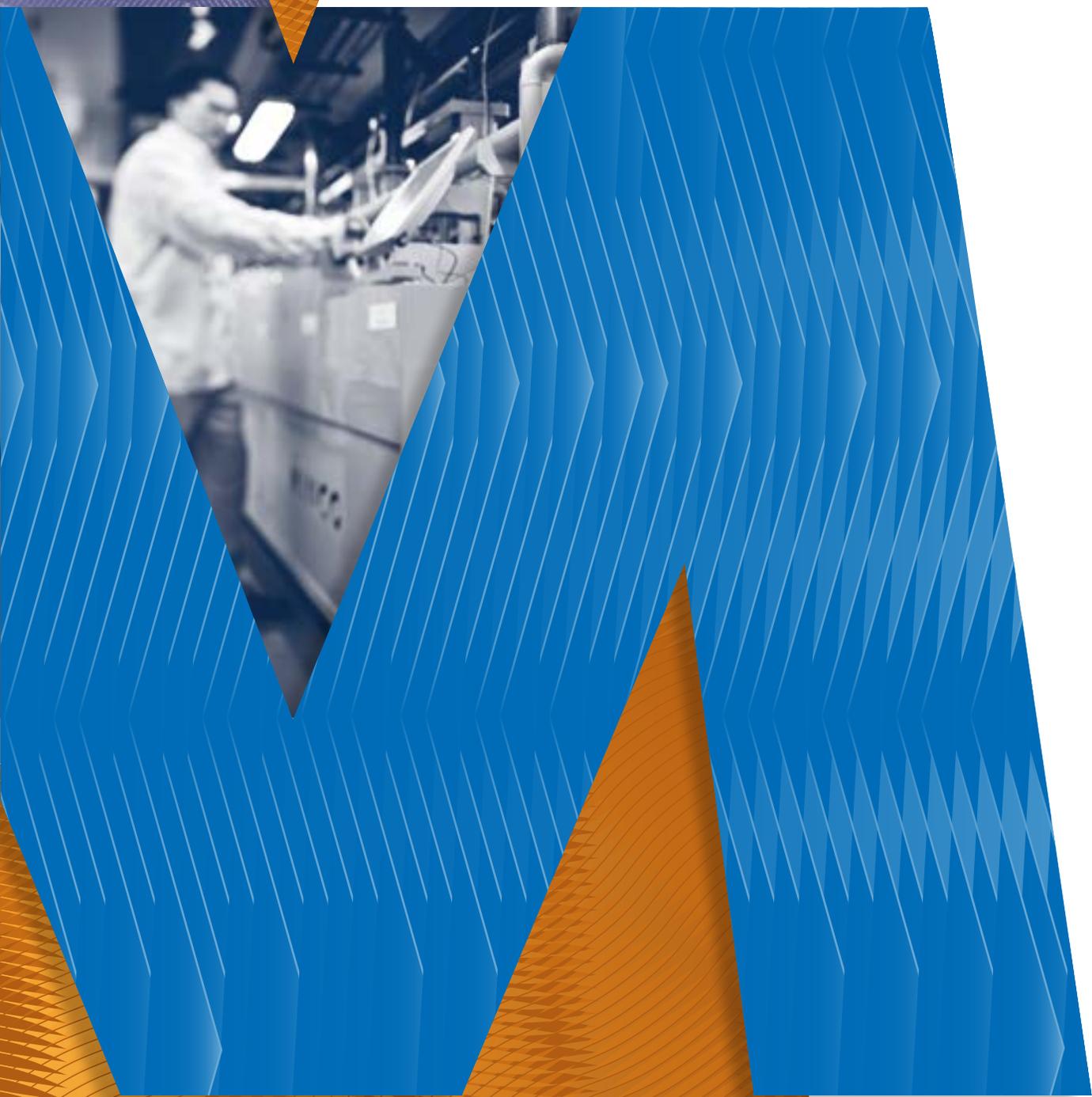


Glossary of Terms



Minco Glossary of Terms

Industry jargon as well as Minco-specific terms defined

Overview

There's no doubt about it, the engineering world is rife with obscure jargon and technical terminology. Even engineers might scratch their heads if it's a term from outside their specialty. Not only are a lot of the vocabulary simply unfamiliar, sometimes a word means one thing in one industry and something else altogether in a different one. Our solution is this all-encompassing, thousand-term glossary, just the thing to tell Microsection and Micrometer apart.

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“A” Model: A heater built without any type of adhesive or foil backing. Also defines which artwork to use when etching Rubber Heaters.

AC: See alternating current.

Access hole: A hole punched, drilled, or skived in the cover layer of a heater or flex circuit. Access holes allow electrical access to heater elements, tabs or circuit conductor pads and through-holes. Ref. major access hole and minor access hole.

Accuracy: 1. How much a measurement made by an instrument differs from the true value. 2. The difference between the preferred and actual characteristic of a tool or part.

Acetone: A clear, flammable, solvent which evaporates quickly and is used for cleaning. Acetone removes grease and oils from Kapton™, foils, glass and photographic negatives. Acetone will soften or attack most paints, plastics, and adhesives.

Acetylene torch (mini torch): A small, hand-held torch used to fuse element wires together.

Acid: Compounds, chemicals, and solutions with a pH less than 7 that can neutralize a basic solution.

Acid brush: A small, hand brush used in various cleaning processes.

Acro-drill™: A single spindle drill that makes use of a magnified viewing microscope to precisely locate holes to be drilled. Its use is limited to low volume or prototype circuits, heaters, and printed circuit boards where location and hole size must be very accurate.

Acrylic: A thermosetting plastic, commonly used as an adhesive. For example, WA adhesive is an acrylic.

Activating: 1. A chemical process that promotes a good initial plating bond of a plated metal to a base metal. 2. Chemically treating a nonconductive material to prepare it for electroless plating. 3. Adding a catalyst to an epoxy so that it hardens.

Adhesion: The property of one material to remain attached to another.

Adhesive: A material used to bond things together. Film adhesives such as FEP, CMC, and WA are adhered using heat and pressure and may be either thermosetting or thermoplastic. Other adhesives used are epoxy, PSA, and RTV.

Adhesive flow: 1. The process of molten adhesive filling the “valleys” between conductors or strands during lamination. 2. Excess adhesive that has squeezed out from under the cover during lamination. Solder will not stick to the adhesive, and consequently the annular ring is reduced.

Adhesive tack: The process of pressing an adhesive for minimum time, temperature, and pressure to obtain an adequate bond for further processing without curing the adhesive.

Adhesiveless polyimide: See all-polyimide.

Air box: A small, bench-mounted box that supplies filtered air at a uniform temperature during temperature sensor calibration.

Air hood: An enclosed or covered area with circulating air to ensure a dust-free, uniform environment (temperature, humidity, anti-static) during lay up of sheet materials or calibration of temperature sensors. See clean hood.

Air knife: A device that uses high-pressure streams of air to eliminate static and clean dust and other particles from material. Other uses include drying etched elements before they leave the etcher and leveling solder on circuit boards.

Alcohol: A clear, flammable, quickly-evaporating solvent used for cleaning. Alcohol removes grease or oil from Kapton, foils, glass, and most photographic negatives; it is less aggressive than acetone. Isopropyl and ethanol alcohols are typically used.

Alignment holes: Holes punched or drilled outside the trim line of etched circuits or heaters. These holes align printing negatives to drilled material, align predrilled covers to substrates, align parts on tooling, and align stiffeners. Also called guide holes, tooling holes, or blanking holes.

Alignment pins: Small metal pins that fit into alignment holes for aligning materials accurately during printing, cover lay-up, lamination, punching and drilling.

Alignment plate: The part of the die that allows the artwork to be aligned to the blades.

Alkaline: Compounds, chemicals, and solutions with a pH greater than 7 that can neutralize an acidic solution. Also known as a base.

Alloy: A metal that is a mixture of two or more metals. Examples of alloys used at Minco are solder, Kovar™, Inconel™, Cupro-nickel™, Nichrome™, and Balco™.

All-in-one heater: A heater which incorporates the functions of an external sensor and controller.

All-polyimide: A heater-or flex circuit that uses a layer of “uncured” polyimide in place of the film adhesive layer and this allows use at higher operating temperatures.

Alternating current: Abbreviated AC. An electric current that reverses its direction at regular intervals, typically 60 Hertz (U.S.) or 50 Hertz (Europe). See Hertz.

Alumina: Aluminum oxide. A ceramic used as a high temperature electrical insulation.

Ammonium persulfate: See AP dip.

Amp (Ampere): A measure of the flow of electrical charge.

Anchor patch: 1. Extra insulating material (Kapton™ or silicone rubber) laminated over a lead weld area to prevent large-gauge wires from penetrating through the cover. 2. Extra adhesive used to anchor leadwires by filling in around them.

Anneal: To soften and relieve strains in any solid material, such as metal or glass, by heating to just below its melting point and then slowly cooling it. Annealing generally lowers the tensile strength of the material, while improving its flexibility and lifetime. Wire-wound sensors are annealed after winding.

Annular ring: The ring of solder or exposed copper that surrounds a through-hole of a flex circuit or heater-sensor.

Anode: 1. A positively charged electrode. 2. In electroplating, anodes are usually bars or nuggets of metal that dissolve into solution when electrical or chemical force is applied. See cathode and electrolytic plating.

Anti-reset windup: Turns off integral action outside of the proportional band to prevent false accumulation of error during warmup.

AP: See all-polyimide.

AP dip: Ammonium persulfate, a micro-etchant liquid used for cleaning copper panels, for removing through-hole smear that resulted from the grinding process on a microsection. Also used to help differentiate roll-annealed copper from plated copper.

Appendix: Section at the end of an Engineering Instruction that contains additional information and/or charts. Section at the end of an Assembly Instruction that contains instructions for specialized or non-standard processes.

Arbor: An axis or shaft that supports a rotating part.

Arbor press: A piece of equipment used to apply pressure during pin staking, eyelet staking, or bending flex circuits. Various fixtures are mounted to the press, depending on the job that needs to be done. The necessary pressure is applied by pulling the arbor press handle down.

Arcing: A condition where two electrical conductors in a circuit, heater, or sensor are so close together that current can jump across the gap. An electric arc or current path can be created even though the conductors are not actually touching. This is usually a rejectable condition in our products; it is why we require either minimum conductor spacing or insulated conductors.

Artwork: Generally, a glass or Mylar sheet that bears the design of the flexible circuit or heater and is used to print the design onto a resist-coated panel. Technically, artworks are “phototools” or “negatives,” or “positives.”

Assembly: A combination of parts or subassemblies that may be taken apart without destruction and which has limited application or use of its own, but is essential for the completeness of a more complex item of which it is an element.

Assembly drawing: A drawing showing how to put the components together, e.g. head, fitting, sensor, and thermowell. The drawing often is an exploded view. For a printed circuit, a drawing depicting the locations of components with their reference designators.

AWG: Abbreviation for American Wire Gauge. AWG numbers indicate wire size; as the AWG number gets larger, the wire diameter gets smaller. Normally, the smallest leadwire we use is AWG 30 and the largest is AWG 18. We use element wire as small as AWG 53 (0.7 mil diameter) for temperature sensors and inductance coil windings.

Axial leads: Leadwires that are mounted along the axis or center line of a unit so that they extend from opposite ends of the unit, rather than out the sides. Refer to radial lead.

Babbit: A soft, solder-like metal applied to the ends of bearing RTDs so they're easier for the customer to install. The babbitt layer on the bearings protects a rotating machine's shaft from damage.

Balco™: A metallic alloy containing 70% nickel and 40% iron. Balco changes resistance rapidly as temperature changes. Its high resistance makes it useful for temperature sensors. Often abbreviated NiFe (Nickel-Iron). Balco is a trade name of the W. B. Driver Company.

Banana plug: A type of electrical plug-in connector.

Bare board: An unpopulated PCB.

Barrier sheet: A thin sheet of material that protects a circuit or heater from silicone oil emitted from the rubber press pad during autoclave lamination.

Base: See alkaline.

Baseline: Customer-approved documentation defining the system, procedures, and design of specific product models. Usually used for high-reliability products.

Base material: At a beginning step for an etched heater or flex circuit, it is a foil panel (typically copper, Cupro-nickel, or beryllium copper) laminated with sheets of adhesive to one or both sides of an insulating material such as Kapton™.

Bend axis: The direction on the heater-sensor that is perpendicular to how the heater-sensor will be formed (bent) when in use.

Beta backscatter: A method used to determine the thickness of foil or plating. A radioactive source bombards the sample being tested with beta particles, and the amount of return or backscatter is used to determine its thickness.

Beveling: A sanding or cutting procedure that removes part of an edge so that the material does not have a sharp, square corner.

Bifilar: Sensors that have two wires wound on a bobbin and that will be connected at one end after calibration. Compare this to monofilar and quadfilar elements. Bifilar elements are sometimes described as non-inductive. See noninductive, monofilar, and quadfilar.

Bill of materials (BOM): A list of the materials required to make a specific model.

Blanking holes: See alignment holes.

Blanking procedure: The process of using die tools and a punch press to cut material into patterns. Blanking refers to any step that cuts the outline.

Blister: A form of delamination demonstrated by the localized swelling and separation between any of the layers of a laminated unit.

Boa-But

Board: Printed circuit board.

Bobbin: A thin, flat form or a small, cylindrical form used to hold wire windings. The bobbin remains part of the final assembly after wire has been wound onto it.

Body: The portion of an electronic component not including its pins or leads.

Bolt circle: A circular centerline on a drawing that locates holes equally spaced from a center point. Abbreviated B.C.

Bond: To adhere two or more layers together, usually with an adhesive. The lack of a good bond results in delaminating, bubbles, or poor peel strength. Factors that may affect the quality of bonding include surface cleanliness, lamination time, temperature, and pressure.

Bond strength: A measure, in pounds per inch width, of the pulling force required to separate layers of material that have been laminated together. See peel strength.

Border: The area from the edge of a unit's trimline to the edge of a circuit element.

Bowing: The bending between two opposite ends of a sheet or strip.

Braze: High temperature soldering (above 800° F). Brazing is done with a welding machine or an oxyacetylene torch and a hard, high-temperature solder such as Sil-Fos™. Hard solder joints are able to withstand higher temperatures than soft solder joints. See silver solder.

Breakdown: 1. Dielectric failure where insulation is damaged or blown through (dielectric breakdown). 2. Partially missing conductor areas in a developed or etched element. After being developed, a unit with breakdown in the resist will have strand flaws unless the resist is touched up before etching. Strand breakdown is usually not repairable.

Break point: The point in which one layer of material is removed exposing the layer of material underneath. In developing, this is the point where the unexposed resist breaks free from the foil layer. In etching, this is the point where the foil is completely removed exposing the substrate layer. In stripping, this is the point where the resist breaks free from the foil leaving the foil of the etched element visible. For sensors, the point at which the sensor wires are broken (cut) when the correct reading is obtained during calibration.

Bridge: 1. An instrument that accurately measures electrical resistance. 2. The unrouted section of an RTD body that has holes for leadwires to pass through. 3. See conductor bridging.

Brush plating: Applying a thin layer of metal (usually copper) with a hand-held, cotton-wrapped electrode. Plating is brushed onto metal with the cotton swab while current passes through the electrode. Brush plating is performed to improve solderability or to reduce heating of a specified area.

B-stage: A stage in the reaction of a thermosetting epoxy resin where it is only partially cured.

Bubbles: 1. Air trapped between laminated layers of a unit. Unlike delaminating, which usually involves a much larger area, the area around a bubble usually has a bond. Small bubbles may sometimes be eliminated by laminating units again at higher heat and pressure. 2. Voids in potting.

Burn-in: Operating a heater, sensor, or flex circuit at a rated power for a specified period of time to demonstrate that it will perform properly. Burn-in may take place in still air or between metal plates. Burn-in times range from one to over 1000 hours.

Bushing: A device that is drilled out in the center to accommodate a specific drill bit size. A bushing helps to strengthen a bit with a diameter of less than 0.040" and to remove drilled particles during drilling.

Butyl carbital: A solvent that is added to the developer and stripper in the photo-etch process to break up the resist and prevent foaming.

C7-Car

C-7: A type of epoxy used to coat coil end points and exposed conductors to protect them from damage.

C-20: A cover material made of Teflon, treated for bondability on both sides. WA adhesive is usually tacked to one side of the C-20 so that it can be laminated to base material.

Cable: A group of individually insulated conductors twisted helically, with or without a jacket overall.

CAD: Computer Aided Design. CAD equipment allows products to be designed in detail on a computer screen. It is used to generate artworks and drawings.

CAD file: Electronic data generated by CAD (output formats may vary). i.e. used for die ordering.

CAD plot: The output to paper of a CAD layout.

Calibrate: To electrically or mechanically adjust a part, a device, or an instrument to make it conform to an acceptable standard. Wire-wound sensors are calibrated to a specified resistance by changing the length of the sensor wire. Resistance-measuring instruments and other pieces of equipment are calibrated regularly to ensure their accuracy (dial calipers, ohmmeters, resistance thermometers, etc.).

Calibration: Comparison between two instruments or devices, one of which is a known standard of accuracy, to detect and to correlate or adjust the variation in the accuracy of the instrument being compared.

Calibration check: Testing the electrical properties of a small sample set of sensors before production quantities are built. Results of a "cal check" are used to adjust calibration limits to allow for resistance shifts during production. They also verify that the production temperature coefficient of resistance and stability requirements are met.

Calibration clip: A copper clip with flat parallel jaws. A calibration clip is used to electrically connect a sensor wire to a resistance-measuring device during calibration.

Calibration dot: A small piece of foil (.036" or 0.075" diameter) that is welded to the wire ends of a sensor after calibration.

Calibration loop: Known loop used to adjust resistance.

Calibration plate: Aluminum plate on which units being calibrated are laid. Small rubber pads attached to the bottom of the plate allow it to stabilize at room temperature.

Calibration point: The nominal value to which a unit should be calibrated.

Calibration range: A specific range within which the units should be calibrated to meet the required resistance tolerance.

Caliper: An instrument used for measurements to the nearest 0.001" (1 mil). A caliper has jaws for outside measurements, ears for inside measurements, and a tailbar for depth measurements.

CAM: Computer Aided Manufacturing. The CAM system works with the CAD system. Information about a part is programmed into the computer during the design phase, and is used later to perform certain manufacturing steps. For example, the computer can program a large machine to drill holes perfectly matched to the original artwork of a part. See CAD, artwork, and photo-tool.

Camber: The amount of overall warpage present in a substrate.

Capacitor: An electronic component that can temporarily store a voltage charge and release (or discharge) it suddenly.

Capacitor discharge: A sudden flow of current released by a charged capacitor. Capacitor discharge is sometimes used to test heaters or sensors for shorts or partial shorts between wires or conductor strands.

Carbon particles: Finely divided carbon that acts as the conductive element in the carbon-silicone matrix.

Carbon-silicone matrix (CSM): The key component of SmartHeat SLT heaters, it's a patented polymer inner-layer of silicone embedded with carbon particles, and its resistance changes with temperature.

Case: The outer sheath of a probe-style temperature detector. It is usually a cylindrical metal or plastic part that covers and protects the fragile temperature sensing element inside.

Catalyst: A substance that enhances a chemical reaction and regulates the rate at which it proceeds. Several types of catalysts may be used in two-part epoxies to give them different temperature capabilities. Catalysts are also used to begin the plating action in electroless plating baths.

Cathode: A negatively charged electrode. In electrolytic plating, the cathode is the part being plated. See anode and electrolytic plating.

Caustic soda: See sodium hydroxide.

Celsius: A scale used to measure temperature, where pure water freezes at zero degrees and boils at 100 degrees. To convert to Celsius (°C) from Fahrenheit (°F) use the formula: $^{\circ}\text{C} = (^{\circ}\text{F} - 32) \times (5/9)$

Centigrade: See the preferred term, Celsius.

Ceramic: A high-temperature, inorganic, nonmetallic material, such as alumina, beryllia, steatite, or forsterite, which is used to manufacture temperature sensors.

Certificate of conformance (cert): A formal statement by the supplier that materials delivered, or services performed, conform to the necessary requirements. Also called "C of C" or Certificate of Compliance. Minco receives certs from many of our raw materials suppliers, and provides certs to many customers.

Chamfer: See bevel.

Chemically milled die (CMD): A tool used in a punch press with blades formed by a chemical milling process, and mounted on an aluminum base.

Chip: Integrated circuit.

Chuck: A device used to securely hold the drill bits while the drill is in operation.

Circuit: A complete conductive path used to carry current.

Circuit board: A circuit manufactured on a rigid base material; printed circuit board.

Circuit Scrub: An acid-based, abrasive cleaner used to clean and roughen the surface of a foil panel.

Circular mil: The area of a circle one one-thousandth of an inch (.001") in diameter. Measuring the circular mil area of the resistance wire can be used to determine what length of wire will be necessary to produce 100 ohms when winding an RTD. One circular mil = 0.7854 square mils.

Circumference: 1. The boundary line of a circle.
2. The length of a boundary line of a circle.
Circumference = 3.14 x diameter of the circle.

Clamp bar: A bar with a lengthwise slot through the center and a smooth side that is used for clamping dies.

Clamp-on RTD: A resistance temperature detector (RTD) that can be clamped to a pipe or similar cylindrical surface. The resistance of the detector indicates the temperature of the pipe, which is related to the temperature of the pipe's contents.

Clamping: The act of securing a heater to a heat sink by means of a bolted backing plate, or other object, applying pressure to the back side of the heater to hold the heater in place.

Class A to H: See temperature class.

Clean hood: An enclosed work bench that is continually rinsed by a flow of cleaned air drawn through high-efficiency filters. The clean hood is used primarily for lay-up work on units with strict foreign material requirements. Also called a clean work station.

Clean room: A room with filtered air and controlled pressure. The filtered air reduces foreign material during lamination lay-up. A clean room is kept at a positive pressure—its air pressure is higher than connected rooms. This helps prevent dust from floating into the room when the doors are open.

Closed circuit: An electrical circuit that has a continuous, uninterrupted path for the flow of current; normally including a voltage or power source.

Clusters: See nested circuits.

CMD: Chemically Milled Die – Die consists of two steel plates that have been etched; then accurately machined to create a sharp cutting edge. The two plates are then mounted on an aluminum base. The plates are typically for tight tolerance applications or as a lower cost alternative to punch and die sets.

CNC drill: Computer Numerically Controlled Drill – A machine that drills material by following a drill program.

Coating: Covering foil with resist film. Resist film is rolled onto foil by a machine that applies heat and pressure to laminate them together.

Coco far and coco near: Coco is short for cover coat. These terms are being replaced; see far cover and near cover.

Coefficient: The ratio of change under specified conditions of temperature, length, etc.

Coil: A winding with several turns of insulated wire. A coil creates a magnetic field when current passes through the wire. See Flex-Coil™.

Cold solder joint: A solder connection exhibiting poor wetting and a grayish, porous appearance due to insufficient heat, inadequate cleaning prior to soldering, or excessive impurities in solder.

Cold weld: A resistance weld where two metals apparently bonded, but they have not melted and flowed together. A cold weld often looks acceptable even though little or no fusion has actually taken place. The weld has insufficient pull strength.

Color code: 1. The American National Standards Institute has established a color code for thermocouple wires where the negative lead is always red. Color code for base metal thermocouples is yellow for Type K, black for Type J, purple for Type E, and blue for Type T. 2. The coding system for resistors and capacitors where colors stand for numbers.

Comparator: An instrument used to compare a known resistance to an unknown resistance during the calibration of temperature sensors. The comparator shows the difference in resistance as a percentage.

Component: A physical part to be modified or assembled.

Component side: Side of a board onto which components are mounted.

Compound die: A punch and die set that punches holes and/or cutouts at the same time it cuts the outside edge of a part.

Concentric: Sharing a common center point or axis. For example, two circles, one inside the other, are said to be concentric if they share a common center point.

Conduction: The transfer of thermal energy between adjacent bodies (usually solids) or parts of the same body.

Conductive: A term which indicates that a material is able to carry electrical current.

Conductivity: A measure of the ability of a material to carry current; the reciprocal of resistivity.

Conductor: The path that carries electrical current from one point to another. Minco's flex circuit conductors are commonly in the form of copper strands.

Conductor bridging: A defect that causes a short circuit where: 1. unwanted metal is not completely etched away between two conductor strands. 2. metallic foreign material is touching two conductor wires or etched foil strands.

Con-Cos

Conductor pad: See pad.

Conductor spacing: The distance from one conductor to the next, measured at the base from the back of the conductor. Minimum spacing must be maintained so that the insulation between conductors can prevent bridging and short-circuiting.

Configuration: 1. The arrangement of conductors, tabs, and wires on an artwork or finished unit. 2. The outline or final shape of a part after trimming.

Configuration control: A requirement that a vendor notify the procuring and/or qualifying activity of a change in product manufacture or test. In some cases, the requirement will include delay of change implementation until after formal approval of the change.

Configuration management: The responsibility for configuration control.

Conformal coating: A thin non-conductive coating applied to a circuit for environmental and/or mechanical protection.

Connection head: A cast iron, aluminum, or plastic enclosure, attached to the end of an RTD or thermocouple, that protects the electrical connections of RTD or thermocouple wires to the external wiring.

Connector: A device designed to allow electrical flow from one wire or cable to a device on another cable. A connector will allow interruption of the circuit, or the transfer to another circuit, without any cutting of wire or other preparation.

Contact assembly: 1. A fixture used in plating to connect the part being plated to the voltage source. 2. Other types of electrical connections.

Contaminant: An impurity that may or may not affect the performance of a circuit assembly. Typically, contaminants are classified as polar, non-polar or particulate in nature.

Continuity: An uninterrupted path for current. A conductor has electrical continuity if there is no break or separation in the current path.

Continuity test: A test on electrical units to ensure that there is no break in the conductor path that will prevent current flow.

Continuous sampling plan: In acceptance sampling, a plan intended for application to a continuous flow of individual units of product. It involves acceptance and rejection on a unit-by-unit basis and employs alternate periods of 100% inspection and sampling. (The relative amount of 100% inspection depends on the quality of a submitted product.)

Control chart: A graphical chart with control limits and plotted values of some statistical measure for a series of samples of subgroups. A control line is usually shown.

Control limits: Limits on a control chart which are used as criteria for action or for judging whether a set of data indicates a lack of control.

Controlled copy: A copy of a document which is under control.

Controlled document: A document which affects product quality. A controlled document must be given a number and be recorded in the master document list.

Convection: The transfer of thermal energy in fluids and gases by mixing warmer areas with cooler ones. Convection currents can form, due to differences in density. Generally, warmer fluids (or gases) are less dense and tend to rise.

Copper: A reddish-brown metal that is an excellent conductor of electricity. It is used in most flex circuits, leadwires, and for some temperature sensors.

Cost of quality: The cost of not doing work right the first time. Cost of quality includes the cost of preventing errors from occurring, of inspecting and testing products, and of failure, scrap, rework or returns. Reducing cost of quality is the cornerstone of quality improvement.

Coupon: See plating coupon.

Cover: Insulator material laminated to an etched element. Covers can be located on the inner or outer layers. Internal cover layers are found in the unbonded regions of a circuit.

Cover coat: An ink that is applied over an etched circuit that takes the place of a polyimide cover.

Cover layer: Insulating material laminated over conductors to prevent them from short circuiting to things they contact. Cover layer materials include Kapton™, silicone, rubber, Mylar™, etc.

Coverage: Heater coverage is the percentage of the available area within a heater that is covered with heater element strands. Most of Minco's heaters are designed with 50% coverage but reduced or increased coverage can offer advantages in some designs.

Crazing: A condition where fibers in epoxy glass have separated. Crazing appears as a white crisscross pattern. It usually results from excessive pressure.

Creep action: A switching method, often used in thermostats, in which a temperature-sensitive bi-metallic element causes slow make and break of electrical connections. In contrast to snap action, this method results in tighter temperature control, but greater electrical noise and usually shorter life.

Critical application: Using our products in an application where failure would be extremely costly in terms of lives or dollars.

Cross section: A section formed by cutting through an object. This allows the object, such as a multi-layered circuit, to be viewed from the side. See microsection.

Cryogenics: The science that deals with very low temperatures and their effect on the properties of materials. Cryogenic temperatures are below -100°C (-148°F). Minco makes resistance thermometers that are specially designed for use in cryogenic temperatures.

CSM: See carbon-silicone matrix

Cupric chloride: An acid used to etch copper foil.

Cupro-nickel™: A metallic alloy containing 70% copper and 30% nickel. It's normally used in the form of metal foil to make etched heaters or transition tabs. The chemical abbreviation is CuNi. A commonly used abbreviation is CN.

Cure: 1. To change the physical properties of a material by chemical or temperature reaction. Materials are often heated to high temperatures to improve bonding (in adhesives) and hardness (in potting compounds). Some cures happen at room temperature and others at elevated temperatures. 2. The process of heating circuits after they have been marked with ink to harden the ink on the circuit.

Current: The rate of flow of electric charge in a conductor. The unit of current is the Ampere (amp).

Cycle time: The duration of an on/off cycle with time proportioning. With cycle time of 10 seconds, for example, 80% power would give 8 seconds on, 2 seconds off. General rule: Shorter times give better control and less oscillation, but require solid state relay.

Cycling: See temperature cycling.

Cyrel stamp: A printing element with adhesive backing (protected by a Mylar cover) that adheres to the face of the stamp base.

Database: A collection of interrelated data items stored together, without unnecessary redundancy, to serve one or more applications.

Damage-tolerant: The characteristic of SmartHeat that allows it to continue functioning after sustaining breaks in one or more layers of the heater.

Datum: A point, line, or plane used as a starting point to measure and locate characteristics of a part.

DC: See direct current.

Deadband: See hysteresis.

Decade box: A variable resistor set by adjusting dials to the required resistance.

Defect: Any deviation from the specified requirements or characteristics of a product or component.

Definition: The sharpness of a screen-printed pattern; the exactness with which a pattern is printed.

Degree: 1. A unit of temperature measurement. 2. A unit of angular measurement.

Deionized water: Water which has had a degree of positive and negative ions removed so as to decrease its conductivity (raise resistivity). Typically, this is done by an ion exchange process. In general, the highest degree of deionization possible under normal conditions will result in resistivity of 18.2 megohms. Tap water has resistivity as low as 1 to 5 kilo-ohms. In addition to having low conductivity potential, DI water is prone to absorbing ions aggressively in the rinse process. Because of low dissolved mineral content, DI water is also less prone to leaving water spots on a board.

De-reel: To remove wire or other material from a spool.

Derivative: Adjustment to output based on the process's rate of change, usually to allow faster recovery from upsets. Also expressed as "rate." General rule: Increase derivative time if system frequently overshoots; decrease if system acts sluggish.

Design review: A formal, documented, comprehensive, and systematic examination of a design to evaluate the design requirements and the capability of the design to meet these requirements and to identify problems and propose solutions.

Desoldering: The process of applying heat and suction to solder in order to remove it from the circuit.

Develop: To chemically process a light-sensitive material in order to reveal the image or pattern that has been recorded on it.

Developer: 1. The chemical solution used to reveal an image that has been recorded on photographic film or photo-resist film. 2. The piece of equipment used to develop photographic film or photo-resist.

Dial caliper: An instrument used for measurements to the nearest 0.001" (1 mil). A dial caliper has "jaws" for outside measurements, "ears" for inside measurements, and a "tailbar" for depth measurements.

Diameter: A straight line that passes through the center of a circle with both of its ends on the boundary. The diameter of a circle is twice the length of the circle's radius.

Die: The larger of a pair of cutting or shaping tools that, when moved toward each other, cuts a desired shape or impresses a form by pressure. The punch is the other half of the shaping tool. See steel rule die.

Dielectric: A material which is an insulator (a poor conductor of electricity). Examples of dielectric material that we use are silicone rubber, polyimide, Teflon™, Mylar™, mica and epoxy glass.

Dielectric breakdown: The reduction of a material's electrical insulating properties, usually detected during dielectric testing. Breakdown occurs when voltage exceeds the dielectric strength of the material. Flaws such as pinholes in insulation and nicked leads will appear as breakdown during testing. This is a test to ensure user safety.

Dielectric strength: The maximum voltage a dielectric material can withstand before material breakdown occurs. See insulation resistance.

Dielectric test: A pass/fail high-voltage test to verify that the insulation between a unit's element and its outer surface is good. The test can also verify the insulation between two elements in a unit. A dielectric test checks for excessive current flow through insulation, possibly caused by a nick or pinhole. The test is usually done in water but it can also be done between conductive plates or by using metal beads.

Digital multimeter: A digital instrument used to measure resistance (ohms), voltage (volts), and current (amps).

Dimensional stability: The ability of a material to maintain its dimensions. Dimensions of material can be affected by humidity, temperature, chemical treatment, age, or stress.

DIN: A German standards agency for engineering and dimensional standards. DIN is often associated with calibration of platinum temperature sensors.

Dip soldering: Dipping circuits into a pool of molten solder to solder coat several exposed conductor pads at one time.

Direct current: Abbreviated DC. An electric current that flows in only one direction. Batteries produce DC power.

Discoil™: A spiral winding of resistance wire on a single plane (like the groove on a phonograph record). Discoil elements are used for very thin, fast-responding temperature sensors.

Document control: Procedures which require documents to have a distribution and revision control system.

Dog ear: A small flap on a flex circuit that allows a portion of the circuit to be bent away from the unit's surface.

Double-sided foil: 1. (Heaters) Foil on both outer surfaces, with the substrate material laminated in between. Typically, one side is aluminum and the other is a resistance foil, but resistance foil can be on both sides. 2. A circuit board with tracks on both sides. Typically one side of the PCB is used for vertical tracks, and the other side for horizontal. Via holes are used to carry signals from one side to the other. See single-sided and multilayer.

Drill schedule: An information package that gives various drill information about a specific circuit model.

Droop: An error inherent in simple proportional control where the temperature reaches equilibrium at a point other than the setpoint, but still within the proportional band.

Dual element heater: A Thermofoil Heater that contains two heating elements within the same unit.

Dual element sensor: A temperature sensor with two separate elements. The two sensing elements may or may not be identical.

Dual layer heater: A thermofoil heater with heating elements on two layers. A dual layer heater may be designed to provide wider strand widths, additional heating elements, or magnetic cancellation.

Dull solder: A condition that exists when flux has not been properly rinsed from circuits, or when a solder joint has not been adequately heated. See cold solder joint.

Duro: Describes the hardness of soft rubber. For example, a silicone rubber press pad may have hardness of 60 duro.

Durometer: An instrument used to measure the hardness of soft rubber.

DXF: Data Exchange Format. A computer format for import and export of drawings for AutoCAD. Adopted by many CAD packages as a convenient means of transporting drawing data. Does not provide many of the features required for advanced PCB design.

Dynamic application: An application using a flex circuit that requires repeated flexing while in use.

EI: See Engineering Instruction.

EI file: A file that contains the original copy of the EI, obsolete copies, and any related information.

Electrical inspection: An inspection to verify electrical characteristics of a product. Electrical inspection may include resistance measurement, insulation resistance testing, and/or other special measurements and testing.

Electrode: A metal terminal that conducts electricity into or away from conductive material.

Electroless plating: A plating process that does not require the use of current. Metal ions dissolved in solution are thinly deposited in any object placed in the solution. This process is usually used to electrically connect conductor layers of multi-layer flex circuits. Electroless plating is followed by electrolytic plating. See electrolytic plating.

Electrolyte: A substance that becomes electrically conductive in solution by separating into charged ions.

Electrolytic plating: A plating process that requires the use of current. Metal is placed in an electrolyte solution and connected to the positive terminal of a DC voltage source. The object to be plated is also placed in the solution, and is connected to the negative terminal of the voltage source. Charged particles (ions) from the plating metal transfer through the solution and attach to the object when current is applied. Also called electroplating. See anode and cathode.

Electromagnetic interference: Unwanted electrical interference on signal wires. Also called noise.

Electromotive force: Electrical energy that has been converted from chemical energy, mechanical energy, or other forms of energy. The conversion takes place in a device such as a battery or thermocouple. Electromotive force is expressed as voltage or energy per unit of charge (volts). Abbreviated EMF.

Electroplating: See electrolytic plating.

Electro-static discharge (ESD): Movement or separation of materials can generate static electricity. The term electro-static discharge refers to a charged person, or object, discharging static electricity. Although the current associated with such a static charge is low, the voltage can be in the thousands of volts and can severely damage electronic components.

Element: 1. The foil or wire that has electrical resistance in heaters or sensors. An etched foil heater element produces heat when a voltage is applied.
2. A wire element in a temperature sensor that changes resistance as its temperature changes. For sensors, element sometimes refers to a subassembly consisting of a bobbin, the winding, and short, bare leadwires.

Element filler: An adhesive material that softens and flows when laminated. It is placed over an entire element to prevent delaminating between strands when thicker foils are used.

Element lead attachment: The point of connection between a leadwire and an element wire, or between a leadwire and an etched foil element. The connection can be made by welding, soldering, or crimping.

Element wire: The wire used to make a sensor winding. See resistance wire.

Elongation: The amount a material stretches when placed under a load.

EMCS thermometers: Energy Monitoring and Control System thermometers. Resistance thermometers, transmitters, and accessories specifically designed for use in energy monitoring and control systems.

EMF: See electromotive force.

Emulsion: A light-sensitive, dull textured coating on one side of a Mylar artwork that blocks light in order to print an artwork design on photosensitive material.

End item: A final combination of end products, components parts and/or materials that are ready for their intended use.

Engineering instruction: MINCO's assembly instructions or suggested installation procedures for a product.

Engineering release: A set of drawings and assembly instructions that provide details of how a product is to be built and inspected. A copy of the engineering release is forwarded to production and QA after the design, drawings, manufacturing instructions, and inspection requirements are complete.

Epoxy: A nonconductive, thermosetting adhesive that hardens and attains its adhesive properties through chemical reaction. Epoxies are used for bonding, sealing, and potting.

Epoxy glass: A rigid, epoxy-based material reinforced with glass fibers. Epoxy glass is used for stiffeners, RTD bodies, and some rigid flex circuits.

ET: A letter code for TFE Teflon™-coated leadwire that has a nominal wall thickness of 0.006" and a maximum voltage rating of 250 volts RMS.

Etch factor: In etching, the ratio of how the etchant affects the thickness (depth) of the conductor to how it affects the width of the conductor (undercut).

Etch inspection: A visual inspection of etched conductors under high-powered microscopes. Conductors that do not conform to requirements are marked so that no further work is done on them. Typical requirements checked are: conductor width, conductor spacing, conductor flaws, and registration between pads and through-holes.

Etch out: A condition where any part of an etched foil strand is missing.

Etchant: An acidic solution that dissolves metal during the photo-etch process. Ferric chloride and cupric chloride are two etchants used at Minco.

Etchback: 1. In etching a circuit, the amount of extra copper that is removed beyond the boundary defined by the hardened protective resist. 2. The amount of extra adhesive that is removed during the plasma-etching procedure.

Etched foil heater: A heater made of etched foil strands rather than wire.

Etched foil pad: 1. A small pad of foil etched on substrate material. An etched foil pad provides a support base on which a leadwire, sensor wire, or transition tab may be welded. 2. A widened area at the end of an etched heater element. It can be used for leadwire attachment or as a solder pad. Also called etched pad.

Etched foil sensor: A sensor made of etched foil strands rather than wire.

Etched sensor pick: Bridges are created in etched sensors to aid calibration to the required resistance. They are used on sensors with tight tolerances. Picking a bridge increases the resistance reading of the elements, which allows calibration of an etched sensor. Etched sensors are usually etched on Balco foil. Balco foil is sensitive to heat, therefore, all resistance measurements on the etched element must be performed under an air hood using a calibrated standard. Each new spool of foil requires a new standard.

Etcher: A large piece of equipment that contains etchant. Etchant is sprayed onto metal foil parts as they are carried through the etcher on a conveyer.

Etching: Using etchant to dissolve metal in a desired pattern.

Exposed junction: A thermocouple probe constructed so that the hot, or measuring, junction protrudes beyond the sheath material so that it is fully exposed to the medium being measured. This form of construction usually gives the fastest response time.

Exposure: Exposing a light-sensitive photographic material (such as resist film or photographic film) to light to record an image. The image is later revealed by developing.

Eyelet: A short, metallic, hollow tube whose ends can be bent outward and over to fasten it in place. Eyelets are used to electrically connect conductive layers of a flex circuit. They may also be used to reinforce etched pads of heaters or circuits that will be connected to pins.

Eye point: Distance eyes are from the microscope.

Fabrication drawing: A drawing used to aid the construction of a printed board. It shows all of the locations of the holes to be drilled, their sizes and tolerances, dimensions of the board edges, and notes on the materials and methods to be used. It relates the board edge to at least one hole location as a reference point so that the NC drill file can be properly lined up. Called "fab drawing" for short.

Fahrenheit: A scale to measure temperature, where pure water freezes at 32 degrees and boils at 212 degrees. To convert to Fahrenheit (°F) from Celsius (°C) use the formula: °F = (°C x 1.8) + 32. See Celsius.

Far cover: Refers to the cover layer on the far side of a unit. A circuit is always set up with a "near" side (coco near) and a "far" side (coco far). On a single-layer circuit, the substrate is usually the far cover. See far side.

Far side: On a specification drawing, the side of a unit that is away from the viewer.

Feed-through (feed-thru): A plated-through hole in a printed circuit board that is used to provide electrical connection from a trace on one side of the printed circuit board to a trace on the other side. Since it is not used to mount component leads, it generally has a small hole and pad diameter.

Feeler gauge: See gap finder.

FEA: See Finite Element Analysis. FEP: See Teflon™.

Ferric chloride: An acid commonly used as an etchant in the photo-etch process.

Fiberglass: Fine threads of glass used to add strength or shape. Woven fiberglass cloth is used to reinforce epoxy, silicone rubber, and Teflon™.

Fiducial: A mark or feature on an artwork, layer, stencil, or pc board that is used for alignment purposes.

Field of view: The area the microscope can view.

Filler: See lead filler and element filler.

Fillet, solder: A blended or rounded configuration (normally concave) of solder around a component or wire lead and pad.

Film adhesives: The thin, flat adhesive sheets which include the pressure-sensitive adhesives; #10 PSA, #12 PSA, and #16 PSA, plus #14 acrylic film. For heaters, PSA offers easy press-in-place installation but is limited in temperature and watt density ratings.

Fine pitch: Any part or pad geometry which has a pitch of 0.025" or smaller.

Finger: A conductor that extends outside the part edge of a flex circuit that is used by the customer for connection.

Finite element analysis (FEA): A numerical method used to predict the behavior of a heater/heat sink design. It is typically employed only if actual modeling is not practical.

First article inspection: A complete dimensional inspection done on a completed unit from the first lot (and/or other lots), to check for conformance to all customer requirements.

First part inspection: An inspection done after a few parts of a lot have been through a processing step. First part inspection ensures that the first parts meet specifications before the bulk of the order goes through that processing step.

Fitting: A small part used to join, adjust, or adapt other parts. We make a variety of fittings for installing our products. Examples include compression fittings, spring-loaded holders, and retaining rings.

Fixture: A device used to aid in the positioning of a circuit during a given process. Fixtures can be made of virtually any material.

Flash plating: Plating for a short time to get a very thin deposit of material.

Flat leads: Leadwires that have had their insulation flattened during lamination.

File-Gap

Flex circuit: Flexible circuits made of etched foil conductor strands laminated between layers of insulation. The conductors are usually copper, the insulation is polyimide (usually Kapton™). Flex circuits are used in place of wire for electrical connections in medical, military, and other electronic equipment.

Flex-Coil™: A product that has thin wire wound into a specific shape and laminated between layers of an insulation, usually Kapton. Flex-coils are used to pick up electromagnetic fields the way a TV or radio antenna picks up signals in the air. Coils can be used alone, but are usually part of a flex circuit. They are typically used inside pacemakers to allow reprogramming of an implanted pacemaker without operating on the patient.

Flood: In screen printing, using a squeegee to apply ink to the top of the screen before the ink is pressed through it.

Flowchart: A chart or diagram of the sequence and progress of a series of operations for a specific project.

Flush-flex circuit: A type of rigid-flex circuit that includes a layer of exposed conductors placed evenly or “flush” with a rigid layer of pre-preg material.

Flux: A chemical that is applied to the area to be soldered in order to remove any surface oxidation and improve the bond between the solder and the base material.

Flux residue: Flux that has not been properly removed from units after soldering.

Foil: Metal in the form of very thin sheets or strips which are used to make etched heaters and etched sensors. Types of foil commonly used at Minco include Inconel, Cupro-nickel, Balco, and copper. Foils of various thicknesses are generally used in the range of 0.0005” to 0.003” thick.

Foil cleaning: Removing oils and foreign material from foils. Foil is cleaned before it is bonded to substrate, and before resist film is applied.

Foil lay-up: The process of taping pieces of cut foil to a lamination plate and taping a piece of substrate on top of the foil piece.

Foil weights: Heavy blocks of metal covered with felt. Foil weights are used to hold foil and substrate down flat during the taping step before etching.

Foreign material: Any unwanted material or particles laminated in a unit. Foreign material may be leftover resist, dirt, dust, hair, or metal. Non-metallic foreign material is translucent, therefore light passes through it. Metallic foreign material is opaque and light will not pass through it.

Forge weld: A weld using pressure and filler material in a viscous state while brazing. This results in poor pull strength.

Forming fixture: A piece of equipment that uses pressure to bend flex circuits or heaters.

FR4: A material used as a substrate for a PCB made of fiberglass and epoxy. It is the same as G10 material, but made with a flame-retardant additive.

Freon™: A DuPont trade name for various nonflammable gaseous or liquid fluorocarbons. Some types of Freon are used as coolants in refrigeration and air conditioning. Other types are used as cleaning solvents.

Fuse clip: Metal clip used to hold a fuse.

Fusion weld: Two metals melted together forming a uniform bond, resulting in good pull strength. A fusion weld is a preferred weld.

Fuzzy logic: A control scheme that operates in addition to PID and gives the controller more “common sense” for dealing with unpredictable systems. Not required for most heating situations.

G10: A material used as a substrate for a PCB, made of fiberglass and epoxy. Cheap, and reliable except where exposed to moisture. See FR4.

Gap: The distance measured between the electrodes of parallel-gap welders.

Gap-Hea

Gap finder: A tool used to measure the distance between the electrodes on parallel-gap welders. Also called a feeler gauge.

Gap-soldering: A procedure that involves connecting two base materials together by melting high temperature solder between them and using special flux.

Gauge: 1. A standard system, or scale of measurement, e.g. a size of wire or sheet metal. See AWG. 2. An instrument for measuring, registering, or testing.

Gerber file: Data file used to control a photoplotter. Named after Gerber Scientific Co., who made the original vector photoplotter.

Gigohm: One billion ohms. The symbol is Gohm or $G\Omega$.

Gram: The standard unit of weight in the metric system. A gram is one-thousandth of a kilogram, or approximately 1/28 ounce.

Grit: The texture of the sandpaper that is used in the microsectioning grinding process. The lower the number, the coarser the sandpaper; coarse sandpaper is about 100 grit, medium is 400 grit, and fine sandpaper is 600 grit.

Grounded junction: A thermocouple probe constructed so that the hot, or measuring, junction is in electrical contact with the sheath material so that the sheath and thermocouple will have the same electrical potential.

Guide holes: See alignment holes.

Hand (manual) soldering: A soldering method which uses an electrically heated, temperature-controlled, hand-held soldering iron.

Hand punch: A metal cylinder that has one end sharpened and beveled and is used to punch holes by hitting it with a hammer.

Hank-wound element: An unsupported, wire-wound temperature sensing element made by looping wire around two or three points on a straight line.

Hard tool: Two precisely-matched metal plates that can be attached to a bench press (such as the Komatsu press). When the two plates come together, they punch (blank) material out in the shape of the plates. Generally used where very tight dimensional tolerances are required. The tools are also called "punch and die."

Hazardous waste: A waste, which because of its physical, chemical, or infectious characteristics may pose a substantial hazard to human health or the environment when improperly managed.

HCl: Hydrochloric acid, which is used in the HCl/water combination (95% water/5% HCl) in cleaning certain areas of the Etch Room. (See Safety Data Sheet for safe usage.)

Heat sink: An object that absorbs heat. Heat sink refers to the surface or object to be heated by a heater.

Heater: An electrical device that contains a resistive element that produces heat when connected to a voltage source.

Heater area: The area within the part over which element stranding can be routed. This is the total area covered by the part less the space used for borders, tabs, and any other unheated portions.

Heater backing: A material applied to one or both sides of a heater. A sheet adhesive, such as a PSA, can be used to affix a heater to an object that must be heated. A foil layer bonded to the surface can serve a variety of purposes. But most often, it serves as a lateral heat spreader.

Heater-sensor: A product we manufacture that combines at least one heating element and at least one temperature sensor within the same unit.

Heaterstat™: A temperature controller without a sensor which uses a high TCR heater to sense and control heat output.

Heat transfer: The transfer of thermal energy between bodies of different temperature.

Hermetic seal: A complete seal against the escape or entry of air. An example is a glass-to-metal header where glass is used to insulate and hold header wires in place.

Hertz: A unit of frequency equal to one cycle per second. Abbreviated Hz.

Hi-pot: An abbreviation for high potential test (high voltage test). See dielectric test.

Hold-down tabs: An extension of foil on a conductor pad that aids the pad in gripping to the substrate insulation. Hold-down tabs are also referred to as “anchoring spurs” and provide mechanical strength.

Hole misregistration: See misregistration.

Hollow-wound: A wire-wound element used in some of our probe-type RTD's. A hollow-wound element is cylindrical, but has no bobbin or internal support that might slow its response to temperature changes. The wire element is wound on a mandrel which is later removed.

Hood: See air hood or clean hood.

Hot air solder leveling (HASL): Solder-coating the pads of a circuit by fluxing, applying molten solder, then blowing off the excess solder using air.

HVAC: Heating, Ventilation, and Air Conditioning.

Hydraulic: Operated by water or other fluid. The force created by the ram or piston is generated by forcing the fluid into a chamber that moves the ram or piston.

Hydrochloric acid: A clear, colorless, fuming, poisonous, highly acidic solution of hydrogen chloride in water. Abbreviated HCl.

Hydrogen chloride: A colorless, corrosive, suffocating gas. This gas is dissolved in water to form HCl.

Hysteresis: Usually associated with on/off temperature controllers. Heat is applied to the system until the sensor reaches the setpoint temperature. The heat will then stay off until the temperature drops a few degrees below the setpoint. This difference in temperature is called hysteresis or deadband.

Hz: Abbreviation for Hertz.

I.D.: See inside diameter.

I-beam effect: The tendency of a flex circuit to have reduced flexibility and to fracture conductor strands if the conductor strands are layered directly over each other, instead of being staggered from layer to layer.

Ice bath: A mixture of ice and water in an insulated container. A well-prepared bath of high purity ice and water is exactly 0°C (32°F). Temperature sensors are immersed in an ice bath while their resistance is measured so that calibration accuracy can be verified.

Immersion plating: Plating without the use of catalyst or electric current.

Impedance: In an electrical circuit, opposition to the flow of an alternating current, at a particular frequency, measured in ohms. The impedance depends on many factors: DC resistance, capacitance, inductance of the line, frequency of the AC signal, width of the conductor strands, and the conductor spacing relative to ground and insulating layers.

In Hg: Measurement that stands for inches of mercury; it measures the amount of vacuum in the vacuum oven.

Inconel™: A metallic alloy containing 75% nickel, 15% chromium and 10% iron. Inconel is usually used as metal foil to make flexible heaters.

Inductance: A condition in a circuit where a change in current creates a voltage in the circuit, or in a neighboring circuit. Inductance is generally undesirable in heaters, sensors, and circuits (see non-inductive and bifilar). Flex-coils, on the other hand, are designed to be inductive.

In-house: Existing, originating, or carried on within a group or organization or its facilities, not outside.

Innerlay: An insulator with a layer of adhesive laminated to one or both sides. Innerlay is laminated between etched elements to prevent them from shorting out.

In-process: Product that has been released from production to build but has not been shipped to customer.

In-process inspection: An inspection of parts between manufacturing steps to separate acceptable parts from nonconforming parts. Nonconforming parts are marked or removed from the process so that no more time and material is wasted on them. In-process inspection also helps identify common defects soon after they occur. This makes it easier to find the cause of the problem.

Inside diameter: Measurement taken of a line that passes through the center of a circle, for example, a tube measured between inner walls.

Inspection: The process of measuring, examining, testing, gauging, or otherwise comparing one or more units of product to the applicable requirements.

Inspection, measuring and test equipment: All devices used to measure, gauge, test, inspect, or otherwise examine items to determine the acceptability of a product.

Insulation (electrical): A material that significantly resists the flow of current. Insulating material is sometimes referred to as a dielectric.

Insulation resistance: The ability of insulation to resist the flow of current. For example, if one mil Kapton™ can withstand 7000 volts of electricity, its insulation resistance is 7000 volts per mil. Also called dielectric strength.

Insulation resistance test: A nondestructive test that measures a unit's insulation resistance.

Insulator: A material that significantly resists the flow of current. Types of insulation we use are Silicone rubber, Kapton, Teflon™, Mylar™, epoxy glass, Nomex™, and Mica. Insulating material is sometimes referred to as a dielectric.

Integral: A controller feature that continuously compensates for droop by integrating errors over time and adjusting the proportional band up and down. Also expressed as "reset" (integral time = 1/ reset rate). General rule: Short integral times give faster correction, but too short causes oscillation.

Interchangeability: The comparison of accuracy of two identical thermometers mounted side by side in the same environment.

Interchangeability error: A measurement error that can occur if two or more temperature sensors are used to make the same measurement. It is caused by a slight variation in characteristics of different sensors.

Interconnect hole: See via.

Ion: A molecule with a positive or negative charge due to a gain or loss of an electron. A neutral molecule may gain or lose electrons if electrical or chemical force is applied.

ISO: Abbreviation for International Organization for Standardization.

ISO 9001: The ISO document which describes a model to shoot for in a company's quality control system. It describes quality assurance in design, development, production, installation, and servicing.

Isolated spacing reduction: A condition where spacing between etched strands or pads is reduced in an isolated area.

Isolated strand width reduction: A condition where a part of a conductor strand has been etched away in an isolated area.

Item: An all-inclusive term including assemblies, subassemblies, accessories, parts, equipment, and services. Job Orders have one or more sequentially-numbered lines listing each item ordered or each special charge.

ITS-90: The International Temperature Scale of 1990 came into effect January 1, 1990 in order to define temperatures so that all measurements around the world have a common base. It replaces the IPTS-68 and the EPT-76 scales.

Junction: The point in a thermocouple where the two dissimilar metals are joined.

Kapton™: An amber-colored, polyimide material that has high temperature capability and very good mechanical, chemical, and electrical insulating properties. Kapton is a DuPont trade name.

Kelvin: A scale used to measure temperature, especially very low temperatures. The symbol for Kelvin is K. Zero K, called absolute zero, is the complete absence of heat (-273.16°C). To convert to Kelvin from Celsius use the formula: $K = °C + 273.16$.

Kelvin clip: A spring-loaded clip with gold-plated, saw-like teeth used to make four-lead electrical connections.

Kilohm: One thousand ohms. Its symbol is kohm or $k\Omega$.

Kovar™: A metallic alloy containing 29% nickel 17% cobalt and 54% iron. We use gold-plated Kovar tabs to make certain weld connections. Kovar wire is used in some glass-to-metal sealed header connections. Kovar is a trade name of the Westinghouse Electric Corporation.

Kovar tweezer: An anti-magnetic tweezer with a sharp point used to pick up pieces of Kovar.

Kynar™: A clear, thin plastic film. Kynar PVDF has high-temperature capability and very good mechanical, chemical, and electrical insulating properties. Kynar is a trade name of Atofina Chemicals.

Laminate: 1. To assemble layers of material and bond them together under heat and pressure. 2. A material or assembly that is made up of a number of layers.

Laminating press: A press used to bond materials under heat and pressure.

Lamination fixture: Tooling used to place heat sinks into a lamination press without causing damage or to hold heat sinks in place during lamination.

Lamination inspection: An inspection of parts after lamination to look for delaminating, foreign material, and misalignment.

Lamination plate: A flat metal plate used in a lamination press when bonding layers of material together. Alternating layers of units to be laminated, rubber pads and slip sheets are placed between two lamination plates, then "pressed." Also called a press plate.

Land: A metalized conductor on a pc board that is designed to accept a surface-mount component lead.

Laser trimming: Using a laser to cut, trim, or skive a unit.

Lathe: A machine that spins a piece of wood or metal so that it can be shaped by a cutting tool.

Layer: When numbered, a layer is one sheet of copper in a flex circuit.

Lay-up: To assemble and align layers of material to prepare for lamination.

Lay-up plate: A flat plate with alignment pins mounted into it. Lay-up plates are used to assemble and align layers of materials before they are laminated.

Lead: The wire or formed conductor that extends from a component and serves as a mechanical and/or electrical connection. It can be formed to a desired configuration. See winding lead.

Lead bulge: The thickness built up over a leadwire on a unit after lamination and the spread of adhesive around the leadwire area.

Lead filler: An adhesive material that, when laminated, softens and flows to form around the leadwire area to prevent air bubbles and delamination.

Lead patch: A stack-up of materials placed over the lead termination to electrically insulate the area.

Lead pull test: A test that determines whether leadwires are properly anchored to a unit. A specified amount of force is applied to the wires to see if they remain intact.

Lead time: The time required to fill a customer's order, from the date the order is taken to the date when the shipment should be made.

Leadwire: See lead.

Leadwire attachment: See element lead attachment.

Leadwire resistance: The resistance of the leadwire. Each leadwire has its own resistance that must be subtracted from the design resistance.

LED (Light-Emitting Diode): a semiconductor diode that emits light when a voltage is applied to it. Used in electronic displays.

Letterscreen: The process of adding a set of letters to PCB, heater, or flex using silk screening methods.

Lifted conductor: A condition in which a strand or pad separates from the polyimide insulating material.

Line width: See strand width.

Linearity: A characteristic relationship that can be described by a straight line. For example, copper is said to have near perfect linearity. That is because when copper's resistance versus temperature is plotted on a graph, the result is a straight line. In some applications, linearity is desirable, such as in a temperature sensor. In other applications, non-linearity has more advantages.

Liquid photoimageable solder mask (LPI): A mask sprayed on using photographic imaging techniques to control deposition. It is the most accurate method of mask application and results in a thinner mask than dry film solder mask. It is often preferred for dense SMT assemblies.

LPI: See liquid photoimageable solder mask.

M: The abbreviation for mega or 1 million.

m: The abbreviation for milli or one-thousandth.

mA: See milliamperere. Magnesium oxide: A ceramic used as a high- temperature electrical insulation. Abbreviated MgO.

Major access hole: An access on the soldered side of the through-hole that must be large enough to maintain minimum annular ring.

Mandrel: A metal core that material can be wound, molded, bent, or shaped around. A mandrel is used as a temporary bobbin to wind wire for hollow-wound elements. A mandrel is also used as a temporary fixture to shape etched heaters and heater-sensors.

Manganin: An alloy of copper, manganese, and nickel with a low temperature coefficient of resistance; used to make heater buttons.

Marked-up document: A controlled document that has been marked with approved changes. (a date and initials typically constitute approval).

Marking: Labeling parts with ink and heat-curing the ink. A typical marking might include a customer part number, revision letter, "Minco", and a date code.

Marking stamp: A thin piece of rubber with typeface on one side and possibly an adhesive on the other side.

Material: Raw, bulk, piece parts, subassemblies, assemblies, and devices which are consumed into the end item.

Material review: A function for the identification, segregation, control, and disposition of nonconforming items.

Material safety data sheet: A form that provides necessary information to safely use, store, and dispose of chemical products.

Material specifications: A document which describes to Minco's suppliers what is required from a certain product or material.

Material stack-up: See stack-up.

Materials Review Board: A panel of experts from Minco that meet to determine whether a questioned material or product is suitable for use.

Mea-Min

Measurements lab: A laboratory that uses precision resistance and temperature measuring equipment to verify proper calibration and performance of many of our products.

Mechanical inspection: An inspection to verify that both a product's dimensions and markings are correct, and that the product's appearance and mechanical characteristics meet specifications.

Megohm: One million ohms. Its symbol is Mohm or MΩ.

Megohmmeter: An ohmmeter that can measure resistance in the megohm range (millions of ohms), gigohm range (billions of ohms), or even higher. It is used to measure an insulating material's resistance to the flow of current.

Metal stamp: A stamp that is used with the marking machine. It has a flat surface for placement of a marking stamp.

Metal type: Small metal blocks with raised characters that leave a printed impression when inked and pressed upon a unit or on the marking platform.

Metallic foreign material: When back and front lit, metallic foreign material will appear shiny and opaque. Metallic foreign material is recognized by its irregular shape, thin cross-section, and shiny appearance.

MgO: See magnesium oxide.

Mica: A heat-resistant mineral that separates easily into very thin leaves. Mica paper is used for insulation on some of our high-temperature heater models.

Micro-inch: One millionth of an inch: 0.000001"

Micrometer: A device that can measure length, width, or depth of an object up to 1" with a 0.0005" resolution. Measurements are displayed digitally.

Micron: One millionth of a meter, and another term for micrometer. An easy conversion scheme is to remember that 25.4 microns = 0.0254mm = 0.001" = 1 mil = 1,000 microinches. Use this formula to translate between inch and metric references.

Microsection: A cross-section of a product encased in a potting compound. The cross section is ground, polished, and examined under a high-power microscope to inspect plating thickness, grain structure, inter-metallic compounds, welds, etc.

Microvolt: One millionth of a volt, 10⁻⁶ volts

Mil: A unit of measurement equal to 0.001". (one-thousandth of an inch).

Mill: A milling machine. Mills are used in our machine shop to cut and shape metal and other materials.

Milli-: A term placed at the beginning of a word to indicate 1/1000 (one-thousandth). For examples, see milliamp and millivolt.

Milliampere: One thousandth of an ampere; 0.001 amps. The symbol is mA.

Millivolt: One thousandth of a volt; 0.001 volts. The symbol is mV.

Mil-spec: Referring to a military specification that outlines the requirements for a part. A test or method during the manufacturing process will sometimes refer to specifications from the military.

MIN: See minimum.

Mineral-insulated thermocouple: A type of thermocouple cable which has an outer metal sheath with mineral insulation (magnesium oxide) inside, separating the pair of thermocouple wires from each other and from the outer metal sheath.

Minimum annular ring: The minimum allowable width of metal around a through-hole. Before a cover is applied, it is a copper annular ring. After a cover and solder is applied, it is a solder annular ring.

Minimum electrical spacing: The minimum allowable distance between conductors that is sufficient to prevent insulation breakdown between them.

Minor access hole: An access hole that is only slightly larger than the through-hole it's exposing. Minimum annular ring is not required on a minor access hole.

ML: A thin enamel-like insulation that coats single strands of sensor wire. ML has good chemical and thermal properties. ML insulated wire is used in many of our temperature sensing products.

Module: A pre-calibrated sensor used in stick RTDs.

Moly electrode: An electrode made of molybdenum. This type of electrode is recommended for welding copper and large-gauge wire.

Monofilar: A wire winding that has one wire wound in a continuous length. See bifilar and quadfilar.

Mueller bridge: A bridge designed to measure the resistance of a Standard Platinum Resistance Thermometer. It is capable of measuring resistance over one specific range.

Multilayer circuit: A flex circuit with more than two layers of copper. The conductor layers alternate with layers of insulating Kapton™ and adhesive. Electrical connections are made between the layers with plated through-holes.

Multimeter: A test instrument which is used to measure voltage, current, or resistance.

Multiple die: A steel rule die or hard tooling that blanks (punches out) more than one unit at a time.

Multiple negative: A photographic negative with more than one image. Also called a multiple.

mV: Millivolt

National Bureau of Standards: Old name for the National Institute of Standards and Technology.

National Institute of Standards and Technology: Abbreviated NIST. An agency of the U.S. government that maintains fundamental units of measurement. NIST provides the service of comparing the fundamental units of measurement to working standards used in industry and elsewhere. When this is done, the working standards are said to be calibrated and traceable to NIST. This assures that measurements correlate between all users. NIST was formally NBS, National Bureau of Standards.

National Pipe Thread: A standard used to specify thread form for Minco thermowells, probe fittings, and similar products.

NBS: National Bureau of Standards. Old name for National Institute of Standards and Technology.

NC drill: Numerically-controlled drilling machine. A machine used to drill holes at exact locations, under computer control.

Near side: The side of a unit that is seen by the viewer on a specification drawing.

Needle pin vise: See pin vise.

Negative temperature coefficient: The characteristic of showing a decrease in resistance when temperature increases. This is typical in thermistors. See positive temperature coefficient.

Nested circuits: A group of circuits that are placed tightly together on an artwork in order to maximize the amount of panel area used. Nested circuits may be called clusters.

Nesting: Arranging units on an artwork so that parts fit tightly against each other. Manufacturing costs are reduced by fitting more units on each panel of material.

Net: Circuit connection from one test point to another; may include other connections (pads, via holes, etc.) through layers of circuits.

Net weight: The weight of a material or sample after deducting the weight of its packaging or container.

Newton: A metric unit of force. (1 newton = approx. ¼ pound.)

Nichrome™: A metallic alloy containing 60% nickel, 16% chromium, and 24% iron. We use Nichrome wire in heater-button elements and Nichrome foil in etched heaters. Nichrome is a trade name of the W. B. Driver Company.

Nickel: A hard, silver-white metal. Nickel has the highest resistance temperature coefficient of any of the metals. It is often used to plate other metals because of its hardness, appearance, and resistance to corrosion.

Nickel-iron: A metallic alloy containing 70% nickel and 30% iron. It changes resistance rapidly as temperature changes. Similar to Balco™.

NIST: See National Institute of Standards and Technology.

Nodule: An irregular bump on an etched foil conductor strand or in a plated through-hole that can cause undersized holes or bumpy, wavy strands. Nodules reduce flexing reliability.

Noise: See electromagnetic interference.

Nominal: The specified design value, ignoring the specified tolerance. For example, if a drawing specifies a dimension of 1.125" +/-0.005", then 1.125" is the nominal value. However, if the tolerance is single-sided, we usually define the nominal value to be the center of the acceptable tolerance range. For example, if a drawing specifies 1.250" +0.000/-0.004", then the acceptable tolerance range is 1.246" to 1.250" and we would say that 1.248" is the nominal value.

Nonconforming item: Any material, part or product in which one or more characteristics do not conform to the requirements specified in the order, specification, drawing, or other applicable product description.

Nonconformity, nonconformance: A condition (or conditions) affecting a product that does not allow the required specifications to be met.

Noninductive: Having low inductance. In a bifilar element, the magnetic field created by current in a conductor is cancelled because current in a nearby conductor is flowing in the opposite direction.

Non-metallic foreign material: Any material that is encapsulated within a unit that should not be in the heater and does not contain metal. When backlit, non-metallic foreign material will either appear translucent or dull and opaque. Non-metallic foreign material may retain a recognizable shape or may appear melted or burned. Examples include hair, clothing fibers, skin flakes, Kapton slivers, and dust particles.

NPT: See National Pipe Thread.

Null detector: An instrument that accurately measures or monitors for a zero voltage condition. One use for a null detector is with a bridge. The bridge's resistance settings are adjusted until the null detector is balanced at zero, then the resistance measurement is taken.

O.D.: Outside diameter.

Off-contact: In screen printing, the distance between the bottom of the screen, mounted in the printer, and the material to be printed.

Ohm: A unit of electrical resistance. The symbol for an ohm is Ω .

Ohm circular mil per foot: A measure of resistance of a conductor. For any conductor, it is the resistance of a one foot length of 0.001" diameter wire.

Ohm's Law: The scientific law that says electromotive force is equal to the current multiplied by the resistance in a circuit. $E = I \times R$ where E is electromotive force (volts), I is current (amps), and R is resistance (ohms). If you know two of the three terms, you can find the unknown third one.

Ohmmeter: An instrument used to measure electrical resistance.

On-off: A simple control scheme where output is on below the setpoint, off above, as with a thermostat.

Open circuit: An unwanted break in a circuit that does not permit current to flow. It can be caused by a broken wire or foil path, a broken weld or solder connection, or a switch, fuse, or a circuit breaker.

Ope-PFA

Operating temperature: The temperature at which the heater or item will be controlled.

Opposed gap welding: A resistance welding technique where electrodes are placed on opposite sides of the materials to be welded. Electric current passes through the materials from one electrode to the other, and produces enough heat to weld the materials together. Opposed gap welding is generally used for high-temperature materials.

Oscillation: Moving back and forth with a steady, uninterrupted rhythm.

Outgas: To expel entrapped gas from a solid or liquid, generally in a vacuum environment or at high temperature. Outgassed materials are sometimes toxic, and tend to foul up electrical contacts, optical lenses, etc. Kapton™ is often used for high reliability applications because it outgasses very little.

Outside diameter: Measurement taken of a straight line that passes through the center of a circle, i.e. of a tube, from the outside walls

Oxidation: The corrosion of a metal (or other substance) caused by its combination with oxygen. For example, rust is oxidized iron.

Oxide: A compound of oxygen combined with another substance.

Packaging cardboard: Special cardboard used to shrink package units. The cardboard has small holes space 1" apart to allow the vacuum to be pulled on the packaging film.

Packing instruction: Inspection performed during or following the packing operation and prior to shipment.

Pad: The part of an etched foil conductor used to connect or attach a component for an electrical connection. A conductor pad may surround a through-hole, and it may be round, oblong, or rectangular. Also called terminal pad or land.

Pads-only plating: A method of plating flex circuits so that only through-holes and surrounding pads are copper-plated. The conductor strands get very little plating, so they remain more flexible. Abbreviated POP.

Paliney M: A palladium alloy used for leadwires on high-temperature elements. Most of its characteristics resemble platinum, but Paliney M is much less costly.

Panel: A general term that is used to refer to a layer of foil and insulator material. A panel begins as one or two sheets of foil, or one or two sheets of foil with insulator bonded to it; more layers may be added as the manufacturing process continues.

Panelize: Arrange more than one (usually identical) printed circuits on a panel.

Parallel circuit: A circuit that allows current to split and flow through more than one path at a time.

Parallel gap welding: Parallel gap welding is a resistance welding technique. Electrodes are placed close together on the same side of the materials to be welded. Electric current passes through the materials from one electrode to the other. The current produces enough heat to weld the materials.

Part: Component. The smallest subdivision of a system, or an item which cannot ordinarily be disassembled without being destroyed (for example, a resistor or a metal stamping).

PCB: See printed circuit board.

PDF: Portable Document Format originated by Adobe to printing high-quality drawings and text from a computer.

Peel strength: The force in pounds per square inch required to peel a conductor, foil, cover layer, or stiffener away from the base material bonded to it. See bond strength.

PFA: See Teflon™

pH: A measure of how acidic or alkaline a solution is. A neutral solution has a pH of 7. pH increases with greater alkalinity to a maximum of 14, and decreases with greater acidity to a minimum of 1. See alkaline and acid.

Photo printing: The process of creating a desired pattern of resist film on foil to protect the foil during etching. Resist film is applied onto foil, then exposed to light through a pattern on a negative. Due to a reaction with the light, the resist hardens in the pattern of the negative. The film is then chemically developed to remove the soft, unexposed resist from the foil. The hardened resist remains to protect the conductor pattern during etching.

Photoetching: Manufacturing etched products using the photo printing method of applying resist film to foil substrate. Once the desired pattern of resist film is established, the assembly is exposed to intense light to harden and protect the trace areas. Then it is passed through a chemical etchant that removes the undesired, unprotected metal. Remaining resist film is then removed in a chemical process called stripping.

Photofilm: A photographic Mylar film or glass with a light-sensitive coating called emulsion. The emulsion contains silver nitrate, which is developed in a chemical developer.

Photoplot: To draw, with light, the graphical circuit pattern onto photographic film.

Photoresist: See resist.

Photosensitive: A material whose properties are altered by exposure to light.

Pick-and-place: High-speed machine placement of components onto PCB's.

PID (Proportional, Integral, Derivative): A control algorithm incorporating proportional, integral, and derivative action.

Pilot hole: A hole that is drilled into a stack-up at the point where routing is to begin. This hole prevents the routing bit from having to drill the initial starting hole, thus keeping the router bit cleaner during routing.

Pin: The solid wire or formed conductor that extends from a component and serves as a mechanical and/or electrical connection. (Derived from its physical shape on through-hole components, which predated SMT.) Also called lead.

Pin gauge: A tool used to check through-hole diameter before or after soldering.

Pin staking (or pin swaging): Inserting and forming small metal pins into circuit through-holes. The pins are usually soldered after they're staked to the circuit. See bullet-nose pins and swage pins.

Pitch: 1. During winding, the distance the wire is advanced along the bobbin for each turn is called the pitch or winding lead. The pitch determines the spacing between winds. 2. On a printed circuit board, the center-to-center distance between pads, rows of bumps, pins, etc.

Plasma etching: A gaseous cleaning process that cleans out the inside of the through-holes. This process occurs when the gasses O_2 and C_4 are vibrated to an excited (ionized) state by radio frequency to break down the polyimide and WA adhesive in the through-holes. Plasma etching is done in-process for the plating and the through-holes.

Plated-through hole: A hole in a multilayer PCB with metal plating added after it is drilled. Its purpose is to serve either as a via (electrically connecting circuit layers) or as a connection point for a through-hole component, or both.

Platen: The flat, steel plates of a press machine used to transmit mechanical pressure to laminate products under heat and pressure.

Plating: Applying a thin coat of metal. See electrolytic plating and electroless plating.

Plating coupon: A drilled-hole pattern on a panel of parts that are being plated. It used as a sample for microsectioning to test plating thickness and quality in the holes.

Platinum: A grayish-white metal that has high resistance to corrosion. Minco uses platinum wire in platinum resistance thermometers.

Point-wise thermal regulation: The ability of SmartHeat to control heating at individual points on the heater surface based on ambient conditions at each point.

Polarity: In electricity, the characteristic of having two oppositely charged poles, one positive and one negative.

Polyester: A family of synthetic plastics. A synthetic polymer used to electrically insulate heaters, flex-circuits, and Thermal-Ribbons™. It is an economic alternative to polyimide, when high temperature and chemical resistance are not critical. It is a transparent, thin film used as cover material on some heater models.

Polyimide: flexible, amber-colored, translucent film to electrically insulate heaters, flex circuits, and Thermal-Ribbon sensors. It is widely used for its temperature range and resistance to chemicals. DuPont's tradename for Polyimide is Kapton.

Polyolefin: An electrical insulation used on leadwire and as tubing. Treated polyolefin tubing will shrink when heated. Polyolefin is resistant to nuclear radiation and has a temperature capability of 135°C.

Population: In statistics, the totality of the set of items, units, measurements, etc., real or conceptual, that is under consideration.

Positive: See photo-tool.

Positive temperature coefficient (PTC): The characteristic of increasing resistance when temperature increases. This characteristic is typical of Minco sensors. See negative temperature coefficient.

Potentiometer: A variable resistor that functions as a voltage divider.

Potting: Filling with potting compound (such as epoxy or silicone rubber) to hold and seal leads where they emerge from the end of a probe case.

Potting compound: A liquid material that hardens into a solid by curing. Typical potting compounds we use are epoxies and two-part silicone rubbers.

PPM (parts-per-million): A measurement scale for defect rates of components or impurity levels in materials.

Precision resistance thermometer: A group of Minco's platinum RTDs that have excellent repeatability and stability for precise temperature measurements. Abbreviated PRT.

Pre-preg: An uncured glass and epoxy weave that becomes rigid like fiberglass after it is laminated. Also referred to as b-stage.

Prescribed set point: The temperature goal designed into a SmartHeat heater as the point of production.

Press: A machine that produces a very large force to compress, shape, or cut materials. See laminating press and punch press.

Press pad: Thick rubber pad that is used in the lamination stack-up to prevent damage to the units or materials. Used to apply uniform pressure over an entire heater surface and to accommodate any voids or differences in thickness of heaters.

Pressure-sensitive adhesive (PSA): An adhesive that does not require heat or extreme pressure to apply. Simply peel off the release liner, and firmly press into place.

Printed circuit board (PCB): The term generally used for printed circuit configurations such as rigid or flexible, single, double, or multilayered boards that are completely processed. A PCB is a substrate of a glass fabric impregnated with a resin (usually epoxy) and cured and clad metal (almost always copper) upon which a pattern of conductive traces is formed to interconnect components. Also called Printed Wiring Board (PWB).

Probe: 1. A slender, tubular-shaped temperature sensor (RTD or thermocouple) designed for insertion into liquids and gasses to detect a temperature. The sensing element, located at the tip of the probe, is sealed in a case to protect it. 2. A rigid, pointed, metallic, wire-shaped device used for making electrical contact to a circuit pad for electrical test purposes.

Profiled heater: A method of providing uniform temperature, by varying watt density in a single heater to accommodate non-uniform heat loss from the heat sink.

Profile tolerance: Dimensional tolerancing where the part trim line is contained within a tolerance zone consisting of the area between two parallel lines, separated by the specified tolerance. For example, a circuit to be trimmed with a steel rule die might have a tolerance of 0.015" (0.38mm) – a 0.030" (0.76mm) wide profile tolerance zone. The circuit trim line could vary anywhere inside the zone.

Proportional band: A region around the setpoint where the output is proportional to the process's distance from that setpoint. For example, 100% heater power during warmup is proportioned to 75%, then 50%, then 25% as temperature nears setpoint. General rule: Set just wide enough to prevent temperature from wandering outside band during normal operation.

Proportional control: A control method where the controller output is proportional to the temperature difference from the setpoint.

Prototype: A unit that is manufactured using experimental procedures in order to develop the most effective manufacturing procedure and/or provide customers with an initial unit for their own developmental procedures or to use as a test unit.

PRT: Platinum resistance thermometer or precision resistance thermometer. See resistance thermometer.

PSA: See pressure-sensitive adhesive.

PSI: Abbreviation for pounds per square inch. PSI is a unit of pressure.

PTFE: See Teflon™.

PTH: See plated through hole

Pull test: See lead pull test.

Punch and die: Hard tooling used in a punch press for cover cutouts, circuit through-holes, and final blanking. A punch and die consists of two precisely-matched metal plates held in special die shoes. When the punch press is triggered, the metal plates come together and punch out a unit.

Punch press: 1. A press that can be fitted with a steel rule die or a punch and die to cut out parts. See blanking 2. A press used with a press brake in our machine shop to bend, cut, or punch holes in metal.

Pyrometer: An electrical thermometer used to measure high temperatures.

QA: See Quality Assurance.

QA provision clauses: An integral part of a purchase order: The requirements of these clauses are in addition to, and not in derogation of other Purchase Orders, Work Orders, and/or Letter Contract Requirements. Compliance with the requirements of these clauses does not relieve the supplier of his responsibility for furnishing material and services which fully comply with applicable drawing and specification requirements. Examples of these clauses are: Government/customer source inspection, product conformance certifications, in process inspection, lot traceability, special marking, etc.

Quadfilar: Describes sensors that have four resistance wires wound simultaneously on a bobbin. A quadfilar winding may be used to produce two bifilar elements on a single bobbin. See bifilar and monofilar.

Qualification personnel/process: Documented verification that personnel or processes are capable of performing to requirements.

Qualification testing: Testing performed one time only.

Qualified product: An item on a Government Qualified Products List or tested and approved for inclusion in a Qualified Products List.

Quality: Conformance to a set of predetermined design and workmanship standards. Quality and reliability are not synonymous.

Quality assurance (QA): A system of activities whose purpose is to provide assurance that the overall quality control job is, in fact, being done effectively.

Quality control: The overall system of activities whose purpose is to provide a quality of product or service that meets the needs of users.

Quality records: Data, records, or other documentation, such as Inspection/Test reports, corrective action reports, failure reports, manufacturing records, etc., related to conformance of an article, product, material, or service to specified requirements.

Quantum tunneling: The process by which electrons travel between conductive carbon particles in a non-conductive silicone matrix.

R: Abbreviation for radius, usually appearing with a measurement on a drawing.

Radial lead: A lead extending out the side of a component rather than from the end. Refer to axial lead.

Radiation: The transfer of thermal energy through space (especially a vacuum) by electromagnetic waves.

Radius: The distance from the center point of a circle to any point on its edge.

Ramp: A programmed rise or fall in temperature.

Range: The difference between the largest observed value and the smallest observed value.

Ratio: The relation between two quantities, expressed as a fraction. One common use of a ratio is to describe the resistance-temperature characteristics of sensor wire or foil as the ratio of the resistance at 100ΩC to the resistance at 0ΩC. For example, if the resistance is 917 ohms at 100ΩC, and 604 ohms at 0ΩC, the resistance ratio is $917/604 = 1.518$.

Raw material: Metal or other material in primary form as furnished by the mill where no subsequent fabrication has been performed. Included in this category is sheet stock, bar stock, and rod stock.

REF: See reference dimension.

Reference designator (abbr. "ref des"): The name of component on a printed circuit by convention beginning with one or two letters followed by a numeric value. The letter designates the class of component; e.g. "Q" is commonly used as a prefix for transistors. Reference designators usually are printed in white or yellow epoxy ink (the "letterscreen") onto a circuit board. They are placed close to their respective components but not underneath them, so that they are visible on the assembled board.

Reference dimension (REF): A dimension that is to be used for informing during production, but not during inspection.

Reference documents: The documents and test reports that are mentioned in the Engineering Instruction. These documents may include (but are not limited to) other Engineering Instructions, Minco Quality Assurance documents, Government documents, and customer-supplied operational or service manuals.

Reference standard: A measurement standard of the highest accuracy within the system. Reference standards such as thermometers, gauge blocks or resistors are periodically sent to the National Institute of Standards and Technology for calibration. They are used at Minco to calibrate our own measurement devices. Reference standards allow all of Minco's measurements to be NIST traceable.

Ref-RMS

Reflow: 1. Heat up the p.c. board to melt and fuse the tin-lead covering the conductors. 2. The process to solder SMT components where heat is applied to the pc board causing the solder paste to melt and flow onto the component leads that are stuck in the paste.

Register: To properly align various phototools or layers of PCB material to expose or laminate them.

Registration: Alignment of conductor pads around through-holes, access holes around through- holes, and the outline of a part (usually a flex circuit) to its hole and conductor pattern.

Reliability: The continued conformance of a device or system to a specification over an extended period of time.

Repeatability: The ability to repeat a reading after conditions have changed and returned to the original conditions. A temperature sensor had good repeatability if its resistance at a specific temperature returns to the same value after it has been repeatedly cycled to other temperatures.

Requalification: Reverification that machine settings are within the optimum range. .

Request for Quote (RFQ): A request for price and delivery information for a product or service.\

Resist: A light-sensitive film used in the photo-etch process. When exposed to light, the film hardens and becomes resistant to removal by developing and etching chemicals. Also called photo-resist. Riston™ is DuPont's trade name for the resist often used at Minco.

Resistance: The opposition of a conductor to the flow of electric current. The unit of electrical resistance is the ohm.

Resistance density: Resistance per unit area. Usually listed as a maximum, it is dependent upon construction materials such as foil, adhesive, and insulation.

Resistance profiling: Adjusting element widths of Thermofoil heaters, allowing different parts of the circuit to reach different temperatures.

Resistance temperature coefficient: See temperature coefficient of resistance.

Resistance temperature detector: Abbreviated RTD. See resistance thermometer.

Resistance thermometer: A temperature sensor of hair-thin wire, or of metal film, whose resistance increases when temperature increases, and in a known and repeatable manner. Often called RTDs (resistance temperature detectors).

Resistance tolerance: The range of actual resistance from nominal (or target resistance), at a reference temperature (usually 0°C). Generally, wire elements have a tighter resistance tolerance than etched foil elements.

Resistance wire: Wire that is used for elements in resistance thermometers, heaters, or fixed resistors. Resistance wire is specially processed and controlled by the supplier to meet our specifications. We use platinum, nickel, nickel-iron and copper resistance wire in various sizes from ½ mil (0.0005") to 3 mils (0.003") in diameter.

Resistivity: The tendency of a material to oppose the flow of electric current. Resistivity is usually expressed in ohms circular mil per foot or ohms square mil per foot. Resistivity of a conductor equals resistance multiplied by cross-sectional area, divided by length.

Resistor: An element used to provide resistance in a circuit. Its resistance remains the same over a wide temperature range.

Respirator: A mask worn to filter out fumes.

Response time: An expression of how quickly an RTD responds to a sudden temperature change. See time constant.

Reticle: The ruler-like measurement scale seen and used through a microscope.

Rigid-flex: A circuit containing both rigid and flexible areas. The rigid layers have conductors and plated through-holes connecting them to other layers.

RMS: Abbreviation for Root Mean Square

Rodar: Gold-plated transition tab, same as Kovar™ except made by different manufacturer.

Roll to roll (roll lamination): The joining of two or more rolled materials together by means of heat and/or pressure to produce a laminated roll of material.

Rosin flux: A class of solder flux that is relatively inactive compared to other types of flux. From mildest to most active, the types of rosins in this class are: R (rosin), RMA (rosin mildly activated), and RA (rosin activated). Rosin flux is often required in high-reliability units to avoid the possibility of corrosive residue which might remain if a more active flux were used.

Rotary wire stripper: A hand-held tool that uses rotating blades to strip insulation off of leadwires. Wire ends must be bare before they are welded, soldered, or crimped.

Rout tabs: See tabs.

RPM: An acronym for revolutions per minute which is a measure of rotational speed.

RS-485: A communication standard for interfacing computers to process instruments. Allows multiple instruments on a single twisted-pair cable. Convertible to RS-232 with proper adapter.

RTD: A sensor whose resistance changes with temperature. The most accurate of commonly used thermometer types. See resistance thermometer.

RTV: 1. Abbreviation for room-temperature vulcanizing. 2. A silicone rubber adhesive used to mount heaters or Thermal Ribbons to parts. 3. Abbreviation for return to vendor.

Run: A group of units that are all of the same model number and travel through the production areas together at approximately the same time. The group is tracked by its run number.

Safety data sheet: See Material Safety Data Sheet.

Safety temperature: The temperature at which a SmartHeat heater becomes an isolator, completing shutting down current flow.

Sample variation: A range to either side of a set-point temperature.

Scaling: Panel shrinkage or stretching along the X-Y axis.

Schematic: A diagram which shows, by means of graphic symbols, the electrical connections, components, and functions of a specific circuit arrangement.

Scoring: The process of cutting through material partway to make it easy to break the material.

Screen printing: Applying liquid resist ink onto a substrate in a desired pattern. The pattern is achieved by forcing the ink through a stencil screen with a squeegee. Screen printing has fewer steps than photo printing, but it cannot hold the tight tolerances that the photo method can. Also called silk screening.

Scribe: To score or mark with lines, grooves, scratches, or notches.

Scrim: An open-weave fiberglass cloth. An adhesive-coated scrim is used to support an etched heater element that a customer wishes to mold into plastic parts.

Scrubbing: The mechanical process of removing corrosion and residues from foils. Scrubbing also improves a unit's bond to resist film and its cover layer by roughening its foil surfaces. Foil panels may be scrubbed in a machine, or by hand with a rotating brush or by a soft-bristled hand brush.

SDI: See Suggested Design Improvement.

Seamless die: A blanking die that is machined out of a block of steel so that its cutting edge is one continuous blade.

Selective plating: A method of plating flex circuits so that only the circuit's through-holes and surrounding pads are plated. This greatly adds to a circuit's flexibility.

Self-heat: Heat developed by electric current flowing through an RTD element. Self-heating causes a higher temperature reading by raising the temperature of the RTD element. In most cases the self-heating error is very small.

Self-limiting heater: The characteristic of SmartHeat that allows it to reach, but not exceed, the temperature set point.

Self-limiting technology (SLT): The characteristic of the carbon-silicone matrix (CSM) that stops current flow at any area where the set-point temperature is reached.

Self-tuning in dynamic environments: The ability of SmartHeat to adjust rapidly to local changes in heat loss.

Semiconductor: A substance that conducts electricity better than an insulator, but worse than a good conductor.

Sensor: A transducer that detects a physical quantity and converts it into a form suitable for processing. For example, a temperature sensor's resistance increases as the temperature rises then electronics converts this to a voltage or current signal suitable for metering.

SensorCalc: A Minco web-based program that provides resistance versus temperature data for a variety of sensors and heaters.

Sensor wire: Metal that has been drawn into a very long, thin thread or roll. Usually circular in cross-section. In the sensors division, it is also referred to as resistance wire or element wire.

Series circuit: A connection in a circuit that allows current to flow on one path without branching.

Set point: The temperature at which a controller is set to control a system. In SmartHeat SLT heaters, the setpoint is the temperature at which the heater is designed to reach and maintain.

Shear: A machine which cuts sheet materials to size using a guillotine-like blade.

Shield: A tape or braid (usually copper, aluminum, or other conductive material) placed around or between electric circuits or cables or their components, to prevent signal leakage or interference.

Short circuit (short): A defect in a circuit, heater, or sensor where current bypasses part of the intended electrical path, or connects conductors designed to be isolated. Examples of short circuits include crossed sensor wires and conductor bridging.

Shrink band: A strip of pre-stretched Mylar™ or Kapton™ film that shrinks when heated. A shrink band is used on a cylindrical surface to hold a sensor, heater or heater-sensor in place without adhesive.

Shrink tubing: Flexible plastic tubing that shrinks to a smaller diameter when heated. Some uses are a sleeve over leadwires and insulation over electrical connections.

Silicone: A synthetic compound that withstands a wide range of temperatures and is generally resistant to moisture. Silicones are used in lubricants, electrical insulation, adhesives, sealant, synthetic rubber, and release agents.

Silicone glass: Woven glass fibers saturated with a silicone compound to provide mechanical strength, electrical insulation properties, and moisture resistance. The silicone glass used in Thermofoil™ heaters is thin, flexible and red in color. The silicone glass used in stick-RTD's is semi-rigid and white in color.

Silicone matrix: The sheet of silicone material in which carbon particles are embedded.

Silicone rubber: A synthetic rubber that maintains its mechanical and electrical properties over a wide range of temperatures. We use it as electrical insulation for some heaters and sensors, and as O-rings for pressure seals in fittings used to install probe-type RTD's.

Silk screen: Same as letterscreen. Printing on the component side (sometimes both sides) of a PCB, using outlines and symbols to show component locations. So-called because the ink is applied using a silk screen. Also, see screen printing.

Silver solder: A high-temperature solder containing silver, copper, and zinc.

Single-sided: The most common style of PCB in mass-produced consumer electronic products, having all conductors on one side of the board. See also double-sided and multilayer.

Skip-lot sampling plan: In acceptance sampling, a plan in which some lots in a series are accepted without inspection, when the sampling results for a stated number of immediately preceding lots meet stated criteria.

Skived hole: A hole drilled in only the cover layer (exposing the transition tab), using a flat-bottomed drill bit.

Skiving: Removing a small circular area of Kapton™ cover material with a special drill to expose underlying Kovar™ or foil.

Slope: The change in resistance divided by the change in temperature about a given temperature range. Slope is measured using resistance change over several degrees of temperature change.

Smart heating element: A generic term for a heating element that controls its own temperature without input from external heaters and sensors.

Smart layer: The layer within the SmartHeat heater that both heats and controls current flow.

SMD: See Surface Mount Device.

SMT: See Surface Mount Technology.

Snap action: A switching method, often used in thermostats, in which a temperature-sensitive bi-metallic element causes fast make and break of electrical connections. In contrast to creep action, this method results in less electrical noise, but requires a significant differential between temperatures that open and close the connection, resulting in looser control.

Soda: Sodium bicarbonate. Used to neutralize acid left on parts after etching, and to bring acidic chemicals to neutral pH level before disposal.

Soda ash: Sodium carbonate. A powdered chemical used to make developing solution.

Sodium hydroxide: 1. A strongly alkaline compound used to strip insulation coating off coil wires. 2. Used in waste treatment to raise the pH of waste water. Also known as caustic soda or lye.

Solder: 1. To join or coat metals by applying melted solder. 2. A metal alloy, often a mixture of lead and tin. Different types of solder have different melting temperatures. Solder must have a lower melting temperature than the metals it joins. Bars of solder are melted and used in solder pots for dipping parts. Wire solder is used for hand soldering.

Solder annular ring: See annular ring.

Solder mask: A dielectric material used to cover the entire surface (except where the joints are to be formed) of the PCB primarily to protect the circuitry from environmental damage. Solder mask also helps to reduce bridging.

Solder pad: The exposed part of a circuit conductor requiring solder coating.

Solder paste: A thick mixture of tiny solder balls and flux used for surface-mount assembly of pc boards.

Solder plating: Solder-coating conductor pads by plating solder onto them. Solder plating is precise because solder is deposited onto exposed copper in a solder bath with controlled current.

Solder reflow: The process of melting solder paste in order to solder surface-mounted components onto a pc board.

Soldering iron: A hand-held, temperature-controlled tool used to melt and apply solder.

Solvent: A liquid that can be used to dissolve another substance. We use several solvents as cleaning solutions. Examples are: acetone, alcohol, Freon™, methyl ethyl ketone, toluene, and trichloroethylene.

Source inspection: Inspection performed at MINCO, by a customer's inspector, to examine product before shipment.

Spacer: 1. A non-adhesive material, typically Teflon, that is placed on a circuit panel during lay-up to make the panel surface more even. 2. A piece of FR-4 material that separates the wires within a split coil. 3. Metal block that helps fit a die more snugly into the punch press so it will cut more evenly.

Spacing: The distance between adjacent conductor edges.

Span: The difference between the top and bottom scale values of an instrument. For example, a Temtran whose range is 20°F to 120°F has a span of 100°F. On instruments starting at zero, the span is equal to the range.

Span adjustment: The means provided in an instrument to change the slope of the input-output curve. Used to set the output for the maximum scale value, e.g. 20 mA.

Special process: An activity that requires controls other than inspection to demonstrate compliance with requirements. These controls include training and certification of personnel and equipment.

Specification: A detailed description including dimensions, details of construction, and performance and testing requirements.

Specification drawing (spec drawing): An engineering drawing showing finished dimensions, configuration, characteristics, ratings and limitations of a product.

SPRT: Standards-quality PRT; a thermometer of very high accuracy. See standard.

Square mil: A measure of area equivalent to a square with sides of 0.001" length.

SRD: See steel rule die.

SSR (solid state relay): A type of relay with no moving contacts to wear out, offering life many times that of mechanical relays. Best for time proportioning.

SST: Abbreviation for stainless steel.

Stability: The ability to remain constant or steady in value over a long period of time. Stability usually refers to resistance thermometers, meaning that the resistance at a given temperature will vary only slightly over time.

Stabilize: To improve stability. Special manufacturing processes used to stabilize resistance thermometers include annealing, heat aging, temperature cycling, or thermal-shocking.

Stack-up: The vertical stacking arrangement of materials to be laminated, including lamination plates, slip sheets, rubber press pads, barrier sheets, and units or materials.

Stainless steel: A highly corrosion-resistant alloy of steel and chromium.

Stamp base: A metal block that holds printing stamps.

Standard: Something that is established as a basis of comparison or measurement. 1. A resistance calibration standard is a temperature sensor that meets specifications and is used as a basis of comparison to calibrate similar temperature sensors. 2. Our measurements lab maintains standards of dimensions, resistance and temperature that are used to verify other measuring equipment throughout the plants.

Standoff: A device that elevates a package above its mounting surface.

Sta-Sub

Static application: An application using a flex circuit that requires minimal flexing during installation and equipment maintenance only.

Statistical quality control: Quality control in which statistical techniques are used. These techniques include the use of frequency response distribution, measures of central tendency and dispersion, control charts, acceptance sampling, regression analysis, test of significance, etc.

Stator: The stationary part of a motor, generator or turbine, in which a rotor turns. See stick-RTD's.

Steel rule die: A tool used for blanking or to cut cover slots and large holes. It consists of steel cutting blades in the shape of a heater, circuit or sensor, embedded in a plywood base. Abbreviated SRD.

Stencil: A thin sheet of material (usually metal) with a pattern cut into the material where solder paste should be applied to an SMT printed circuit board.

Stick RTD: A resistance temperature detector having the appearance of a flat stick. Stick RTD's are used as temperature detectors in the stators of large rotating electric generators, motors, and turbines. Since the RTD also serves as an electrical insulator between conductors in the machine, high dielectric strength and good insulation properties are important.

Stiffener: Rigid or flexible layers of polyimide or epoxy glass that are added to circuits so that customers can mount components on them more easily. There are no conductors in the stiffeners.

Strain: An undesirable effect on a sensor wire caused by its expansion and contraction on bobbin material that doesn't expand and contract at the same rate. Strain can cause the sensor resistance to permanently shift, or cause a sensor wire to break.

Strain free: A platinum resistance thermometer in which the wire element is supported on the spiraled groove of a ceramic bobbin. The wire is free to expand and contract as temperature changes. This design, which makes the element completely strain free, gives the thermometer excellent repeatability, stability, and accuracy over a wide temperature range.

Strain relief: Shaping of a sensor wire or thermistor leadwire in the welded areas to minimize strain when the unit is used or bent.

Strand: A single uninsulated wire.

Strand width: The distance from one edge of the conductor to the other edge, measured at the base from the back of the conductor. Etched foil conductors are narrower at the top than at the bottom because of undercut. Undercut happens because the top of the foil is exposed to the etchant longer. Conductors must be wide enough to carry a specified amount of electrical current.

Stranded wire: Leadwire that is made of several fine wires twisted together. We typically use seven- or nineteen-strand leadwire at Minco. Stranded wire is more flexible than solid wire.

Stretch factor: Measuring a dimension from one feature to a second feature on the board, the factor is the ratio of the difference as compared to the original artwork or as compared board-to-board.

Stuff: The process of inserting components into a printed wiring board.

Subassembly: 1. An assembly that is used at the next level of the bill of material to build another assembly. 2. A replaceable combination of parts which is an element of an assembly (e.g., terminal board with mounted parts).

Substrate: Insulation material used beneath an etched heater, circuit, or sensor to support it. Common substrate materials include silicone rubber, Nomex™, mica, Mylar™ and Kapton™.

Sur-Tem

Surface etch: The process used to raise the resistance of an etched element and achieve acceptable resistance by hand-applying etchant to the surface of the foil.

Surface mount technology: A technique for assembling circuit boards in which components are mounted directly onto the surface of the PCB. A layer of solder paste is screen printed onto the pads and the components are attached by pushing their leads into the paste. When all of the components have been attached, the solder paste is melted using reflow soldering.

Surface uniformity: The ability of SmartHeat to adjust local current flow to maintain even temperature across the heating surface.

Surfactant: A substance that alters the properties of surfaces of materials. Soaps and wetting agents are examples of surfactants.

Swage pin: A hollow-headed pin that is mechanically crimped onto a flex circuit to provide a means of mechanical and electrical connection.

T/C: Abbreviation for thermocouple.

Tabs: Bridges of solid material that keep the circuit connected to the panel after router slots are cut. Rout tabs allow for further processing of the circuit in panel form. Same as rout tabs. See also transition tab.

Tangency: A condition that occurs when the edge of a stiffener or cover access hole is flush with the edge of a through-hole.

Tare: Deducting the weight of the container from the gross weight of the container and its content. (This results in the net weight.)

Target temperature: See set point.

TCE: See thermal coefficient of expansion.

TCR: See temperature coefficient of resistance

Tear stops: Copper, polyimide, or Teflon guards that are located in the inner corners of polyimide-insulated flex circuits in order to prevent propagation of tears.

Tempco: Abbreviation for “temperature coefficient;” the error introduced by a change in temperature. Normally expressed in $\%/^{\circ}\text{C}$ or $\text{ppm}/^{\circ}\text{C}$.

Temperature class A: A classification of materials that includes the maximum operating temperature as part of the specifications. All materials in a Class A unit must withstand a temperature of 105°C (221°F) without deterioration over an extended period of time.

Temperature class B: Same as Class A, except temperature capability must be 130°C (266°F).

Temperature class F: Same as Class A, except temperature capability must be 155°C (311°F).

Temperature class H: Same as Class A, except temperature capability must be 180°C (356°F).

Temperature coefficient of resistance (TCR): The amount of change in resistance of a metal per degree of temperature rise. The purity or composition of a metal affects its TCR. Platinum, for example, has one of several standard TCRs depending on its purity. TCR is expressed as the ratio of resistance at 100°C to the resistance at 0°C . Refer to positive temperature coefficient and negative temperature coefficient.

Temperature cycling: Subjecting a product to alternating hot and cold temperature extremes to verify its stability and reliability. Temperature cycling is relatively slow and is not as severe as thermal shock testing.

Temperature overshoot: The potential for a heater to exceed its target temperature; typically caused by lag between heating and recognition of temperature by an external sensor.

Temperature sensor: A device used to indicate or control temperature. Examples include resistance thermometers, thermocouples, thermistors, thermostats, and mercury thermometers.

TemptranTM: Minco tradename for a temperature transmitter which amplifies and scales the signal of a temperature sensor, converting it to a DC current signal which can go thousands of feet.

Tensile strength: The maximum force in opposing directions a material can withstand without breaking.

Tented via: See via

Terminal: A device attached to an end of a wire or to a through-hole of a circuit for making a convenient electrical connection.

Terminal pad: See pad.

Test coupon: An area of patterns on the same fabrication panel as the printed circuit, but separate from the electrical circuits and outside of the actual board outline. It is cut away from the printed circuit board prior to assembly and soldering of components and it is used for destructive testing.

Test fixture: A holder, built to match a particular product, for the purpose of easy, reliable connection for testing.

Testing instruction: Model-specific instructions on how to verify the functionality of the product and its conformance to specifications.

TFE: See Teflon™.

Thermal Calc: A Minco web-based program to assist in calculating heater wattage requirements from known parameters. Thermal Calc is available at B.

Thermal-Clear: A heater made with transparent insulation and a fine wire element. Thermal-Clear heaters transmit over 80% of visible light.

Thermal coefficient of expansion: The rate at which a material expands or contracts with a change in temperature, expressed in inches per degree Fahrenheit.

Thermal conductivity (Kt): How well the material conducts heat through it.

Thermal control: The desirable maintenance of a target temperature.

Thermal equilibrium: Maintaining temperature within a range despite variation in external conditions both over time and from point to point.

Thermal expansion: The enlargement of a material when heated.

Thermal fuse: A safety device that shuts off an electrical circuit if temperature exceeds the rated shut-off temperature.

Thermal Ribbon™ sensor: A resistance thermometer with an element wire laminated between two layers of a thin, flexible material such as Mylar™, Kapton™, or silicone rubber. Thermal Ribbon is a Minco trade name.

Thermal runaway: Uncontrolled heating when a heater separates from the heatsink or a liquid heatsink runs dry.

Thermal shock testing: Rapid cycling of a product between hot and cold temperature extremes to severely test its materials, structure, and stability. Thermal shock is a quick way to detect flaws in workmanship or design.

Thermal uniformity: Maintaining even heat over a surface even if conditions vary from point to point.

Thermal-Clear™ heater: Thin, flexible wire heating element laminated between see-through layers of insulation. Thermal-Clear is a Minco trade name.

Thermistor: A temperature sensor made of semiconductor material whose resistance decreases as temperature increases. Thermistors are highly sensitive. They exhibit a large resistance change per degree of temperature change. Thermistors may be as small as a pinhead for sensing temperature at a point.

Thermocouple: A temperature sensor made of two types of metal conductors that produce a voltage when connected. The voltage developed at the junction changes predictably when temperature changes. Thermocouples are rugged and have extremely high temperature capabilities. They can be used to sense the temperature of a microscopic area. Abbreviated T/C.

The-Too

Thermofoil™ heaters: Thin, flexible, etched-foil heating elements laminated between insulating layers such as Kapton™, Nomex™, or silicone rubber. Thermofoil heaters are capable of producing precise, efficient heat because of their thin insulation, light weight, and flat foil element. Thermofoil is a Minco trade name. Minco originated the etched-foil heater concept in 1960.

Thermoplastic adhesive: Adhesive that becomes soft and flexible (plastic) each time heat is applied, but is rigid below its softening point (behaves like a high temperature wax). For example, FEP and TFE Teflon.

Thermoset adhesive: Adhesive that becomes permanently cured or set by a chemical reaction. This can occur by chemical reaction or the application of energy (heat, UV light, etc.). Once cured, a thermoset adhesive cannot return to its original state.

Thermostat: A temperature-sensitive switch used as an economical on/off controller, or for overtemperature protection. See “snap action” and “creep action.”

Thermowell: A closed-end tube used to protect temperature sensors from harsh environments, high pressure, and liquid or gaseous air flows. Thermowells are usually made of corrosion-resistant metal or ceramic (depending on the need), and are installed with pipe threads or a welded flange.

Thin-film component: An electrical component made by depositing a thin layer of metal on a substrate (usually ceramic). Thin film techniques can be used to make heaters or temperature sensors.

Through-hole: A hole drilled through all the layers of a flex circuit to permit connection of the circuit to customer components.

TIG welding: An electric arc welding process that fuses metals together under a blanket of inert gas (gas that is not chemically active). The inert gas prevents the metals from oxidizing and keeps the weld free of foreign material. TIG is the abbreviation for tungsten inert gas.

Time constant: The time required for a temperature sensor to indicate 63.2% of a sudden change in temperature. Approximately five time constants are required for a sensor to reach the correct temperature.

Time domain reflectometer: A device to measure the characteristic impedance of a conductor on a PCB, thus insuring an accurate build for controlled impedance.

Time proportioning: A process of temperature control wherein heat is regulated in production to the proximity of the system’s temperature to the desired setpoint temperature.

Tin flash: A thin layer of tin plated onto a circuit to prevent oxidation of the underlying copper.

Tin point: The temperature at which high purity tin freezes (changes from a molten liquid to a solid). The tin point (231.97°C) is used as a reference temperature for calibrating highly accurate resistance thermometers.

Tolerance: The amount of variation allowed from a specific, nominal value.

Tolerance block: An information box on a drawing that defines standard tolerances for dimensions that do not have tolerances specified.

Tool proofing: Proving that the design of tooling meets requirements and will produce parts that conform to Engineering specifications.

Tooling: See punch and die, steel rule die.

Tooling holes: See alignment holes.

Tooling pins: Metal pins (.1181” diameter) used in alignment holes to align materials one to another. Materials aligned include but are not limited to: covers to substrates, artworks to drilled substrates, material to dies and cover to stiffener. Alignment pins may need to be added to steel rule dies by the tooling technician before inspecting the die. Punch & dies arrive with the alignment pins permanently fastened. Also known as alignment pins.

Torch fusing: The use of a small flame, fueled by oxygen and acetylene gas, to fuse or weld two resistance wires together. Torch fusing is the preferred method of making a calibration connection in a platinum or copper RTD.

Trace: A conductor going between pads. May also be called a track.

Traceability: 1. The ability to trace the history of something back to its origin. When required by customers, we ensure the traceability of materials used in products by recording lot numbers of materials used in production on a lot control sheet. 2. All Minco measurements are NIST traceable, which means that we can trace or refer our measurements to standard measurements maintained at the National Institute of Standards and Technology.

Track: A copper "line" on a PCB to conduct signal current. May also be called a trace.

Transformer: An electrical device for transforming an alternating current from a high voltage to a lower voltage, or vice versa.

Translucent: Allowing complete or partial passage of light.

Transmitter (two-wire): An electronic device which amplifies and sends a DC temperature signal from either a thermocouple or RTD, via two wires, over long distances. The signal loop wiring requires a separate power supply and the transmitter acts as a variable resistor, letting current flow through it in proportion to the temperature of the sensor. The current is the same everywhere in the loop.

Traveler: A form used to record manufacturing data. A traveler accompanies (travels) with parts and materials as they move through assembly operations so that production and inspection data can be recorded. The data is analyzed and used for planning, scheduling, and cost estimating.

Trim border: The distance between a unit's trimmed edge and its nearest conductor or pad.

Trim edge: The inside and outside edges of a circuit.

Trim line: The location of the final cut edge of a unit.

Triple point: The temperature and pressure at which a substance exists as a solid, a liquid, and a vapor at the same time. At the triple point of water, 0.01 C, water exists in three physical states in balance with each other: ice, vapor, and liquid. The triple point of water is used as a temperature reference for calibrating highly- accurate resistance thermometers.

Turn: One complete revolution of wire on a bobbin (or in a Discoil™). The number of turns of wire is one of the specifications for making an RTD or coil. Refer to winding lead.

TUV: A testing and certification organization, through which Minco has ISO 9001 accreditation and other approvals.

Twisted pair: Two lengths of insulated conductors twisted together.

Twisting (lead): Twisting two or more parallel leadwires (consisting of conductors and insulation) along their lengths.

Typ: A dimension on a drawing that is typical, or applies to more than one place. For example, "0.045" element border (Typ)" means that the element border is 0.045" all the way around, unless otherwise specified.

UL (Underwriters Laboratories): An independent product safety testing and certification organization, recognized mostly in the United States and Canada.

Ultra-fine pitch: Any part of pad geometry which has a pitch of less than 0.020."

Ultrasonic cleaner: A machine that cleans parts by using sound waves to vibrate a solvent cleaning solution.

Ultraviolet light: A special type of light used to cure resist, silk screened cover coats and other compounds. (Also known as black light.) Abbreviated UV light.

Unbonded region: Area of a rigid flex or multi-layer circuit that is not bonded. These allow the circuit to bend or flex more easily.

Undercut: The tapered sides of an etched conductor strand caused by sideways etching action under the resist coating during the etch process.

Under etch: An etching defect where not enough foil has been removed or etched away.

Ungrounded junction: A thermocouple probe constructed so the hot, or measuring, junction is fully enclosed by and insulated from the sheath material.

Union: A pipe fitting that joins two pipes by a separable coupling.

Unit: One of a number of similar items, objects, individuals, etc.

UV: Abbreviation for ultraviolet.

UV ink: Light sensitive ink used in screen printing that is cured (hardened) by ultraviolet light.

Vacuum pump: A device that pulls the air out of the oven chamber to create a vacuum.

Value-added product: Additional or add-on services that Minco performs on a unit which results in additional business for Minco and a savings of time, effort or money for the customer.

Varglas™: Define A nylon paper material used for insulation on some heater models. Varglas™ is a trade name of the Varflex Corp.

Variability: The inconsistencies normally present in any manufacturing process.

Variables: A term used to designate a method of inspection whereby units of product are measured to determine and to record, for each unit, the numerical magnitude of the characteristic under consideration. This involves reading a scale of some kind. Expressions used: Variables inspection, inspection by variables.

Variac™: A transformer used to adjust voltage to required values for operating equipment or for burn-in testing of Thermofoil™ heaters and heater buttons.

Verification: The act of periodically reviewing in a quantitative manner, the data supplied by a vendor or generated "in-house" as objective evidence of contract conformance.

Vernier caliper: A measuring device that has a sliding jaw and a stationary jaw attached to a measurement scale. The scale indicates the distance between the jaws to the nearest 0.001". Some vernier calipers have a second vernier scale that permits measurements to the nearest 0.0001".

Vernier scale: A system of scales attached to a measuring instrument (such as a micrometer) to add precision to the measured value. A measured value is determined by adding the reading on vernier scale to the readings from the main scale of the instrument.

Via (tented via): A plated through-hole covered by polyimide or solder mask on both sides (it connects to the top or bottom conductor layer, but no access is provided to the outer surfaces). Its purpose is to electrically connect circuit layers. Sometimes a via is tented on the top side of the board and left uncovered on the bottom side to permit contact by a test fixture probe.

Via, buried: A via connecting inner layers of a multilayer PCB; it does not connect to either the top or bottom conductor layer.

Volt: A unit of electromotive force. Voltage is used to indicate an electric pressure between two points on a conductor. Voltage equals current multiplied by resistance.

Vulcanize: A process using heat and pressure to bond a silicone rubber heater to a heat sink.

W: Symbol for watt or wattage.

WA: A thermosetting, acrylic adhesive used to laminate or bond material together. WA has low outgassing, is limited to temperatures below 150°C (300°F), and is less expensive than FEP adhesive. Since WA is a thermosetting adhesive, strand swimming and remelting are not problems, so it is often used on products that have fine strand and spacing requirements.

Watt: A unit of electric power. Power equals current multiplied by voltage.

Watt density: Wattage divided by the heater area. Will be used to determine the element temperature.

Wave soldering: The process of soldering joints on circuit boards by bringing the circuit boards in contact with a wave of molten solder.

Wave soldering fixture: A tray used to hold circuits and connectors in place while going through the solder wave.

Weld: To join two pieces of metal by fusion (melting). Resistance welding is frequently used to make electrical connections in our products. The welding machine passes a high electric current through the metal parts (wire and/or foil) to be joined. This heats the surface of the parts and melts them sufficiently to flow together and fuse (join) under the pressure of the welding electrodes. When very high electrode pressures are used, the weld is sometimes called a spot weld.

Weld tips: Two copper chromium (copper), tungsten, or molybdenum carbide (moly) conductors that rest on the material to be welded and deliver voltage and current. See also electrodes.

Welder: The welding machine used by the weld operator.

Welding: A process where two metals are joined by passing a low voltage, high density electric current through their interface for a precise length of time while under the compressive force of two electrodes.

Wetting: The formation of a relatively uniform, smooth, unbroken, and adherent film of solder to leads and pads. Good wetting is the most important characteristic of a soldered connection.

Wheatstone bridge: A bridge that is capable of accurately measuring resistance over several ranges.

Whisker disk: A disk with bristles around its diameter. It is placed over the wire spool to restrict the wire as it unwinds.

Wind: A wind program command that directs the wind machine to wind a specified number of turns using a specified pitch and at a specified spindle speed.

Wind check: The first sensor wound on a job is welded and calibrated to check the wind length.

Wind length: The overall length of an individual sensor wind.

Winder: A machine that spins a bobbin while resistance wire is wound onto it to make windings for temperature sensors.

Winding card: See bobbin.

Winding lead: During winding, the distance the wire is advanced along the bobbin for each turn. The winding lead determines the spacing between the winds.

Wire: A conductor, either bare or insulated.

Wire gauge: See AWG.

Wire-wound sensor: Resistance wire wound on a bobbin or mandrel (or in Discoil™ form) for use as a temperature sensing element.

Wiring hole: A through-hole that is at least partially encircled by a pad that connects to a strand or shield.

Work hardening: Strengthening metals by bending, forming or rolling them.

X-axis: The horizontal or left-to-right direction in a two-dimensional system of coordinates. For a machine, it is the axis direction left and right in relation to the front of the machine. The left being negative X and the right being positive X.

X-ray fluorescence: A non-destructive thickness measurement instrument that operates by exposing the sample with electromagnetic radiation and measuring the amount of energy that bounces back from the sample.

X-Y-Z motion: X motion is left to right (the normal direction of travel for a conveyerized system). Y motion is front-to-back and Z motion is vertical.

Y axis: The direction perpendicular to the X axis, in a two-dimensional system of coordinates. In a machine, it is the axis direction which is from front to back; into the machine the machine being positive Y and out of the machine being negative Y.

Z: Symbol for impedance

Z axis: The vertical direction. See X-Y-Z motion.

Zero: The bottom scale value of an instrument. For example, a Temptran whose range is 20°F to 120°F has a zero point of 20°F. Note: The output signal at the zero point need not be zero; in this example the Temptran output is 4.0 mA, not 0.0 mA, at 20°F.

Zero adjustment: The means provided in an instrument to produce a parallel shift of the input-output curve. Often used to set the output so that zero on a display corresponds to a non-zero signal, such as 20°F or 4 mA.

Zinc point: The temperature at which high purity zinc freezes (changes from a molten liquid to a solid). The zinc point (419.58°C) is used as a reference temperature for calibrating highly accurate resistance thermometers.

Zymurgy: The chemistry of fermentation, particularly as it relates to brewing and wine-making. Included here because it is the last word in almost any dictionary.