strike it normal to its surface to form the sheet metal thinner in some areas, with some material spreading laterally to potentially also create slightly thicker areas as well. Coining is typically done without the addition of heat, and so may also be classified as a type of cold forging. Coining generally requires relatively thick, soft material, as well as the absence of adjacent material restricting lateral expansion.

Cold Forging: Refers to complex forming of a metal by cold working (i.e., deformation without the addition of heat. When applied to sheet metal, cold forging is used to create areas of different thickness, and is often called Coining.

Cold Work: Cold work is plastic deformation applied without the application of heat. Most metals increase in strength and decrease in ductility as they are cold worked (such as when sheet metal is reduced in thickness by a rolling mill.) This process is called work hardening.

Compression Force (F [lbs. (pounds): N (Newtons); gf (grams force); kgf (kilograms force)]): the force required to compress a part a particular distance.

Compression Set ([%]): Refers to the ratio of permanent set to the compression displacement that caused the permanent set, generally expressed as a percentage. This definition is found in ASTM D395 as "Compression Set B", or more formally, "compression set under constant deflection in air", and the test specimen is compressed to 75% of its original height. ("Compression Set A", or "compression set under constant force in air" are not used by Laird.)

Contact Resistance [mΩ (milliOhms): Ω (Ohms)]: the electrical resistance associated with a contact interface.

Coplanarity: In geometry, a set of points in space are coplanar if there exists a geometric plane that contains them all.

Corrosion: Corrosion is a chemical action which causes destruction of a metal surface by chemical contamination, oxidation, or electrolysis.

Chromate Conversion Coating: Refers to a type of conversion coating used to passivate galvanized steel, aluminum, and other metals. This coating is primarily used as a corrosion inhibitor, primer, decorative finish, or to retain electrical conductivity. The process is named after the chromate found in chromic acid, also known as hexavalent chromium, the chemical most widely used in the immersion bath process whereby the coating is applied. However, hexavalent chromium is toxic, thus, highly regulated, so new, non-hexavalent chromium-based processes are becoming more readily available at a commercial level. One alternative contains trivalent chromium. Chromate conversion coatings are commonly applied to everyday items such as hardware and tools, and can usually be recognized by their distinctively iridescent, greenish-yellow color.

Creep: Refers to the accumulation of plastic deformation under constant load. Creep is caused by the same phenomenon as stress relaxation, only creep is due to constant load, and stress relaxation is the decrease in stress (and spring force) due to constant total strain (such as a fixed displacement.) The rates of creep and stress relaxation generally increase with temperature. The effects of creep deformation generally become significant at approximately 35 percent of the melting point for metals.

dB (Decibels): A unit used to measure the power level of an electrical signal by comparing it with a reference level on a logarithmic scale.

Deboss: See Dimple.

Deburr: A process to remove burrs.

Deep Drawn: Sheet metal that has been drawn relatively deep (considering material thickness and formability.)

Dielectric: A medium or substance that transmits electric force without conduction; an insulator. Dielectric coatings are applied in some shielding applications for the purposes of insulating.

Dimple: (a.k.a. deboss) A small indentation. Among Laird's sheet metal products, the opposite side of the dimple, specifically the embossed side, is more often the functional side.

Draw: As a verb, draw means to form sheet metal with compound curvature, typically done by a progression of stretching operations. As a noun, draw means an area of sheet metal having compound curvature. Such an area is referred to as having been drawn. The act of producing a draw is called drawing.

Ductility: Ductility is a measure of a material's ability to undergo plastic deformation before rupture.

EDM: Electro Discharge Machining, also known as spark machining, spark eroding, die sinking, wire burning or wire erosion, is a manufacturing process whereby a desired shape is obtained by using electrical discharges (sparks). Material is removed from the work piece by a series of rapidly recurring current discharges between two electrodes, separated by a dielectric liquid and subject to an electric voltage.

Elastic Modulus: (E [psi (pounds per square inch); MPa (Mega-Pascals); GPa (Giga-Pascals)]): Also known as "Young's Modulus" or "Modulus of Elasticity," this property is the ratio of stress to strain in the early part of a tensile test, while the material is behaving elastically. It describes the inherent elastic stiffness of a material. Part geometry, elastic modulus, and to a small extent Poisson's ratio are all that are needed to fully characterize the elastic force versus displacement behavior of metal components.

Most commonly, it is determined from a tensile test, along with yield strength, ultimate tensile strength, and elongation. Bend tests are sometimes used to derive a “Flexural Modulus”, however there is much more potential for error in this measurement, making it inappropriate for use in product simulations. To distinguish from the inferior flexural modulus, elastic modulus derived from a tensile test is sometimes called, “Tensile Elastic Modulus.”

Elastic: Elastic deformation is deformation (strain) that is fully reversed by removing the loads that caused the deformation (strain.)

Electroless Plating: Also known as chemical or auto-catalytic plating, electroless plating is a non-galvanic plating method that involves several simultaneous reactions in an aqueous solution, which occur without the use of external electrical power. Electroless nickel (actually a nickel-phosphorus alloy available in multiple ranges of percent phosphorus) is a common type of electroless plating, having very different mechanical properties from the various types of electrolytic nickel plating.

Electrolytic Plating: Refers to a process that uses electrical current to deposit metal ions from a plating solution (electrolyte) to the material to be plated (cathode.) In some cases, ions enter the solution through oxidation off an anode. In other cases, a non-consumable anode is used, and metal ions are periodically replenished to the electrolyte bath. Due to variations in current density in the electrolyte, final plating thickness can vary on parts, from thicker on exposed areas, to thinner where there is less circulation of the plating bath.

Elongation: a.k.a. Tensile Elongation, is traditionally measured after a tensile test specimen has been pulled to failure, by placing the broken test specimen back together and recording the ratio of final – original gauge length to original gauge length. In the absence of necking (as with relatively brittle materials), elongation is the uniaxial plastic strain at failure. (In contrast, elongation for polymeric materials is typically defined as the total strain at failure; elastic + plastic strain.) Necking is a tensile test instability affecting ductile materials, where localized shrinking of the cross section of the tensile specimen leads to locally increased stress and strain, and further localized reduction of the cross section, leading to premature failure. Plastic strain in the necked region can be several times higher than plastic strain elsewhere on the specimen gauge length, and since elongation is calculated over the total gauge length, it becomes a poor measure of plastic strain at failure for ductile materials.

Emboss: Refers to a raised area. In sheet metal, this is done by a stamping punch that hits the opposite side. The indented area opposite an emboss is called a deboss or a dimple.

EMI: Electromagnetic Interference: Electromagnetic interference (EMI), also called radio-frequency interference (RFI) when in the radio frequency spectrum, is a disturbance generated by an external source that affects an electrical circuit by electromagnetic induction, electrostatic coupling, or conduction. The disturbance may degrade the performance of the circuit or even stop it from functioning. Both man-made and natural sources generate changing electrical currents and voltages that can cause EMI: ignition systems, cellular network of mobile phones, lightning, solar flares, and auroras (northern/southern lights). EMI frequently affects radios, mobile phones, and televisions, as well as observations for radio astronomy and atmospheric science. EMI can be used intentionally for radio jamming, as in electronic warfare.

ESD: Electrostatic Discharge is the recombination of unbalanced electric charges accumulated on an insulated object. Lightning is a powerful example of ESD.

EZ Peel: These patented shields have a solid top, scored to allow peel-off when access to board level components within the shield is required. The peel-off feature prevents damage to the board and components by eliminating the need for labor intensive de-soldering, which often results in increased scrap. Peeling off the cover is accomplished by using a hook scriber or tweezers to pull from a small starter hole.

Fatigue Life: Fatigue life (a.k.a. Endurance Life or Cycle Life) is a measure of how many times (cycles) a spring may be loaded before failure. Fatigue life is a function of the maximum and minimum stress levels, material type and temper, grain direction, and surface conditions. Small imperfections in the surface can have a relatively large impact on fatigue life.

Fatigue Strength: Fatigue strength (a.k.a. fatigue limit or endurance limit) is the stress level below which an infinite number of loading cycles can be applied to a material without causing fatigue failure. Ferrous alloys and titanium alloys have a distinct limit. Other structural metals, such as aluminum and copper, do not have a distinct limit and will eventually fail even from small stress amplitudes. In these cases, the term endurance strength is used. Endurance strength is defined as the maximum value of completely reversed bending stress that a material can withstand for a finite number of cycles (like 108) without a fatigue failure.

FEA: Finite Element Analysis is the simulation of any given physical phenomenon using the numerical technique called Finite Element Method (FEM). Engineers use it to reduce the number of physical prototypes and experiments and optimize components in their design phase to develop better products, faster. To solve a problem, the FEM subdivides a large system into smaller, simpler parts that are called finite elements. This is achieved by discretization in the space dimensions, which is implemented by the construction of a “mesh” of the object: the numerical domain for the solution, which has a finite number of points. The finite element method formulation of a boundary value problem finally results in a system of algebraic equations. The method approximates the unknown function over the domain. The simple equations that model these finite elements are then assembled into a larger system of equations that models the entire problem. The FEM then uses variational methods from the calculus of variations to approximate a solution by minimizing an associated error function.

Finger: A finger (a.k.a. spring finger) is a relatively long and thin spring, cantilevered off a broader area of sheet metal. Fingers may range from simple flat or bent cantilevers beams, to more complex shapes formed by many bends, and having drawn contact embosses on the fingertips.

Fingerstock: Figerstock products are generally long sheet metal strips, each carrying a pattern or patterns of fingers, typically oriented perpendicular to the strip length. The strip is often called the carrier because it carriers all the fingers, but also because it is often also used for carrying the fingerstock through the tooling.

Fold: When used with respect to sheet metal, “fold” is similar in meaning to the word “bend” but tends to more often refer to relatively sharper inside bend radii, and/or 90 degree or 180-degree bend angles.

Folded (Bent): Refers to the past tense of the word “fold” (“bend”), and is often used to describe a BLS that is not drawn.

Formability: Formability is the ability of a piece of metal to undergo plastic deformation without being overly damaged for use. See Bend Formability definition for more specific information related to bending.

FR Coating: Flame Retardant Coating

Full (or Fully) Drawn: Refers to a BLS having corners that are fully drawn, fully from the top surface of the BLS to the bottom.

Galvanic (Bimetallic) Corrosion: Refers to an electrochemical process in which one metal corrodes preferentially when it is in electrical contact with another, in the presence of an electrolyte. (A similar process is used by batteries.) The electrolyte can simply be air with humidity. Greater humidity and the presence of salts and/or other pollutants in the air will accelerate the corrosion reaction. Dissimilar metals and alloys have different electrode potentials, and when two or more come into contact in an electrolyte, one metal acts as anode and the other as cathode. The electro-potential difference between the reactions at the two electrodes is the driving force for an accelerated attack on the anode metal, which dissolves into the electrolyte. This leads to the metal at the anode corroding more quickly than it otherwise would

and corrosion at the cathode being inhibited. The presence of an electrolyte and an electrical conducting path between the metals is essential for galvanic corrosion to occur. The electrolyte provides a means for ion migration whereby ions move to prevent charge build-up that would otherwise stop the reaction.

Galvanic Compatibility: Refers to the relative difference between anodic index of two contacting materials, and to the risk of galvanic corrosion. A Galvanic Series is a table or chart, ordering metals by anodic index. Materials having anodic indices differing by more than 0.5V are generally not recommended to be in contact with one another, even in the low humidity of an office environment. For high humidity/outdoor conditions, electro-potential difference is recommended to be 0.1V or less to minimize galvanic corrosion.

Gasket (a.k.a. Seal): A generally flexible part used to seal a seam between two surfaces. Gasket flexibility allows the gasket to make sealing contact over a range of possible gaps, due to manufacturing variation, thermal expansion, etc. Environmental gaskets are used to seal against movement of gases, liquids, dust, etc. EMI gaskets are used to seal against the transfer of electromagnetic energy.

Grain Direction: Material grain direction is the rolling direction of strip materials. The rolling process elongates grains in the rolling direction, creating increasingly orthotropic mechanical properties with increasing cold work done by roll reduction. For this reason, sheet metal bend formability recommendations for longitudinal and transverse bends tend to diverge with increasing temper.

Grain: Grains, also known as crystallites, are small crystals which form, for example, during the cooling of many materials (crystallization). A very important feature of a metal is the average size of the grain. The size of the grain determines the properties of the metal. Randomly oriented, the grains contact each other at surfaces called grain boundaries.

Ground / Grounding: In electrical engineering, ground or earth is the reference point in an electrical circuit from which voltages are measured, a common return path for electric current, or a direct physical connection to the earth. Grounding is the act of electrically connecting to ground.

Half (or Partially) Drawn: Refers to a BLS having corners that are drawn down only partway from the top surface of the BLS to the bottom. The term “Half drawn” is often used even when the draw doesn’t extend exactly halfway down.

Hardness: Refers to the resistance of material to plastic deformation, measured by indentation, scratch, or rebound. Metal hardness is typically measured by indentation. There are many indentation hardness scales in use; the most commonly one used for sheet metal is Vickers Hardness (VH), also known as Diamond Pyramid Hardness (DPH). Indentation hardness correlates roughly linearly with tensile strength, but it is an imperfect correlation often limited to small ranges of strength and hardness for each indentation geometry. A hardness measurement is generally quick, simple, and nondestructive, which makes it very useful as a quality check.

HB: Refers to slow burning on a horizontal specimen; burning rate < 76 mm/min for thickness < 3 mm or burning stops before 100 mm.

Heat Treatment: Refers to the use of heat to modify the properties of a material.

Hem: A hem is a 180-degree bend that has been closed to a very small inside radius.

Hz – Hertz: Refers to the number of cycles per second.

Impedance (Z [Ohms]): Refers to the total opposition offered by a compound or circuit to the flow of alternating or varying electrical current. Impedance is a combination of resistance R and reactance X, computed as $|Z|=\sqrt{R^2+X^2}$, or as $Z=E/I$, where E is the applied AC voltage and I is the resulting current.

Isotropic: Isotropic materials have mechanical properties which are the same when measured in different directions.

Layer Packaging: Refers to the packaging of parts between foam layers (to keep parts from becoming entangled with each other and reduce the risk of damage during shipping.)

MaxAir: Laird trademark name for an EMI suppressing vent panel made of nickel copper plated polycarbonate honeycomb material, with a compressible conductive perimeter gasket to accommodate variations opening dimensions.

Mil: 0.001 inch

Mounting Methods (for Fingerstock): Clip-on, slot mount, edge mount, track mount, groove mount, clamp, rivet, screw, PSA, solder, laser weld, spot weld.

Nominal: A value assigned for convenience, as opposed to an actual one. Nominal values are usually presumed/approximate/typical/average values.

Orthotropic: Orthotropic materials have material properties that differ along three mutually-orthogonal twofold axes. Mechanical properties of sheet metal become more orthotropic (less isotropic) as temper increases.

Overcompression: Refers to any compression causing a permanent deformation to a component.

Oxidation: Oxidation is any chemical reaction that involves the moving of electrons. Specifically, it means the substance that gives away electrons is oxidized. While this often is the result of combining a material with oxygen, oxidation doesn't necessarily involve oxygen.

Passivation: Refers to the process of treating or coating a metal in order to reduce the chemical reactivity of its surface. In stainless steel, passivation typically means removing the free iron from the surface of the metal using a nitric or citric acid solution to prevent rust. A common form of passivation used for galvanized steel, aluminum, and other metals is chromate conversion coating.

PCB: Printed Circuit Board (a.k.a. PWB: Printed Wiring Board)

Permanent Set ([in., mm]): Permanent set is the manifestation of plastic strain on a part, as deformation that isn't reversed when loads are removed.

Pick Bridge: A pick bridge is a typically narrow length(s) of sheet metal that connects the top surface of a BLS to a pick-up area (often located near the BLS center of mass) that can be used by SMT pick-and-place equipment to pick the BLS from packaging and place it onto a PCB.

Pick-and-Place: Refers to automated equipment, packaging, and sheet metal features used to facilitate picking up and placing components on PCBs.

Plastic: The noun, "plastic" refers to a class of polymeric materials. The adjective, "plastic" refers to the ability of a material to be molded to a shape. Plastic deformation is deformation (strain) that is not reversed by removing the loads that caused the deformation (strain.)

Poisson's Ratio: Refers to the ratio of the proportional decrease in a lateral measurement to the proportional increase in length in a sample of material that is elastically stretched. Most alloys used by Laird have a Poisson's Radio of between 0.27 and 0.34

PSA: Pressure sensitive adhesive is a type of non-reactive adhesive which forms a bond when pressure is applied to bond the adhesive with the adherend. No solvent, water, or heat is needed to activate the adhesive. It is used in pressure-sensitive tapes, labels, and a wide variety of other products. As the name

"pressure-sensitive" indicates, the degree of bond is influenced by the amount of pressure which is used to apply the adhesive to the surface. Surface factors such as smoothness, surface energy, removal of contaminants, etc. are also important to proper bonding.

Radiated Emissions: That electromagnetic energy which is radiated in and/or out, through escape coupling paths such as cables, leaky apertures, or inadequately shielded housings.

Radiation: Electromagnetic energy, such as light waves, radio waves, x-rays, or infrared waves traveling through a medium or through space.

REACH: Registration, Evaluation, Authorization and Restriction of Chemicals: a regulation of the European Union, adopted to improve the protection of human health and the environment from the risks that can be posed by chemicals, while enhancing the competitiveness of the EU chemicals industry.

ReCovr: Laird trademark name for a patented BLS product made from a single piece of sheet metal and having a removable and replaceable cover. This is accomplished by shearing the cover from the frame in the flat, before forming the side walls of the frame. After the side walls are formed (in the Rigid Corner style), periodic dovetail features (plus friction and slight interference) keep the two pieces together, while undulations in the cutout keep aperture size small to benefit EMI shielding.

REF: REF on component drawings denotes reference information; not a requirement.

Reflection: The redirection of a propagating electromagnetic field, due to an abrupt change in the impedance at the boundary of a shield.

Reflow: A soldering process whereby PCBs are conveyed through an oven that melts solder paste, bonding components to the PCB with solder as it is cooled.

Relative (Magnetic) Permeability: Refers to the magnetic permeability of a shield material relative to the permeability of free space.

Removable Pick Bridge (ReMovl): ReMovl incorporates the ReCovr attachment mechanism applied to the pickup bridge of the BLS frame to allow for easy, tool-less detachment of the bridge after the frame is soldered to the printed circuit board. The ReMovl feature is ideal for applications that require the bridge to be detached including inspection, rework, thermal interface material (TIM) assembly into cover, and noise or vibration concerns of bridge to cover.

Residual Stress: Residual stress is internal stress remaining in a part, in the absence of external/applied load. In thin sheet metal springs that are heat treated after forming to cause a phase change, residual stress is typically eliminated. Heat treatments that don't cause a phase change, like the low temperature tempering of austenitic stainless steel, can reduce residual stress. Sheet metal springs that are not heat treated after forming will have residual stresses in the bent areas that impacts spring performance. A typically formed bend will have residual tensile stress on the inside surface and residual compressive stress on the outside (of magnitude close to half of yield strength) that makes the bend behave more resiliently when re-bent than when unbent.

Resilience: Informally, resilience is the capacity of a spring to recover to original height after deflection. Formally, resilience is the ratio of yield strength to elastic modulus (a.k.a. yield strain.)

Resistance: Electrical (R [Ω, Ohms]): Refers to the opposition that a substance offers to the flow of direct electric current. The resistance (R) of an object is defined as the ratio of voltage across it (V, Volts) to current through it (I, Amps.)

RFI: Radio Frequency Interference is electromagnetic interference (EMI) within the frequency range 3 kHz to 300 GHz.

RH: Relative Humidity ([%]): Refers to the amount of water vapor present in air expressed as a percentage of the amount needed for saturation at the same temperature.

Rigid Corner: Refers to a Laird patented BLS design having partially drawn corners, with the remainder of the corner apertures being effectively closed by a very narrow serpentine slot that provides excellent shielding effectiveness while allowing a taller BLS than could be fully drawn.

RoHS: Restriction of Hazardous Substances, also known as Directive 2002/95/EC, originated in the European Union and restricts the use of specific hazardous materials found in electrical and electronic products.

Selective Plating: Refers to coating one metal over another in specific areas and not in others.

Shelf Life: Refers to the length of time under specified storage conditions that a material retains its usability and specified properties.

Shield: As a noun, a shield is an electrically conductive material placed around a circuit, component, or cable to suppress the effect of an electromagnetic field within or beyond definite regions. As a verb, to shield is to suppress using electrically conductive material.

Shielding Effectiveness ([dB]): Refers to the effectiveness of a given material as a RFI shield, under a specific set of conditions.

Slot: A slot is a cut feature in sheet metal, either open-ended or closed. Examples: Long, narrow open-ended slots are used to separate the metal into a series of contact fingers. Closed slots often have an obround perimeter (like a racetrack; two semicircles with straight sections in between), and may be used in tandem with latching features, or for mounting.

SMT: Surface Mount Technology refers to components that are attached to the surface of a PCB typically by a reflow solder process, and to the equipment that places them there.

Solder Pad: Solder pad is an area of exposed metal (typically copper) on the surface of a PCB, intended for soldering a SMT component.

Solder Paste: Solder paste is a mixture of tiny solder beads and flux, used with reflow soldering processes, that sticks components to the PCB with surface tension. The flux keeps the joint clean while the solder beads melt together to form solder joints after being cooled.

Solderability: The solderability of a substrate is a measure of the ease with which a soldered joint can be made to that material. Good solderability requires wetting of the substrate by the solder.

Stiffness ([lbs./in., N/mm]): The ratio of force to displacement.

Strain (ε): Engineering strain (a.k.a. nominal strain) is the ratio of deformation to original dimension. For example, a 1000mm long piano wire that is stretched 2mm is strained 2/1000, or 0.002 (notice that strain has no units.) Strain is often written as a percent. In this example, strain is 0.2%. True Strain (a.k.a. Logarithmic Strain) provides the correct measure of the final strain when deformation takes place in a series of increments, taking into account the influence of the strain path, and is the integral of small strain increments, giving rise to the natural logarithm function in the relationship: True strain = ln(1 + engineering strain). FEA generally requires metal mechanical property inputs to be in terms of true (log) strain, and FEA results are generally reported as true (log) strain.

Stress (σ [psi, MPa]): In a tensile test, engineering stress (a.k.a. Nominal Stress) is the ratio of force to original cross-sectional area. True Stress is the ratio of force to current cross sectional area, and = engineering stress * (1 + engineering strain). FEA generally requires metal mechanical property inputs to be in terms of true stress, and FEA results are generally reported as true stress.

Stress Relaxation: Stress relaxation is the gradual decay of stress under constant strain, especially at elevated temperatures. Elastic strain is slowly converted to plastic strain, so that the permanent set increases over time. This property is measured by applying a fixed strain or displacement to a sample and measuring either the decrease in normal force or the increase in permanent set over fixed time intervals. Creep is essentially the same phenomenon, only creep is increasing plastic strain due to constant stress.

Surface Treatment/Plating/Finish: Metals are given surface treatments for corrosion protection, electrical conductivity, electrical insulation, wear resistance, and/or appearance. Some surface treatments are done only to facilitate adhesion of other treatments, to prevent diffusion between layers and the growth of undesirable intermetallics, to level the surface in preparation for a smoother/brighter/low-friction top-coat, or for other reasons, like tin whisker mitigation.

Susceptibility: Refers to the tendency of an equipment to malfunction when subjected to unwanted electromagnetic energy.

Tape and Reel Packaging: Refers to a type of packaging used for components to be applied to PCBs. Components are placed in a strip of plastic tape having periodic vacuum-formed pockets made for holding individual components with a common orientation. As components are placed in the tape, a thinner clear plastic strip is bonded to the top surface to captivate the components, and the tape is coiled around a reel for shipment. Automated equipment is then typically used to advance the tape using pilot holes, peel away the plastic cover, and pick and place the components onto PCBs.

Temper: Temper describes the history of cold work and/or thermal treatment done to a metal alloy. Common temper names include annealed, ¼ hard, ½ hard, ¾ hard, full hard, extra hard, and spring hard. Soft tempers are used to tolerate severe forming operations, where low strength can be tolerated. Hard tempers are used when low formability can be tolerated, and when high strength is needed. Intermediate tempers are used for parts requiring moderate formability and strength. Specifications use different types of temper designations to briefly classify the treatments that have been done. For example, in ASTM B-194, TD02 represents beryllium copper alloy strip that has been reduced in thickness 21% by a rolling mill after the last annealing heat treatment. The common temper name for this material is “1/2 H temper.” TH02 temper, a.k.a. “1/2 HT temper”, is this same material after aging at 315°C for 2+ hours to harden the material by precipitating beryllium atoms out of a supersaturated solution.

Tensile Strength (σT [psi, MPa]): Tensile strength generally refers to the ratio of highest force recorded in a tensile test to the original cross-sectional area of the tensile test specimen. More formally, this is called, “Ultimate Tensile Strength”, abbreviated “UTS.” Tensile strength is less important than elastic modulus and yield strength as a parameter for judging sheet metals for applications where elastic behavior is preferred (such as board level shield, spring, and structural applications.) Tensile strength becomes an important parameter for materials that suffer significant plastic deformation.

Through Hole Loc™ Pins: A Laird patented BLS thru-pin design that pivots during pin insertion to grip the opposite side of the PCB and hold the BLS in place.

Transfer Impedance: A method for testing shielding effectiveness, using a coaxial test fixture. The method is described in SAE-ARP-1705.

Transverse (vs. Longitudinal): Transverse indicates the orientation of a feature, such as a sheet metal bend, relative to the strip (grain) direction of a material.

UL94: The Standard for Safety of Flammability of Plastic Materials for Parts in Devices and Appliances testing. It is a plastics flammability standard released by Underwriters Laboratories of the United States. The standard determines the material’s tendency to either extinguish or spread the flame once the specimen has been ignited. Two of the more common classifications are listed below:

Ultrasoft™: A Laird proprietary process used to reduce thickness of sheet metal products, thereby reducing part stiffness.

V-0: Refers to burning stops within 10 seconds on a vertical specimen; drips of particles allowed as long as they are not inflamed.

Volume Resistivity ([Ω-cm, Ohm-cm]): The electrical resistance between opposite faces of a centimeter cube of material.

Wiping: The act of engaging a gasket with lateral sliding contact, rather than compression normal to the mounting surface.

Work Hardening: Work hardening, also known as strain hardening, is the strengthening of a metal by plastic deformation. This strengthening occurs from dislocation movements and dislocation generation within the crystal structure of the material. Processed that produce work hardening are often called cold work, because they are done without the addition of heat.

Yield Strength (σY, RP0,2 (European) [psi, MPa]): Yield strength (a.k.a. Proof Strength) is a mechanical property of a metal, referring to the stress at which permanent (plastic) deformation begins. Yield strength is most commonly determined from a tensile test, along with elastic modulus, ultimate tensile strength, and elongation. Bend tests are sometimes used to derive a “Flexural Yield Strength”, however there is much more potential for error in this measurement, making it inappropriate for use in product simulations. To distinguish from the inferior flexural yield strength, yield strength derived from a tensile test is sometimes called, “Tensile Yield Strength.” In practice, it is hard to measure and agree on the point where plastic deformation begins. A few materials, like low carbon steel, have a clearly defined yield point. Most materials, like copper alloys, aluminum alloys, and austenitic stainless steel do not have a clearly defined yield point. So, yield strength is typically measured as the stress at which a specific amount of plastic strain has occurred. Most commonly, a 0.2% plastic strain offset is used, and yield strength is reported as 0.2% offset yield strength, or equivalently as 0.2% Proof Stress. When the 0.2% is left off the name, it can be assumed.

Electromagnetic Interference

Basic Weight: The weight of a sheet of fabric, paper, film, or adhesive layer expressed in terms of the weight of a sheet area (gram per square meter)

Compression Set: A measurement of the degree to which a gasket or fam will recover to its original shape after a specified compression is applied for 22 hours or 7 days at a specified temperature. The measurement determines the thickness after the force is released and compares it with the original thickness. The method to be followed is ASTM D3574 Test D.

Conductive Fabric: Fabric, with metal plated, to offer the performance of electrically conductivity. The most popular plated metals include copper, nickel, tin, silver, and gold.

Conductive Fabric Tape: A tape which is composed of a conductive fabric layer and conductive PSA. The conductive PSA can be on one side or both sides.

Conductive Foam: A foam with metal plating over the whole body to offer an overall electrical conductivity in all directions to be used in electrical grounding or EMI shielding.

Cooling Zone: After reflow soldering an area, the product needs a cooling, solidified solder joint**.** Cooling speed control is also very critical. Fast cooling may damage the assembly. Slow cooling would cause weak solder joints.

CPSA: Conductive pressure sensitive adhesive. Usually a small amount of conductive fillers will be added into a pressure sensitive adhesive to make it electrically conductive.

Die-cutting: Cutting a sheet type material such as tapes, film, fabrics, or paper into a shape using machine-sharp steel knives or die.

Double-sided tape: Double-sided tape is a pressure-sensitive tape that is coated with adhesive on both sides.

Dwell time: Time spent in the same position, area, or stage of a process, etc.

ECE: Electrically conductive elastomer.

Electroless plating: Electroless plating, also known as chemical or auto-catalytic plating, is a non-galvanic plating method that involves several simultaneous reactions in an aqueous solution, which occur without the use of external electrical power. It is different from electroplating in that it does not use external electrical power.

EMI Shielding: Electromagnetic shielding, also known as RF shielding. It is the practice of reducing the electromagnetic field in a space by blocking the field with barriers made of conductive or magnetic materials. Shielding is typically applied to enclosures to isolate electrical devices from their surroundings, and to cables to isolate wires from the environment through which cables run.

ERL: Extended release liner. The size of the release liner is larger than PSA so the liner is easy to peel off.

FDR: Force displacement resistance. This is a measure of the compression force and z-axis resistance while compressing a gasket between two brass plates. The result is graphed as resistance and force vs. compression percentage.

FIP: Form In Place is an EMI shielding rubber with filled electronic conductive fillers, which can be dispensed, with one part (1K) and 2 parts (2K) form of factor.

Flame Retardance: A substance that is applied to fabric, adhesive, plastic, or other material in order to make it resistant to combustion. In industrial applications, flame-retardant also refers to the measurement and description of the flammability of a material used in equipment and appliances relative to heat and flames in a controlled laboratory environment.

FOF: Fabric-over-Foam (FOF) is a gasket composed of a layer of conductive fabric over a foam core. This gasket is electrically conductive and can be applied as electrical grounding or EMI shielding.

GOF: Gasket-over-Foam is a gasket composed of graphite layer over foam core to offer good thermal conductive performance from the bottom side to the top side with a high compression ratio.

Halogen-free: Per the definition of IEC 61249-2-21, halogen-free means 900 ppm maximum chlorine, 900 ppm maximum bromine, and 1500 ppm maximum total halogens.

Hardness: The resistance of a material to penetration by an indenter in a standard test. Different indenters may be used, and must be specified. For example: “Shore 00”.”Shore A ”.

HMA: Hot melt adhesive.

Metal adhesion: A test method of metalized fabric to evaluate the adhesion strength between the plating metal and fabric. This is reported by Grade from 1-5 where Grade 1 is the poorest performing (metal will drop easily from the fabric surface) and Grade 5 is the top-performing.

Metal weight gain: Weight gain of the plated metal over the fabric per unit area, the unit can be g/m2 or ounce/inch2 (OPSY).

NRS: Nylon Ripstop, a Nylon, or polyamides, fabric with ristop weaving method. Advantages of ripstop are the favourable strength-to-weight ratio and the likelihood that small tears cannot spread easily.

Operating temperature: Also called an operation temperature. An operating temperature is the temperature at which an electrical or mechanical device operates. Usually this also refers to a material performance of the application environment. The materials can retain good functionality with the maximum or minimum operating temperature for years Or they can degrade or lose their functionality in the short term when outside the range.

Out-Gassing: The release of volatile components from a material under conditions of heat and vacuum. Some volatile components may be prone to condense permanently on nearby surface, while others, such as water, only condense temporarily and are typically of less concern to electronic device manufacturers. Condensed volatiles can be electrically insulating, lead to device failures, and fog optical components. Out-gassing is quantified by the ASTM E595 test protocol.

Peel adhesion: Peel strength, also known as adhesion strength or peel adhesion, is the measure of the average force to Part 2 bonded materials like tape, labels, textile or plastic films. The strength is calculated during a peel test at a constant speed rate by dividing the average force required during the test by the unit width of the bonded samples.

Pre-heat zone: Often this term refers to the area by the rising temperature from room temperature to 150 °C. In this area, slowly rising temperatures will help the parts of solvent and water vapor in the paste to a timely volatile or escape, and electronic components (especially the IC parts) will need to be slowly heated up in order to adapt, in advance, the follow-up processes of high temperature.

Pressure Sensitive Adhesive (PSA): Pressure-sensitive adhesive is a non-reactive adhesive which forms a bond when pressure is applied to bond the adhesive with the adherend. It is popular for use in tapes, labels, and a wide variety of other products.

PTAF (polyester taffeta): Polyester taffeta is a crisp, smooth, plain woven fabric made from polyester.

PU Foam: Polyurethane Foam is a flexible cellular product which provides good rebound.

Reflow profile: A reflow profile includes preheating, a heating/soaking stage, a reflow stage and a cooling stage. There are four zones in the reflow process

Reflow zone: The reflow zone is the highest area in the whole period of reflow soldering. The tin or nickel and copper in the paste will form intermetallic compounds because of the diffusion welding. Users are cautioned not to exceed the highest temperature and heating rate of any temperature sensitive element in PCB.

Release liner: A release liner can be a paper or plastic film-based coating, constituting a very thin layer of release agent to prevent a sticky surface. (e.g. adhesive, from prematurely adhering)..

Selective Plating: coating one metal over another in specific areas and omitting the coating of metal in others.

Shear adhesion: Shear adhesion, also known as holding power, is the ability of a tape to resist the static forces applied in the same plane as the backing. It is usually expressed in the time required for a given weight to cause a given amount of tape to separate from a vertical panel.

Shelf Life: Shelf life is the length of time under specified storage conditions that a material retains its usability and specified properties.

Shielding Effectiveness: The ratio of the magnitude of the incident electric field to the magnitude of the transmitted electric field. Usually shielding effectiveness is in the unit of dB.

Soak Zone: In this zone, the solder paste is melting. Volatile matter of solder paste will be further removed. The activator will be activated, and effectively remove the oxide on the surface of the welding.

Soft SMD Contact: A soft gasket type of SMD (surface-mount device) which is electrically conductive and can be mounted directly onto the surface of a printed circuit board (PCB) via SMT (surface-mount technology) methods.

Solder Pad: An area of exposed metal (typically copper) on the surface of a PCB, intended for soldering a SMT component.

Solder Paste: A mixture of tiny solder beads and flux, used with reflow soldering processes, that sticks components to the PCB with surface tension. The flux keeps the joint clean while the solder beads melt together to form solder joints after being cooled.

Solderability: The solderability of a substrate is a measure of the ease with which a soldered joint can be made to that material. Good solderability requires wetting of the substrate by the solder.

Soldering Strength: The measure of solder adhesive strength (push force) after the SMD contact is soldered to PCB.

Surface Resistivity: Surface resistivity is the resistance to leakage current along an insulating materials' surface. Usually this is measured by a 4-point probe or a copper cube fixture. The unit of surface resistivity is ohm/sq or ohm/□.

Thermal Conductivity (k): The ability of a material to transfer heat. Thermal conductivity is measured in watts per meter Kelvin (W/mK). The higher the value, the more conductive the material.

Thermal Resistance (Tr): The inverse of thermal conductivity. Thermal resistance is a material's resistance to transfer heat. The lower the value, the better the material performs as a thermal interface.

Transfer Adhesive: A sheet type of adhesive layer with no liner inside.

UL 94: The Standard for Safety of Flammability of Plastic Materials for Parts in Devices and Appliances testing is a plastics flammability standard released by Underwriters Laboratories located in the United States. The standard determines the material's tendency to either extinguish or spread the flame once the specimen has been ignited. UL94 includes several different methods and different grades such as V0, V1, V2, HB, VTM0, etc.

Warp: Also known as the machine direction which refers to the threads that run the length of the fabric.

Weft: The weft, or fill, refers to the yarns that are pulled and inserted perpendicularly to the warp yarns across the width of the fabric.

Z-axis Resistance: Z-axis resistance is the electrical resistance measured from the top to the bottom of a conductive gasket, foam, pad, or between two surfaces of a conductive layer.