Applicability of this document

This document is a compilation of general and specific information and process guides (procedures) and instructional video for the Manual Rework and Assembly of Surface Mount and Through Hole Components. These process guides are based on years of experience of technicians and training experts worldwide representing the best industry and IPC compatible practices.

As their name suggests, each process guide takes the user step-by-step through an installation or removal process for a specific surface mount or through hole component using a particular piece of equipment, handpiece and technique. In most cases, there is a variety of methods for removing or installing the same component. Simply select and use the process guide which best suits your organization’s individual requirements and operator preferences.

Industry standards and ISO 9000

For over 50 years, PACE, Incorporated, along with other industry experts, has taken a leadership role in the creation, training of and updates of these standards for the electronic assembly industry. These standards focus on product acceptability requirements such as what characteristics (lead/land alignment, solder fillets, soldering, desoldering etc.) a soldered component and assembly must have to be acceptable.

In contrast, PACE Inc. official Process Guides take a how to approach to manual electronic rework and assembly, and are 100% consistent with the most stringent end product acceptability requirements, specifications, workmanship and equipment standards as well as procedural guidelines found in the latest revisions of IPC-7711/7721, ANSI/J-STD-001, ANSI/IPC-A-610 and other international standards.

So whatever level of end product acceptability requirements your organization follows, PACE Inc. Process Guides will show you how to get there in a safe, efficient, repeatable process. PACE Inc. Process Guides are presented in a concise, self-contained, pictorial form that’s easy to understand and is ideal for helping you document in-house training programs, assembly and rework processes and quality assurance procedures to meet the requirements of your Standard Operating Procedures (SOP) or International Organization of Standardization (ISO 9000). We hope that you find the Pace, Inc. Hand Solder Manual Rework Repair & Assembly of Surface Mount and Through Hole a useful document and once again look forward to receiving your comments and suggestions.

Sincerely,

Eric S. Siegel, President
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Scope

The general information and process guides in this document are for the manual rework and assembly of surface mount and through hole components. More specifically, this document contains manual, high-reliability installation procedures for a wide variety of electronic components which are applicable to assembly (new-build) or rework / repair situations. Also included are non-destructive removal procedures for a wide variety of surface mount components which are equally applicable to production rework or field repair situations. Misaligned, poorly soldered, damaged or faulty components can be removed and replaced using these procedures. The component installation and removal procedures contained herein focus on manual conductive (soldering iron) or (resistance) and manual or semi-automated convective (hot air pencil, convective workstation) heating methods. This general section provides information which is applicable to every surface mount or through hole assembly and rework process guide. This includes information on:

Included are:

- Process Goals and Guidelines
- Non-destructive Component Removal
- Solder Extractor Trouble Shooting Chart
- Surface Mount Land Preparation
- High-reliability Component Installation/Replacement
- Primary Heating Methods
- Pre-Heating and Auxiliary Heating Methods
- Vision Systems and Manual Surface Mount Component Placement
- Selecting Optimum Process of Manual Assembly/Rework
- Health, Safety and the Environment

Also included are sections on:

- Component Identification
- Handpiece Identification
- Terms and Definitions

Finally, there are process guides with embedded video instructions covering subjects such as:

- Surface Mount Desoldering
- Land Preparation
- Surface Mount Soldering
- Thru-hole Desoldering
- Thru-hole Soldering
- Tip Selection
- Tip Preparation and Maintenance with new (no-lead procedures)
- Handpiece Procedures for the Sodr-X-Tractor®, Thermo-Tweez®, Thermo-Pik® (care and maintenance)
WE HIGHLY RECOMMEND THAT YOU BECOME FAMILIAR WITH THIS GENERAL SECTION FIRST BEFORE PROCEEDING AS IT CONTAINS IMPORTANT BACKGROUND INFORMATION FOR EVERY PROCESS GUIDE CONTAINED IN THIS DOCUMENT!

PROCESS GOALS AND GUIDELINES

INTRODUCTION

Each assembly/rework method has certain advantages and disadvantages depending on the particular Surface Mount Device (SMD) (lead/terminations design, size, body material, etc.), component mounting site (adjacent components, access, substrate type, thermal mass, etc.) and the skill of the operator. For this reason, it is advisable to select a method which is likely to be the most appropriate based on the following Process Goals and Guidelines, and your organization’s own particular requirements.

In the three basic processes of Non-destructive Component Removal, Surface Mount Land Preparation and High-reliability Component Installation/Replacement, the fundamental Process Goals and Guidelines are as follows:

**Non-destructive Process** - During any assembly or rework process, no damage or degradation should occur to the board (both substrate and circuit elements), adjacent components, and the component to be installed or removed. This damage may be either mechanical, thermo/mechanical or purely thermal in nature and may result in either immediate failure, degradation in performance over time (latent failure) or a reduction in reliability. EOS/ESD damage must also be avoided by using proper workstations, procedures and equipment controls.

**Controllable, Reliable and Repeatable Process** - The process can be employed, and when necessary, modified by a trained operator in a repetitive fashion with consistently acceptable results.

**Process Appropriate to Particular Application** - The process (or modification thereof) employed is appropriate to the particular application based on the relevant guidelines described below.

**Operator Friendly Process** - An operator of average ability can, with proper training and practice, become acceptably proficient in employing, and when required, modifying the process to suit any particular requirements of a given task.

**Efficient/Economical Process** - The process can be economically and easily set up and carried out at multiple locations in a production or repair environment with minimal training and set-up time.
General

NON-DESTRUCTIVE COMPONENT REMOVAL

The particular process goals and guidelines for non-destructive component removal are as follows:

Surface Mount Components

- Pre-/auxiliary heat assembly and/or component if required

- Evenly apply heat in a rapid, controllable fashion to achieve complete, simultaneous reflow (melt) of all solder joints

- Avoid thermal and/or mechanical damage to component, board, adjacent components and their joints

- Immediately remove component from board before any solder joint re-solidifies

- Prepare lands for replacement component

Thru-hole Components

Desoldering component one joint at a time using continuous vacuum method

- Pre-/auxiliary heat assembly and/or component if required

- Heat joint in a rapid, controllable fashion to achieve complete solder reflow

- Avoid thermal and/or mechanical damage to component, board, adjacent components and their joints

- Apply vacuum during lead movement to cool joint and free lead

Desoldering component using solder fountain method

- Reflow all joints in solder fountain

- Remove old component and either immediately replace with new component, or clear thru-holes for component replacement later
SURFACE MOUNT LAND PREPARATION

Surface mount land preparation should be performed prior to the installation/replacement of a new surface mount component. Avoidance of thermal and/or mechanical damage to the land and substrate is critical. The two primary steps include:

- Remove Old Solder

This may be performed with a soldering iron and braided solder wicking material, or with a continuous vacuum Flo Desoldering technique employing a solder extractor and a special Flo-D-Sodr tip which allows reflow and vacuum removal of the old solder to occur continuously.

-Clean lands

Old flux residues left over after the removal of old solder are cleaned in this step prior to adding new solder.

-Add New Solder

This step is part of the Component Installation process and is accomplished by either prefilling (pretinning) the lands (by reflowing wire solder with a soldering iron or some other heating method), or by applying solder paste (cream) with a dispenser prior to (or after) the component is placed on the land pattern.

The quantity of solder applied is critical to achieving acceptable joints. For instance, acceptable J-lead solder joints require much more solder than acceptable gull wing lead solder joints.

HIGH-RELIABILITY COMPONENT INSTALLATION

The particular Process Goals and Guidelines for safe, high-reliability component installation are as follows:

Surface Mount Components

- Prefill lands or apply solder paste
- Align and place component to lands (tack if necessary)
- Apply solder paste to lead/land area if not applied prior to component placement
- Pre-/auxiliary heat assembly and/or component if required
- Pre-dry applied solder paste
General

- Reflow solder joints (individually, in groups or all together) with concentrated “targeted” heat in a rapid, controllable manner while maintaining lead/land alignment. Joints should remain at target temperature (above melting point of solder alloy) for proper time to achieve optimal intermetallic formation.

- Avoid thermal and/or mechanical damage to component, board, adjacent components and their joints.

- Clean and inspect

Thru-hole Components

- Insert new component into board

- Pre-/auxiliary heat assembly and/or component if required

- Solder joints (individually, in groups or all together) with concentrated “targeted” heat in a rapid, controllable manner. Joints should remain at target temperature (above melting point of solder alloy) for proper time to achieve optimal intermetallic formation.

- Avoid thermal and/or mechanical damage to component, board, adjacent components and their joints

- Clean and inspect

PRIMARY HEATING METHODS

Primary heating methods are those principally responsible for achieving solder reflow during a component installation or removal process. These are to be distinguished from methods used for pre-heating and auxiliary heating which are employed in addition to primary heating methods in particular situations as described in the PRE-HEATING AND AUXILIARY HEATING section.

Conductive Heating Methods

Handheld conductive heating devices generally fall into one of two categories: Continuously Heated Devices and Pulse Heated Devices, each with their own potential advantages and precautions.

Continuously Heated Devices

Continuously heated devices such as soldering irons, thermal tweezers and thermal pick devices may be held at selected idle tip temperatures prior to use. Continuously heat devices generally (but not always) employ tinnable tips to optimize heat transfer to the work.

Virtually all soldering irons and continuous vacuum solder extractors used for thru-hole component installation and removal, respectively are continuously heated devices.
Hand Soldering Manual for Rework / Repair & Assembly

General

For surface mount component installation and removal, continuously heated devices offer the following potential advantages:

- Effective at transferring a large amount of heat to a targeted area rapidly
- Can control amount of heat delivery with tip temperature and dwell time
- Can safely access hard-to-reach places and confine heat to limited areas with proper tip design, selection and use
- Substrate and adjacent components stay cooler during surface mount component installation or removal

With continuously heated conductive heating devices, the following guidelines and precautions should be observed:

- Must utilize a high-efficiency, closed-loop temperature controlled heating handpiece that has sufficient thermal output to keep up with thermal load of the work and duty cycle of the application
- Tip temperature can drop below desired level during heavy, continuous use if handpiece has insufficient thermal output
- Must establish good thermal linkage between tip and joint(s), and use appropriate tip geometry (shape) and for effective heat transfer
- Usually not effective on components whose solder joints are not accessible, e.g., BGA’s (Ball Grid Arrays) and chip components with bottom only terminations.
- Tip and work must be free of oxides and contaminates, and tip must be tinned for effective heat transfer
- Use of external flux or addition of additional solder sometimes necessary to achieve effective heat transfer
- For surface mount component removal, must often have precise match between tip and component geometry for effective heat transfer to all joints
- Contact may disturb component lead-to-land alignment, especially during SMD installation or realignment operations
- May transfer heat too rapidly for use with solder paste or sensitive components
- May obstruct view during alignment and reflow and interfere with joint formation during solder solidification
General

Pulse Heated Devices

Pulse heated devices such as LapFlo type tools, resistance tweezers and other handheld devices produce heat directly in the tip or the work with high current, low voltage power. They are useful for surface mount installation and removal, cup terminal soldering and auxiliary heating of connector pins during removal. These devices generally employ low mass, non-tinnable tips which can remain in contact with solder joints as they cool thereby facilitating proper surface mount component alignment. Pulse heated devices offer the following potential advantages:

- Effective at transferring a large amount of heat to a targeted area rapidly
- Slim design tips can safely access tight places and confine heat to a limited area
- Can control amount of heat delivery with power setting and dwell time
- Low mass tips heat up and cool down rapidly
- Non-tinnable tips can contact surface mount joint cold, heat to reflow and remain in contact during solder re-solidification to stabilize component alignment
- More gradual heat-up works better with solder paste than continuously heated devices
- Can correct minor lead non-coplanarity during gull wing SMD installation

With pulse heated devices, the following guidelines and precautions should be observed:

- Less effective means to control heat delivery since handheld devices are generally not temperature controlled
- Must establish good thermal linkage with joints for effective heat transfer (this is more difficult since tips are generally non-tinnable)
- Improper contact may disturb component lead-to-land alignment
- If used for SMD installation of gull wing components, may produce unacceptable residual stress in some stiff leads if not coplanar with lands
CONVECTIVE HEATING METHODS

Convective heating methods are generally found in devices such as semi-automated benchtop workstations, high powered, handheld hot air guns and nozzle-focused hot air jet handpieces. Convective heating devices are primarily used for surface mount component installation and removal and offer the following potential advantages:

- Can be used to effectively install and remove components whose solder joints are not directly accessible by conductive heating methods, e.g., BGAs (Ball Grid Arrays) and chip components with bottom only terminations.

- Non-contact process which, if used correctly, will not disturb joints or obstruct view

- Can often be used to re-align slightly skewed (misaligned) surface mount components without having to remove first

- External flux or tinning generally not necessary to aid thermal transfer

- Leaves less residue and solder than conductive heating methods for surface mount component removal

- For surface mount component removal, match between nozzle and component geometry less critical

- Works well with solder paste under most conditions

- Can control amount of heat delivery with:
  - Gas/Air temperature
  - Gas/air flow rate
  - Distance of nozzle from work
  - Nozzle design
  - Dwell time

- Well designed, powerful convective heating devices provide continuous output of heated gas/air at a desired set temperature irrespective of the thermal load of the work and duty cycle of the application
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General

With convective heating devices, the following guidelines and precautions should be observed:

- Must properly focus and control heated gas/air flow to minimize errant heating of substrate, adjacent components and their joints

- Must adequately control exit gas/air velocity (via pressure or flow rate) to avoid:
  - Displacement of applied solder paste
  - Disturbing the lead/land alignment of surface mount components during installation or re-alignment, and to
  - Minimize errant heating
  - Heated air flow inefficient means of primary heat delivery when compared to conductive heating methods

PRE-HEATING AND AUXILIARY HEATING METHODS

There are two principal reasons for pre-heating and auxiliary heating during component installation and removal.

First, pre-heating is required when there is present a risk of thermal shock in the substrate, components or both. The goal here is to first ramp up the assembly and/or component at an acceptably safe rate until it reaches a target temperature at which the assembly (or component) is thermally soaked or evenly heated thereby eliminating dangerous temperature gradients which could produce immediate damage, degradation over time or reduction of reliability.

For avoidance of thermal shock, the rate of ramp up can be critical. For example many ceramic chip capacitor manufacturers have traditionally recommended that pre-heating occur at a rate of no greater than about 2-5 degrees C/sec. until a given minimum temperature is reached.

Second, pre-heating/auxiliary heating is required when the primary heating method (during a component installation or removal procedure) cannot bring all of the solder joint(s) completely up to proper reflow temperature at all or in an acceptably rapid period of time due to heat sinking by nearby portions of the substrate, circuit elements and adjacent components. The goal here is to bring the assembly (or a portion thereof) up to a sufficient (yet safe) temperature at which the rate of heat sinking is low enough so that the primary heating device can effect proper solder reflow in an acceptable period of time.
General

For example, bottom side pre-heating is often used to speed up a BGA installation or removal process since the primary heat source typically delivers heat (usually convective) only through the top of the component body and it would otherwise take too long before enough heat passes through to the joints to produce reflow.

For thru-hole desoldering on heavy multilayer boards with internal ground planes, auxiliary heating (typically a soldering iron tip or pulse heated tool on the component side of the lead) is often used since the tip of the solder extractor may not be able to deliver enough heat to completely reflow the joint prior to activating the vacuum. In some cases, as with PGAs (Pin Grid Arrays), the component side of a lead is often not accessible to traditional auxiliary heating, so bottom side pre-heating is often the only option.

Pre-heating is typically accomplished from the bottom side of the circuit assembly by either a temperature controlled conductive heating plate, a controlled convective heating device, or a system which combines both conductive and convective heating. Again, controlling both the rate of temperature ramp up as well as the soak temperature at which the assembly is held during the primary reflow process is critical to avoiding damage and optimizing the component installation or removal process.

VISION SYSTEMS AND SURFACE MOUNT COMPONENT PLACEMENT

As high lead count, fine pitch SMDs become commonplace, the task of properly aligning and placing these devices during manual SMT rework becomes more challenging.

Appropriate vision systems with sufficient magnification, resolution, field of view and working distance are critical for viewing alignment of component leads to lands and monitoring joint reflow during SMD installation.

Proper component handling systems which can adequately establish and maintain X, Y, Z and THETA positioning are also essential for successful alignment and placement during fine pitch SMD installation.

Vision systems come in various forms including large lenses, stereo microscopes, trinocular microscopes and CCTV (video) systems. While microscopes and lenses are generally perfectly adequate and economical, CCTV systems offer greater ease of use and less operator fatigue, particularly with very fine pitch SMDs.
HEALTH, SAFETY AND THE ENVIRONMENT

Technicians in the electronics industry can be exposed to a wide variety of potentially hazardous chemicals, particularly solder fumes, and exposure to such fumes can often exceed recommended allowable occupational health and safety regulations. In addition, the release of fumes or disposal of these substances must comply with environmental regulations. The MSDS (Material Safety Data Sheet) which accompanies virtually all solders (wire and paste), fluxes and cleaners is a good source of information for recommended measures to protect worker health and safety.

Local exhaust fume extraction systems, personal protection equipment, environmental emissions control equipment, and hazardous materials training are necessary and essential components of an effective health, safety and environmental protection program.

Increasing importance is being placed on a commitment to comply with health and safety regulations and prevent pollution. The ISO 14000 series of Environmental Management Standards will enable companies to demonstrate improvements in environmental performance and establish mechanisms to determine the effectiveness of their programs.
LEAD FREE VS. LEADED SOLDER

The Restriction of Hazardous Substances directive is more commonly known in the electronics industry as RoHS. Adopted by the European Union in 2003, the directive took effect on July 1st, 2006 with the onus being placed on each member state to adopt and fully implement the directive into law. The RoHS directive is aimed at restricting the use of 6 hazardous materials in the manufacture of electrical and electronic devices as follows:

- Lead
- Mercury
- Cadmium
- Hexavalent Chromium
- Polybrominated Biphenyls
- Polybrominated Diphenyl Ether

Closely linked with the RoHS directive is the Waste Electrical and Electronic Equipment directive which is more commonly known as the WEEE directive. The WEEE directive sets collection, recycling and recovery targets for electrical goods.

The effect these two initiatives have had on the electronics industry varies greatly depending on product end use and target sales market. The overall supply chain from individual components to bare printed circuit board manufacturing has shifted from a predominately tin-lead alloy based market to one that caters almost exclusively to lead-free finishes. The result has been limited supply, and in some cases, complete elimination of tin-lead plated components. This has, in effect, forced manufacturers to make design and process changes on products that were traditionally tin-lead based.

The primary difference between tin/lead and lead-free solders, from a rework and repair standpoint, is the temperatures required to form a proper intermetallic bond. For the most widely used tin/lead alloys such as Sn60 Pb40 or more commonly Sn63 Pb37, the melting point is 361°F (183°C). The most commonly used lead-free alloy, Sn96.5 Ag3.0 Cu0.5, commonly referred to as SAC 305, has a melting point of 422°F (217°C) to 428°F (220°C). The resultant increase in melting point will have the effect of reducing the overall process window and can change the traditionally accepted appearance of the finished product.

Prior to the implementation of the RoHS and WEEE directives, the use of tin/lead solder was widely accepted, its reliability was exhaustively tested and it’s appearance was easily inspectable. Virtually all electronics assemblies were designed to withstand manufacturing with the use of tin/lead solder and finish and the temperatures they required. Further, virtually all specifications written for the compliance of electronic assemblies in the military, government and consumer markets were written with the same tin/lead alloy in mind.

Today the use of lead-free solder alloys that comply with the RoHS & WEEE directives are in wide use and while various segments of the electronics industry continue to perform reliability and life-cycle testing on complete RoHS & WEEE compliant assemblies and manufacturing practices, the use of individual lead-free components and board finishes is commonplace. Industry specifications have also addressed the differences between the two alloy types to ensure compliance and reliability where applicable.

This Process Guide Book will reference the common tin/lead (Sn63 Pb37) and lead-free (Sn96.5 Ag3.0 Cu0.5) alloys and their associated process temperatures for every application contained herein.
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Activated Rosin Flux (RA) - A mixture of rosin and small amounts of organic-halide or organic-acid activators.

Activator (flux) - A substance that improves the ability of a flux to remove surface oxides from surfaces being joined.

Air flow - The continuous rate of air discharge during convection soldering (e.g., slpm - standard liters/minute, cfm - cubic feet/minute). (See also “Air pressure”)

Air pressure - The volume of air applied to a surface during convection soldering, measured as force per unit of air (e.g., bar - one million dynes/cm², psi - pounds/square inch). (See also “Air flow”)

Annular ring - The portion of conductive material completely surrounding a hole.

Aqueous flux - See “Water-soluble organic flux.”

Aspect ratio - The ratio of the length or depth of a hole to its preplated diameter.

Aspect Ratio Assembly - A number of parts, subassemblies, or other similar combinations joined together. (Note: This term can be used in conjunction with other terms, e.g., “Printed Wiring Assembly.”)


Auxiliary heating - The heating of a large thermal mass solder joint by assisting the primary heat source with a secondary source of heat. The secondary source is usually in the form of a soldering iron, thermal tweezer, hot air pencil or heating surface (convective or conductive).

Axial lead - Lead wire extending from a component or module body along its long axis.
Hand Soldering Manual for Rework / Repair & Assembly

Terms and Definitions

B

**Bake out** - Subjecting an assembly to an elevated temperature in order to remove moisture and unwanted gasses prior to sealing or soldering.

**Ball Grid Array (BGA)** - The generic term for leadless surface mount technology packages with bottom side terminations. The terminations normally consist of solder balls or columns which are reflowed using controlled-collapse soldering techniques.

**Base material** - The insulating material upon which a conductive pattern may be formed.

**Base metal** - See “Basis material.”

**Basis metal** - A metal upon which coatings are deposited.

**Bifurcated solder terminal** - A solder terminal with a slot or slit opening through which one or more wires are placed prior to soldering.

![Bifurcated solder terminal]

**Bridge fill** - A thermal enhancement step used in surface mount component removal procedures where the component leads are deliberately bridged together with solder to achieve rapid, simultaneous reflow of all joints.

**Bumpered quad flatpack (BQFP)** - The generic term for surface mount technology packages with leads on four sides and a molded plastic chip carrier. The carrier is distinguishable by the bumpers located on each of the four corners which serve to protect the gull-wing leads and assist with proper alignment. BQFP’s are manufactured to American JEDEC standards. (See also “Plastic quad flat pack” and “Quad flat pack”)

C

**Castellation** - A recessed metalized feature on the edge of a leadless chip carrier that is used to interconnect conducting surface or planes within or on the chip carrier.

**Celsius (Centigrade) (°C)** - The temperature scale that represents the freezing point of water at 0°C and boiling at 100°C at sea level. Conversion formula: °C = [(°F)-32]/1.8. (See also “Fahrenheit (°F)”.)
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Terms and Definitions

**Ceramic** - Inorganic, nonmetallic, clay- or glass like material, the final characteristics of which are produced by subjecting to high temperatures.

**Ceramic Column Grid Array (CCGA)** - The generic term for surface mount technology packages with a ceramic body and solder cylinders or columns in bottom side terminations. The terminations normally consist of solder balls or columns which are reflowed using controlled-collapse soldering techniques. (See also “Ball Grid Array”)

**Ceramic Grid Array (CGA)** - The generic term for leadless surface mount technology packages made with a ceramic body with bottom side terminations. The terminations normally consist of solder balls or columns which are reflowed using controlled-collapse soldering techniques. (See also “Ball Grid Array”)

**Ceramic package** - See “Cerpack.”

**Cerpack** - A flat pack composed of a ceramic base and lid, a stamped-metal lead frame, and frit glass that is used to secure the structure.

**Certification** - The verification that specified training or testing has been performed and that required proficiency or parameter values have been attained.

**Chip component** - A passive component such as a resistor or capacitor. They are usually made of ceramic material with metallized end caps which provide a solderable contact. The part is normally designated by a four digit number that represents the part size. It is important to know if the part is sized in millimeters or inches — a 1210 (US) measures .12" x .10" (3.2mm x 2.5mm) while a 1210 (Japan) measures 1.2mm x 1.0mm (.05" x.04’), these parts would NOT be interchangeable.

**Chip Diode (CD) SMD** - An electronic device that restricts current flow to one direction, Through-hole and Surface Mount.

**Chip Capacitors (CC) SMC** - An electronic device that can store electrical charge, Through-hole and Surface Mount.

**Chip Inductor (CI) SMI** - An electronic component that stores energy in the form of a magnetic field, Through-hole and Surface Mount.

**Chip Resistor (CR) SMR** - An electronic component that limits or regulates the flow of electrical current, Through-hole and Surface Mount. (aka Resister Array (RA)).

**Circuit board** - See “Printed board.”

**Circuitry** - Electrically conductive elements and devices that have been interconnected to perform a desired electrical function.

**Coefficient of thermal expansion (CTE)** - The linear dimensional change of a material per unit change in temperature. (See also “Thermal expansion mismatch”)

**Cold solder connection** - A solder connection that exhibits poor wetting and is often characterized by a grayish porous appearance. This may be due to either excessive impurities in the solder, inadequate cleaning prior to soldering, or the insufficient application of heat during the soldering process.

**Column Grid Array (CGA)** - The generic term for surface mount technology packages with solder cylinders or columns in bottom side terminations. The terminations normally consist of solder balls or columns which are reflowed using controlled-collapse soldering techniques. (See also “Ball Grid Array”)

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Terms and Definitions

**Conductive Heating** - The manner in which heat is transferred from a soldering tip or other conductive heating tool to the work during soldering or rework. Factors affecting the rate of conductive heating include:

1. the nature of the surfaces (e.g., absence of oxidides, residues, etc.)
2. the geometry or shape of the soldering tip,
3. the surface contact area between the tip and the work, and
4. the average temperature of the tip. The transfer of heat from a hot body to a cool body by way of contact. (See also "Heat Transfer"

**Conductor** - A single electrically conductive path in a circuit pattern.

**Conductor spacing** - The observable distance between adjacent edges of isolated conductive patterns in a conductor layer. (Compare “Pitch.”)

**Conformal coating** - An environmentally protective covering that conforms to the configuration of the objects coated when it is applied to a completed printed board assembly.

**Connector** - A device used to provide mechanical connect/disconnect service for electrical terminations.

**Contact angle, (soldering)** - The angle at which the solder fillet meets the basis metal. A small contact angle indicates good wetting whereas a large contact angle may indicate poor wetting.

**Controlled-collapse soldering** - The making of solder connections by controlling the height of solder balls or columns on a component (e.g., flip-chip, ball grid array) during reflow in an assembly operation.
Terms and Definitions

Convection - The transfer of heat via gas (e.g., nitrogen) or air movement. (See also “Convective Heating.”)

Convective Heating - The transfer of heat through the movement of gas or air; the manner in which heat is transferred to the work when using a convective workstation or hot air pencil during soldering or rework. Factors affecting the rate of convective heating include:

- Gas (air) flow rate
- Gas (air) temperature
- Proximity to the work

(See also “Heat Transfer”)

Crazing - An internal condition that occurs in reinforced laminate base material where glass fibers are separated from the resin at the weave intersections. (This condition manifests itself in the form of connected white spots or crosses that are below the surface of the base material. It is usually related to mechanically-induced stress.) (See also “Measling”)

Cup solder terminal - A cylindrical solder terminal with a hollow opening into which one or more wires are soldered.

Defect - Any non-conformance to specified requirements by an assembly or product.

Dewetting (sSolder) - A condition that results when molten solder coats a surface and then recedes to leave irregularly-shaped mounds of solder that are separated by areas that are covered with a thin film of solder and with the basis metal not exposed.

Discrete Package (DPAK) - An electronic device between two and seven leads that limits or regulates the flow of electrical current, with a square body that acts as a heat sink. (aka, D2PAK to D7PAK)

Double-sided assembly - A packaging and interconnecting structure with components mounted on both sides.

Double-sided printed board - A printed board with a conductive pattern on both sides.
Solutions and systems for soldering, rework and repair of electronics

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Terms and Definitions

**Dross** - Oxide and other contaminants that form on the surface of molten solder.

**Dry solder connection** - A term sometimes used to describe a defective joint due to non-wetting, insufficient solder, disturbance, a fracture or some other defect.

**Dwell time** - Time duration from the first point of contact of the heat source to the workpiece until the heat source is removed.

**Edge connector contact** - A printed contact on or near any edge of a printed board that is used specifically to mate with an edge-board connector.

**EIA** - Electronics Industry Association

**EIAJ** - Electronics Industry Association of Japan

**Eutectic solder** - A term used to describe an alloy that has no plastic range. (e.g., Sn63/Pb37, Sn96/Pb4)

**Excess solder connection** - A solder connection that is characterized by the complete obscuring of the surfaces of the connected metals and/or by the presence of solder beyond the connection area.

**Fahrenheit (°F)** - The temperature scale that represents freezing point of water at 32°F and boiling at 212°F at sea level. Conversion formula: °F = [1.8x(°C)]+32. (See also "Celsius (Centigrade) (°C)"

**Fine-pitch technology (FPT)** - Surface mount assembly technology with component leads or terminations on less than 0.625 mm (0.025 inch) centers. (Or smaller in today’s market) (See also “Pitch"

**Flat Pack** - A rectangular component package that has two or more rows of gull wing shaped leads extending from each of the sides of its body that are parallel to the base of its body. (See also “Quad Flat Pack (QFP)"

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![Flat pack](image)
Terms and Definitions

Flexible printed wiring - A patterned arrangement of printed wiring that uses a flexible base material with or without a flexible cover lay.

Flip chip - A leadless monolithic, circuit element structure that electrically and mechanically interconnects to a base material.

Flo Desoldering - Removal of old solder from multiple surface mount lands using continuous solder extraction; used during land preparation prior to replacement of a new component.

Flux - A chemically and physically active compound that, when heated, promotes the wetting of a base metal surface by molten solder by removing minor surface oxidation and other surface films and by protecting the surfaces from re-oxidation during a soldering operation. Common flux types and abbreviations;

- Rosin type (R)
- Rosin Activated (RA)
- Rosin Mildly Activated (RMA)
- Rosin Super Activated (RSA)
- Organic Activated (OA) also known as Water Soluble (WS)
- No-Clean (NC)

Flux activation temperature - The temperature at which flux becomes active enough to remove oxides from the metals being joined.

Flux activity - The degree or efficiency with which a flux promotes the wetting of a surface with molten solder.

Flux cored solder - A wire or ribbon of solder that contains one or more continuous flux-filled cavities along its length.

Flux residue - A flux-related contaminant that is present on or near the surface of a solder connection.

FR4 - Designation of the EIA for a fire retardant epoxy resin-glass cloth laminate. By common usage, the resin for such a laminate. The most common boards in current use are made of FR4 and commonly referred to as such.

Frit glass - A melted glass composition, ground up and used in thick-film compositions as the portion of the composition that melts upon firing to seal and provide adhesion of the parts.
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Terms and Definitions

**G**

**Glass transition temperature** (Tg) - The temperature at which an amorphous (formless) polymer, or the amorphous regions in a partially-crystalline polymer, changes from being in a hard and relatively-brittle condition to being a viscous or rubbery condition.

**Ground** - A common reference point for electrical circuit returns, shielding, or heat sinking.

**Ground Plane** – An internal layer or layers of a circuit board with a heavy copper layer for electric conductivity.

**Gull wing lead** - See “Lead.”

![Lead (Gull wing)](image)

**H**

**Haloing** - Mechanically-induced fracturing or delamination, on or below the surface of a base material, that is usually exhibited by a light area around holes or other machined features.

**Heat** - A form of energy associated with the motion of atoms or molecules in matter (material).

The three basic components which determine the quantity of heat in a body are:

- **Mass** - the amount of material in the body.
- **Specific Heat** - the heat holding capacity of the material.
- **Temperature** - the “hotness” or “coldness” of the body as measured in °C or °F.

Temperature alone is not a good indicator of quantity of heat! A cup of boiling water (100°C) feels “hotter” than a bathtub full of room temperature water (22°C), but the bathtub contains much more heat since it holds so much water. In soldering and rework, a given quantity of heat (not just temperature!) must be transferred in to the work in a rapid, yet controllable manner to properly accomplish a particular solder reflow or pre-/auxiliary heating task. (See also “Heat transfer”)

**Heat sink** - A mechanical device that is made of a high thermal conductivity material that dissipates heat generated by a component or assembly.
Terms and Definitions

**Heat Transfer** - The movement of heat energy from one body to another via:

- conduction (by physical contact),
- convection (by gas/air movement)
- radiation (IR) (radiant heat like sunshine).

Hand soldering and rework methods in which a heated tip transfers heat into the work by contact are examples of conductive heating.

Surface mount soldering and rework with a convective workstation or hot air pencil which transfers heat into the work by the flow of heated gas or air is an example of convective heating.

Production reflow soldering Infrared (IR) oven or hand-held (IR) equipment are examples of radiant heating.

The efficacy of any heat transfer process is determined by the rate of temperature rise in the work (i.e., how quickly proper solder reflow temperature is reached during component installation.) (See also “Conductive heating”, “Convective heating” and “Infrared (IR) heating”)

**Heatability** - The physical characteristics of the work which determine how, when, where and how much heat must be applied to achieve safe effective solder reflow during a component installation or removal process. Characteristics include: mass or amount of component or substrate materials to be heated (i.e., size of the component), the thermal properties of the material (i.e., ceramic or plastic), the proximity of ground planes and the physical layout of the assembly (e.g., the size and number of connected circuit pathways through which heat can flow). Hence, every individual component substrate and component mounting site has its own particular “heatability.”

**Heat rate recognition** - A workpiece indicator which shows how fast heat is flowing into the joint. This is typically the observed rate at which solder melts. (See also “Workpiece Indicator” (WPI))

**Hook solder terminal** - A solder terminal with a curved feature around which one or more wires are wrapped prior to soldering.

**Hybrid circuit** - An insulating base material with various combinations of interconnected film conductors, film components, semiconductor dice, passive components and bonding wire that form an electronic circuit.
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I

Icicle - See “Solder projection.”

Inclusions - Foreign particles, metallic or nonmetallic, that may be entrapped in an insulating material, conductive layer, plating, base material, or solder connection.

Infrared (IR) heating - The transfer of heat by radiant energy (like sunshine) to the work during reflow soldering. IR heating is typically used in combination with convective heating in a Convective/IR oven. (See also “Heat transfer”)

Insufficient solder connection - A solder connection that is characterized by the incomplete coverage on one or more of the surfaces of the connected metals and/or by the presence of incomplete solder fillets.

Interfacial connection - A conductor that connects conductive patterns on both sides of a printed board (e.g., a plated through-hole or via).

Interlayer connection - A conductor that connects conductive patterns on internal layers of a multilayer printed board (e.g., a plated-through hole or via).

Ionic cleanliness - The degree of surface cleanliness with respect to the number of ions or weight of ionic matter per unit square of surface.

J

J-lead - See “Lead.”

JEDEC - Joint Electron Device Engineering Council

Jumper wire - A discrete electrical connection that is part of the basic or modified conductive pattern formed on a printed circuit board.
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Terms and Definitions

**K**

**Known Good Board** - A correctly fabricated (and often assembled) PCB that serves as a standard unit or assembly by which others can be compared.

**L**

**Land** - A portion of a conductive pattern that is usually used for making surface mount electrical connections.

**Land grid array (LGA)** - See “Ball Grid Array (BGA)”.

**Land pattern** - A combination of lands used for the mounting, interconnection and testing of a particular component.

![QFP Land Pattern](image)

**Land preparation** - The act of renewing or preparing a land (or land pattern) for the receipt of a new surface mount component. The procedure normally involves the removal of all old solder, cleaning and renewal of the solderable surface.

**Leaching metalization** - The loss or removal of a basis metal or coating during a soldering operation.

**Leadless ceramic chip carrier (LCCC)** - A ceramic chip carrier whose external connections (castellations) consist of metalized terminations that are an integral part of the component body.

**Leadless chip carrier (LCC)** - See “Leadless ceramic chip carrier (LCCC).”

**Lead** - A length of insulated or uninsulated metallic conductor that is used for electric interconnections. A metallic conductive portion of a component or wire used for electrical interconnections.

**Lead preparation** - The work performed on the leads of a component prior to installation. This work may involve formation of the component lead to the desired configuration, lead trimming, cleaning and tinning.

**Lifted Land** - A land that has fully or partially separated (lifted) from the base material.
Mealing - A condition in the form of discrete spots or patches that reveals a separation at the interface between a conformal coating and a base material on the surface of a printed board, on the surface of an attached component, or both.

Measling - A condition that occurs in laminated base material in which internal glass fibers are separated from the resin at the weave intersection. (This condition manifests itself in the form of discrete white spots or “crosses” that are below the surface of the base material. It is usually related to thermally-induced stress.) (See also “Crazing”)

Meniscograph - An instrument used to measure solderability using the wetting balance method (time from buoyancy to downward, or wetting, pull).

Metalization - A deposited or plated thin metallic film that is used for its protective and/or electrical properties.

Metalized electrode face (MELF) - A small cylindrical part with a solderable terminal on each end. These packages are more commonly found on boards of European or Japanese manufacture. (See also “Chip component.”)

Micro Ball Grid Array (μBGA) - The generic term for leadless surface mount technology packages with bottom side terminations of very small pitch. The terminations normally consist of solder balls or columns which are reflowed using controlled-collapse soldering techniques.

Mini-Wave® soldering - A specialized form of transfer soldering that makes use of controlled heat, surface tension and externally applied flux to mimic the wave soldering operation during manual surface mount soldering and rework. Mini-Wave soldering is typically used to install multileaded SMD’s. The Mini-Wave® tip is filled with solder which is then passed over a row of surface mount leads and lands supplying just the right amount of solder to form proper joints.

Minimum electrical spacing - The minimum allowable distance between adjacent conductors, at a given voltage and altitude, that is sufficient to prevent dielectric breakdown, corona, or both, from occurring between the conductors.

Modification - The change in the functional characteristics of a product (e.g., printed board or printed board assembly) in order to satisfy new acceptance requirements. (See also “Repair” and “Rework”)

Mother board - A printed board assembly that is used for interconnecting arrays of plug-in electronic modules.
Terms and Definitions

**Multichip module (MCM)** - A microcircuit module consisting primarily of closely-spaced integrated circuit dice.

**Nick** - A cut or notch in a wire or in the edge of a conductor.

**Noble Metal** - Designation for an especially corrosion resistant metal, such as gold.

**Nonactivated flux** - A natural or synthetic-resin flux without activators.

**Nonfunctional land** - A land that is not connected electrically to the conductive pattern on its layer.

**Nonionic contaminant** - A residue that does not readily ionize (dissolve) in water.

**Nonpolar solvent** - A liquid this is not ionized to the extent that it is electrically conductive, that can dissolve non-polar compounds (i.e., hydrocarbons and resins), and cannot dissolve polar compounds (e.g., inorganic salts).

**Nonwetting (solder)** - The partial adherence of molten solder to a surface that it has contacted and basis metal remains exposed.

**Offset** - A number entered into the power supply to ensure that the set tip temperature entered into the control unit is reflected at the working surface of the heated tip. (See also “Tip offset constant”, “Tip temperature offset” and “True tip temperature.”)

**Offset land** - A land that is intentionally not in physical contact with its associated component hole or terminal area.

**Organic contamination** - A type of contamination derived from an organic substance.

**Outgassing** - The gaseous emission from a printed board, component or solder joint when a printed board assembly is exposed to heat, to a reduced pressure, or both.

**Overheated solder connection** - A solder connection that is characterized by solder surfaces that are dull, chalky, grainy, and porous or pitted.

**Oxide** - The non-metallic, non-solderable material that forms on a solderable surface that may affect soldering operations by preventing the proper formation of a solder joint. Oxides are normally removed by chemical or mechanical cleaning operations as well as the use of flux during soldering operations.
Terms and Definitions

Pad - See “Annular Ring.”

Para-aramid - The generic term that describes fibers that are made from wholly-aromatic polyamide, amide polymers in which at least 85% of the amide linkages are directly attached to two benzene rings at the para position of the polymer chain.

Paste (Gel) flux - A flux formulated in the form of a paste (or gel) to facilitate its application.

Perforated (pierced) solder terminal - A flat-metal solder terminal with an opening through which one or more wires are placed prior to soldering.

Phenolic laminate - A relatively low cost resin board laminate constructed from phenol and formaldehyde which may also include paper or cloth as a filler.

Pinhole - A small hole that penetrates from the surface of a solder connection to a void of indeterminate size within the solder connection.

Pitch - The nominal center-to-center distance of adjacent conductors in a conductor layer. (Compare “Conductor Spacing”)

Plastic Leaded Chip Carrier (PLCC) - A plastic bodied chip carrier whose external connections consist of J-lead terminations located around all foursides.

Plastic Quad Flat Pack (PQFP) - A plastic bodied chip carrier with gull wing leads located around all four sides. (See also “Bumpered quad flatpack” and “Quad FlatPack (QFP)”)

Perforated (pierced) solder terminal

Pitch
Terms and Definitions

**Polar matter** - A substance that can dissolve in water and other polar solvents.

**Polar solvent** - A liquid that is ionized to the extent that it is electrically conductive, can dissolve polar compounds (i.e., inorganic salts) but cannot dissolve nonpolar compounds (e.g., hydrocarbons and resins).

**Polyamide** - A flame retardant laminate offering outstanding heat resistance and excellent electrical properties, but with a high water absorption rate.

**Preferred solder connection** - A solder connection that is smooth, bright and feathered-out to a thin edge indicating proper solder flow and wetting action. Also, no bare metal is exposed within the solder connection and there are no sharp protrusions or evidence of contamination (e.g., embedded foreign material).

**Prefill** - The addition of solder to a land (or land pattern) as part of a preparatory step that precedes component installation. The solder may or may not be reflowed as part of the prefill operation.

**Pre-heat** - A preliminary process during which the work is heated at a predetermined rate from ambient temperature to a desired elevated temperature.

**Pre-heating** - The raising of the temperature of the work (i.e., board, assembly, component, etc.) above ambient temperature in order to reduce the risk of thermal shock and to reduce dwell time during the primary heating process.

**Primary side** - That side of a packaging and interconnecting structure that is so defined on the master drawing. (It is usually the side that contains the most complex or the largest number of components.)

**Printed board** - The general term for a printed circuit or printed wiring board. (This includes single-sided, double-sided and multilayer boards with rigid, flexible and rigid-flex base materials.)

**Printed board assembly** - The generic term for an assembly that uses a printed board for component mounting and interconnecting purposes.

**Printed circuit** - A conductive pattern that is composed of printed components, printed wiring, or a combination thereof, that is formed in a predetermined arrangement on a common base. (This is also a generic term that is used to describe a printed board that is produced by any number of techniques.)

**Printed circuit board** - A printed board that provides both point-to-point connections and printed components in a predetermined arrangement on a common base. (See also “Printed wiring board”)

**Printed circuit board assembly** - An assembly that uses a printed circuit board for component mounting and interconnecting purposes.

**Printed component** - A part (e.g., inductor, resistor, capacitor, or transmission line) that is formed as part of the conductive pattern of a printed board.

**Printed wiring** - A conductive pattern that provides point-to-point connections, but not printed components, in a predetermined arrangement on a common base. (See also “Printed circuit”)

**Printed wiring board** - A printed board that provides point-to-point connections, but not printed components, in a predetermined arrangement on a common base. (See also “Printed circuitboard”)

**Printed wiring board assembly** - An assembly that uses a printed wiring board for component mounting and interconnecting purposes.
Pulse (heat) soldering - Soldering with heat generated by a pulsing high current / low voltage tool which reflows a solder joint through physical contact.

Quad flatpack (QFP) - The generic term for surfacemount technology packages with leads on four sides. The most common lead configurations are gull wing. QFP packages are dimensioned in millimeters or inches. (See also “Bumpered quad flatpack” and “Plastic quad flatpack”)

There are many variations (which may be vendor or country related) of the QFP package with their own designations. These include:

- CERQUAD Ceramic quad flat pack
- CQFP Ceramic multilayer quad flatpack
- LQFP LoProfile Quad Flat Pack
- MQFP Metric quad flat pack
- MQUAD® Metal quad flat pack (®OlinCorp.)
- PQFP Plastic quad flat pack
- SQFP Shrink quad flat pack
- TAPEPAK® Molded carrier ring (®NationalSemiconductor)
- TQFP Thin quad flat pack
- VQFP Very quad flat pack

Radiation - The transfer of heat by way of electromagnetic energy; the manner in which the sun, infrared ovens and heat lamps transfer heat.

Rebond - A termination made at, on top of, or adjacent to, the location of a prior bond.

Reflow soldering - The joining of mating surfaces that have been tinned and/or have solder between them by placing them together, heating them until the solder fuses (reflows) and allowing them to cool in the joined position.

Reliability - The probability that a device or assembly will function properly for a definite period of time under the influence of specific environmental and operational conditions.

Repair(ing) - The act of restoring the functional characteristics of a defective or damaged product (e.g., printed board or printed board assembly) without necessarily restoring the appearance or compliance with applicable drawings or specifications. Replacing a damaged trace or lifted land are examples of repair. (See also “Modification” and “Rework”)

Residue - Any visual or measurable form of process-related contamination.

Resin flux - A resin and small amounts of organic activators in an organic solvent.

Resist - A coating material that is used to mask or protect selected areas of a pattern form the action of an etchant, plating, solder, etc.
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Resistance soldering - Soldering by a combination of pressure and heat generated by passing a high current through two mechanically-joined conductors.

Rework(ing) - The act of repeating one or more manufacturing operations, or performing alternative techniques in order to bring a product (e.g., printed board or printed board assembly) into compliance with applicable drawings and specifications. Removal, replacement or realignment of components (after the primary manufacturing operation) are examples of rework.

Rigid board - A patterned arrangement of printed wiring that uses a rigid base material.

Rigid-flex printed board - A printed board with both rigid and flexible base materials.

Rosin - A hard, natural resin, consisting of abietic and primaric acids and their isomers, some fatty acids, and terpene hydrocarbons, that is extracted from pine trees and subsequently refined.

Rosin flux - Rosin in an organic solvent or rosin as a paste with activators.

Rosin solder connection - A solder connection that has practically the same appearance as does a cold solder connection, but that also shows evidence of entrapped rosin separating the surfaces to be joined. (See also “Cold solder connection”)

Saponifier - An aqueous organic or inorganic base solution with additives that promote the removal of rosin and/or water soluble flux.

Semiconductor - A solid material (e.g., silicon) that has resistivity that is midway between that of a conductor and an insulator.

Shelf life - The length of time a material, substance or product can be stored, under specific environmental conditions, while it meets all applicable specification requirements and remains suitable for its intended use.

Single Inline Memory Module (SIMM) - A small hybrid memory module usually consisting of a 3.5" x 0.75" FR4 board with a number of surfacemounted memory chips that is used in many computers and printers.

Single-inline package (SIP) - A component package with one straight row of pins or wire leads.

Single-sided assembly - A packaging and interconnecting structure with components mounted only to one side. (See also “Double-sided assembly”)

Single-sided printed board - A printed board with a conductive pattern on only one side.

Slump - The distance a substance (e.g., solder paste) moves after it has been applied and cured (dried).
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**Small Outline Integrated Circuit (SOIC)** - A small rectangular circuit package usually consisting of a plastic body with gull wing (or J-leads) and usually extending from each of the long sides. The lead count typically runs from 8 to 56 leads or more. (The surface mount equivalent of a dual in-line package (DIP).) There are many variations (which may be vendor or country related) of the SOIC package with their own designations. These include:

- SOIC-L or SOL: Small outline “Large”
- SOIC-M or SOM: Small outline “Medium”
- SOJ: Small outline J-lead
- SOLJ: Small outline “Large” J-lead
- SOP: Small outline package (Japanese)
- SSOP: Shrink small outline package (Japanese)
- TSOP: Thin small outline package
- VSOP: Very small outline package (Japanese)

**Small Outline Transistor (SOT)** - A small chip-like component that may have a plastic or ceramic body style. They typically consist of two gull-wing leads extending from one of the long sides and a third lead extending from the other long side. The package usually contains a transistor or diode.

**Solder** - A metal alloy with a melting temperature that is below 427°C (800°F). Eutectic as in Sn63/Pb37 solder melts at 183°C (361°F) with no plastic range, Non-Eutectic like Sn60/Pb40 solder that starts to becoming a liquid at 183°C (360°F) and is liquidus at 191°C (375°F) that is a plastic range of 8°C (15°F).

**Solder ball** - A small sphere of solder adhering to a laminate, resist, or conductor surface. (This generally occurs after wave solder or reflow soldering when heat is applied to fast.)

**Solder bridge** - The unwanted formation of a conductive path of solder between conductors. A quantity of molten solder between a conductive heating tool (i.e., a soldering iron tip) and the solder joint(s) to improve heat transfer into the work. (See “Thermal enhancement”)

**Solder bump** - A round ball of solder used to make interconnections between a component (e.g., flipchip, land grid array) and a base material during controlled-collapse soldering.

**Solder coat** - A layer of solder that is applied directly from a molten solder bath to a conductive pattern.

**Solder connection** - An electrical/mechanical connection that employs solder for the joining of two or more metal surfaces.

**Solder contact** - A type of connector contact whose nonmating end is in the form of a hollow cylinder, cup, eyelet or hook that can be soldered to a wire in contact within it.

**Solder embrittlement** - The reduction in mechanical properties of a solder fillet (metal) as a result of local penetration of solder along grain boundaries.

**Solder fillet** - A normally-concave surface of solder that is at the intersection of the metal surfaces of an older connection.

**Solder heat bridge** - Solder added to the point of contact between the soldering tip and the work in order to increase the contact area and there by maximize heat transfer during soldering.
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**Solder paste (cream)** - Finely-divided particles of solder, with additives to promote wetting and to control viscosity, tackiness, slumping, drying rate, etc., that are suspended in a paste (cream) flux.

**Solder preform** - solder-wire rings, stampings, and spheres which are available (or can be formed from workstation material) in a wide variety of shapes to conform to component geometry. Like solder paste, solder preforms are positioned in the joint area and heated to reflow during an assembly operation.

**Solder projection** - An undesirable protrusion (e.g., icicle) of solder from a solidified solder joint or coating.

**Solder resist** - A resist material or coating that provides protection form the action of solder.

**Solder side** - The side opposite the component (primary) side of a single-sided assembly.

*See also “Primary side”*

**Solder spatter** - Extraneous fragments of solder with an irregular-shape.

**Solder terminal** - An electrical/mechanical connection device that is used to terminate a discrete wire or wires by soldering. (See also “Bifurcated solder terminal,” “Cup solder terminal,” “Hook solder terminal,” “Perforated (pierced) solder terminal,” and “Turret solder terminal”)

**Solder webbing** - A continuous film or curtain of solder that is parallel to, but not necessarily adhering to, a surface that should be free of solder.

**Solder wicking** - The capillary movement of solder between metal surfaces, (e.g., strands of wire).

**Solderability** - The ease with which solder can adhere to a basis metal surface such as a component lead, termination or circuit board conductor. The presence of contamination, oxides and residues interferes with solderability. (See also “Contact angle” and “Wetting.”)

**Soldering** - The joining of metallic surfaces with solder and without the melting of the base material.

**Soldering flux** - See “Flux.”

**Soldering iron tip** - The end portion of a soldering iron that is used for the application of the heat that melts (reflows) the solder.

**Solvent** - A non-reactive liquid substance that is capable of dissolving another substance.

**Solvent cleaning** - The removal of organic and inorganic soils using a blend of polar and nonpolar organic solvents.

**Specific Heat** - The heat holding capacity of a substance; the ratio of the amount of heat required to raise a unit of mass of a substance a unit of temperature, to the amount of heat required to raise the same unit of mass of water the same unit of temperature.

**Spread** - The distance a substance (e.g., solder paste, paste flux, liquid flux) moves after heat has been applied, and back to an ambient condition.
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**Step soldering** - The making of solder connections by sequentially using solder alloys with successively-lower melting temperatures.

**Stress relief** - The portion of a component lead or wire lead that is formed in such a way as to minimize mechanical stresses after the lead is terminated.

**Substrate** - See “Base material”

**Supported hole** - A hole in a printed board that has its inside surfaces plated or otherwise reinforced.

**Surface Insulation Resistance (SIR)** - The electrical resistance of an insulation material between a pair of conductors which may be measured to determine the state of cleanliness.

**Surface Mount Component (Device) (SMC/SMD)** - A leaded or leadless component (device) that is capable of being attached to a surface conductor of a printed board.

**Surface Mount Technology (SMT)** - The electrical connection of components to the surface of a conductive pattern that does not utilize component holes.

**Surface tension** - The natural, inward, molecular attraction force that inhibits the spread of a liquid at its interface over a solid material.

**Synthetic activated flux** - A highly activated organic flux whose post-soldering residues are soluble in halogenated solvents.

**Synthetic resin** - A synthetic organic material or a chemically-treated natural resin that is capable of being mixed in water.
Tack and Wrap - A thermal enhancement step used in surface mount component removal where flux cored solder is first tacked to one of the corner leads and then wrapped all the way around the component at the lead/land junction. During component removal, this solder reflows helping to achieve rapid, simultaneous reflow of all joints.

Tape automated bonding (TAB) - A fine-pitch technology that provides interconnections between die and base materials with conductors that are on a carrier tape.

Temperature - The measure of the degree of hotness or coldness of a body expressed in degrees (°) Celsius or Fahrenheit. (See also “Celsius,” “Fahrenheit” and “Heat”)

Tenting - 1. The covering of holes in a printed board and the surrounding conductive pattern with a resist that is usually a dry film. 2. Covering the area between a circuit board and the board holder around a pre-heater to drive the surrounding heat in to the board being preheated.

Terminal - A metallic device that is used for making electrical connections. (See also “Solderterminal”)

Terminal area - See “Land.”

Test Coupon - A portion of quality conformance test circuitry that is used for a specific test, or group of related tests, in order to determine the acceptability of a product.

Thermal coefficient of expansion (TCE) – See Coefficient of thermal expansion (CTE).

Thermal conductivity - The property of a material that describes the rate at which heat will be conducted through a unit area of the material for a given driving heat source.

Thermal enhancement - The addition of molten solder, wire solder or flux between a conductive (or convective) heating tool and the work in order to improve heat transfer into the work. (See also “Thermal linkage”, “Bridge fill”, “Tack and Wrap” and “Solder Heat Bridge”)

Thermal expansion mismatch - The absolute difference between the thermal expansion of two components or materials. (See also “Coefficient of thermal expansion (CTE)”)

Thermal linkage - The temporary mating of the surfaces to be soldered with the source of heat in a manner to rapidly assist the flow of heat from the heat source to the parts. This is normally achieved by the use of a solder heat bridge or a flux bridge at the time that the heat source is applied to the connection area. (See also “Solder HeatBridge”, “Tack and Wrap”, “Bridge Fill” and “Thermal Enhancement”)
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**Thermal shock** - 1. [components, boards] Immediate or latent damage caused by the exposure to sudden, large changes in temperature. 2. [soldering tip] The sudden change of the temperature of a soldering tip (e.g., wiping on a damp sponge) to expel oxides from the tip surface; the final step in tip cleaning prior to use.

**Thermal thru-put** - The rate at which heat can be produced by a heating device and applied to the work as evidenced in the rate of temperature rise of the work. (See also “Heat Transfer”)

**Thermocouple** - Sensing devices made of two dissimilar metals which, when heated, generate a DC voltage that can be used in measuring temperatures.

**Tinning** - The application of molten solder to a basismetal in order to increase its solderability.

**Tip offset constant** - A number entered into the power supply to ensure that the set tip temperature entered into the control unit is reflected at the working surface of the heated tip. (See also “Offset”, “Tip temperature offset” and “True tip temperature”)

**Tip temperature offset** - The difference in temperature that exists between the measured temperature at the handpiece heater and the working surface of a heated soldering tip. (See also “Tip offset constant” and “True tip temperature”)

**Tombstoned component** - A defect condition where a leadless device has only one of its metallized terminations soldered to a land and has the other metallized termination elevated above and not soldered to its land.

**Trace** - See “Conductor.”

**Track** - See “Conductor.”

**Transfer soldering** - The use of a soldering iron to transfer a measured amount of solder, in the form of a ball, chip, or disc, to a solder connection.

**True tip temperature** - The actual measured temperature (e.g., by an embedded thermocouple) at the working surface of a soldering tip. (See also “Tip offset constant” and “Tip temperature offset”)

**Turret solder terminal** - A round post-type stud (standoff) solder terminal with a groove or grooves around which one or more wires are wrapped prior to soldering.
Hand Soldering Manual for Rework / Repair & Assembly

Terms and Definitions

U

Ultrasonic cleaning - Immersion cleaning that is done by passing high frequency sound waves through a cleaning medium to cause micro-agitation.

V

Vapor-phase soldering - A reflow soldering method in which hot vapor condenses on the parts to be soldered (giving up its heat of vaporization) and causing solder reflow.

Very large-scale integration (VLSI) - Integrated circuits with more than 80,000 transistors on a single die that are interconnected with conductors that are 0.0015 mm or less in width.

Via - A plated-through hole that is used as an inter layer connection, but in which there is no intention to insert a component lead or other reinforcing material.

Visual examination - The qualitative observation of physical characteristics with the unaided eye or within stipulated levels of magnification.

Void - The absence of any substances in a localized area.

W

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

Wave soldering - A process where an assembled printedboard is brought in contact with the surface of a continuously flowing and circulating mass of solder.

Wettability - The ease with which a specific metal or alloy can be wetted by solder.

Wetting (solder) - The formation of a relatively uniform, smooth, unbroken and adherent film of solder to a basis metal. (See also “Contact angle” and “Solderability”)

Wetting balance - An instrument that is used to measure wetting performance and solderability.

Wicking - The capillary absorption of a liquid along the fibers of a material. (See also “Solder wicking.”)

Wire solder - A wire or ribbon of solder that may or may not contain one or more continuous flux-filled cavities along its length. (See also “Flux cored solder”)

Workpiece Indicator (WPI) - The reaction of the workpiece to the actions being performed on it; reactions that are discernible to the human senses of sight, touch and sound. (See also “Heat Rate Recognition”)
Terms and Definitions

X

X-axis - The horizontal or left-to-right direction in a two dimensional system of coordinates. (This axis is perpendicular to the Y-axis.)

Y

Y-axis - The vertical or bottom-to-top direction in a two dimensional system of coordinates. (This axis is perpendicular to the X-axis.)

Z

Z-axis - The up-down direction in a three dimensional system of coordinates that is perpendicular to both the X- and Y-axis.

References:
1. Terms and Definitions for Interconnecting and Packaging Electronic Circuits, ANSI/IPC-T-50, IPC Standard, Institute for Interconnection and Packaging Electronic Circuits
2. Electronic Materials Handbook - Volume 1 - Packaging, ASM International
3. The American Heritage Dictionary of the English Language, Houghton Mifflin Company
4. PACE Inc., Southern Pines, NC.
Component Identification

Chip Components:

SOIC Components:

SOT Components:

QFP Components:

PLCC Components:

BGA’s:
Hand Soldering Manual for Rework / Repair & Assembly

Handpiece Identification

PS-90

TD-100

SX-80

SX-90

TT-65

MT-100

TP-65

TP-100

TJ-70

TJ-80
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