A guide to making better SMT solder connections

The right SMT solder products, and the right process, yields

THE RIGHT RESULT.

AMTECH

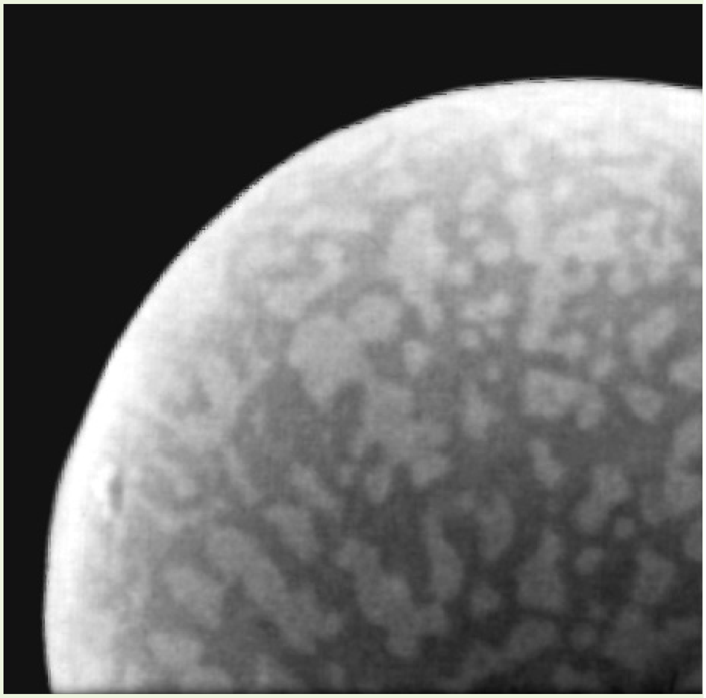
A leader in advanced SMT solder products, AMTECH combines product innovation, advanced quality assurance systems, technical support and individualized customer service to consistently deliver

THE RIGHT RESULT.

AMTECH Inc. is an ISO-9001 certified supplier committed exclusively to the board assembly market. Here at AMTECH, we strive to provide high quality SMT solder pastes and a wide range of process support products, backed by customer service levels unequaled in the industry. Our goal is to help you achieve defect-free assembly. The following pages contain information which serves as a guide to understanding the proper materials and equipment related to this complex process.

Table of Contents

Introduction



62Sn/36Pb/Ag2 solder powder particle enlarged from 1000x scanning electron micrograph.

Since Surface Mount Technology (SMT) was introduced in the 1960's the process has become the state-of-the art in electronics assembly. By placing components on the board surface rather than through the board, PCB manufacturers have realized significant production benefits and cost savings. The shift to SMT has focused attention on the solder joints that now provide the electrical pathway from the component to the board, as well as the mechanical connection. As chip sizes and lead pitches have decreased — with a corresponding increase in lead counts — the mechanical and electrical properties of the solder joint have become ever more critical.

Powder and Alloys

To make the best solder paste, you start with the best solder powder. Only the highest quality solder powder is used in AMTECH products — solder powder manufactured by Advanced Metals Technology, Incorporated (AMT). Solder powder quality is determined by alloy purity, particle size, shape and distribution, oxide levels, and lot-to-lot consistency. All of the alloys manufactured by AMT exceed the applicable IPC, QQS and J-Standard specifications.

AMT's proprietary processes allow the tightest control over size, shape and oxide levels in the industry. The degree of sphericity is related to the oxide levels of the powder. Generally, the more irregulars present, the higher the oxide level. Solder alloys cannot exist in free-flowing powder form without a thin oxide coat, but, through a controlled production and classification process, AMT consistently produces the lowest oxide powder available. One of the properties of finer size powder is that, as the particle diameter decreases, the ratio of surface area (and therefore oxide level) to mass or volume increases. However, a major contributor to the higher oxide levels typically found on smaller particles is the extensive processing most other manufacturers require to produce these finer sizes. Excessive processing thickens the oxide layer. Through advanced technology, AMT makes ultra fine powder without excessive oxide levels.

Advanced technology means working to develop better, stronger and safer alloys for the electronics industry. A cooperative effort with Hughes Aircraft led us to the development of a fatigue resistant solder that can prolong the life of solder joints exposed to cyclic stress. Ongoing research and development will continue to help us bring the latest in soldering technology to the circuits assembly industry.

No-Lead Solder Development

Current industry work on developing lead-free alternatives to the standard 63Sn/37Pb and 62Sn/36Pb/2Ag eutectic alloys has focused on altering the composition of the Sn-Ag eutectic alloy. The various proposals center on two approaches:

1- Substituting a Sn-Cu eutectic for the Sn-Ag eutectic alloy.

2- Modifying the Sn-Ag eutectic with small additions of other elements such as Sb, Cu, Bi or Ni.

In the first instances, the rationale of the Sn-Cu eutectic is to reduce the leaching of Cu from the pads of the circuit board and thereby reduce the formation of the Sn-Cu intermetallics and the resulting embrittlement of the solder joint. In the second instance, the additions lower the melting point of the alloy by a few degrees, and by reducing the Ag content, lower the cost of the resulting alloy.

However, it is the position of AMT that both of these approaches introduce factors that have not adequately been addressed:

1- Data on the Sn-Cu eutectic is extremely limited. The melting point of the 99.3Sn/0.7Cu alloy is reported as 227°C, which is higher than the 96.5Sn/3.5Ag eutectic of 221°C, for which there is plentiful data. Although the introduction of Cu into the alloy will reduce the concentration gradient of the Cu between the pad and the solder joint, the effect will be to lower the diffusion rate of the Cu; it will not eliminate the diffusion completely. Consequently, the resulting joint will be in a non-equilibrium state, and the actual properties of the joint will be largely determined by the cooling rate following reflow. Finally, the higher melting point will require peak temperatures in the reflow oven that will seriously affect the components currently available.

2- The multiple component variations of 96.5Sn/3.5Ag only lower melting temperatures by 3-4 degrees. The slight lowering of the melting point is insignificant when compared to the ability of reflow ovens to maintain precise temperature control, or the ability to accurately profile complex circuit boards. In addition to the lack of long-term reliability data, these multi-component systems have other problems. Due to the number of components, the thermodynamics (Gibbs phase rule) indicate that there will be a large number of phases present in the equilibrium state.

Unfortunately, the standard reflow conditions do not permit equilibrium conditions to exist. Consequently, the solder joint formed immediately after reflow will not be the solder joint that exists some time later. In addition, the distribution of phases following reflow will be largely determined by cooling rates, implying that there can and will be wide variations in solder joint properties, even across a single board.

It is AMT's position that for the immediate future, the most predictable lead-free solder joint is the Sn-Ag eutectic. Its properties are well documented and its shortcomings are no greater than currently proposed alternatives. In its own development work, AMT is working on a number of alloys with melting points in the neighborhood of the standard Sn-Pb and Sn-Pb-Ag eutectic. Getting the right melting point is only part of the problem. AMT is utilizing the same principles utilized in the development of the Fatigue Resistant Solder (using non-alloying dopents) to get the desired metallurgical properties in no-lead.

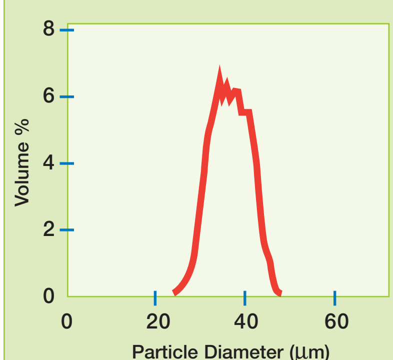
Meanwhile, AMT and its subsidiary, AMTECH Solder Products, Inc. can and will provide powder and paste to customers who want the currently proposed lead-free alternatives.

Particle Size and Consistency

Classification of powders has been a much-disputed area. A good deal of the controversy centers on the tools available for analysis. Until the advent of computers, determining the particle size distribution was carried out through the use of test sieves or screens. This technique was fairly quick and easily carried out by personnel with little training. With particle size distributions that ranged from 150µ – 20µ (-100/+635 mesh) the technique was adequate. However, the demand for more restrictive size distributions pointed out a lack of precision and resolution of test sieves. The development of supplemental sizing techniques (e.g., the Coulter method) permits more precise characterization of powder distribution.

However, the labeling of a given powder distribution is still tied to sieve designations. Unfortunately, these designations can be misleading since test sieves have defined tolerances from sieve to sieve as well as tolerances in the openings of a given sieve. It is much more prudent to specify a given distribution by stating the actual particle diameters required. Saying that a powder contains particles between 45µ and 25µ (-325/+500 mesh) still does not define the distribution. Two powder samples may have the same average particle size (whether the average is calculated on a weight percent basis or population basis) but have widely different properties.

Typical Coulter Report



Particle Size	Volume %
0.001	0.311
25	17.44
32	44.71
38	35.82
45	1.71
53	0
36	0
75	0

% >	10	25	50	75	90
Size µm	42.14	39.78	36.36	33.07	30.69

Volume Statistics (Arithmetic) Calculations from 0 µm to 204.8 µm

Volume:	185.2e6 µm³	95% Conf. Limits:	36.27-36.46 µm
Mean:	36.37 µm	S.D.:	4.43µm
Median:	36.36 µm	Variance:	19.6 µm²
Mean/Median Ratio:	1.000	C.V.:	12.2%
Mode:	34.00µm	Skewness:	-0.132 Left skewed
Spec. surf. area:	0.168m2/ml	Kurtosis	-0.0697 Platykurtic

Therefore, to properly specify a powder, it is necessary to recognize that it is a population of particles, and it is necessary to characterize that population in terms of the distribution of parameters that are important to the particular application.

The demand for finer pitch printing and the development of no-clean pastes require proper characterization of the powders used in solder pastes and creams. Considering Stokes Law ($F=6\pi a\eta v$, where F is the force on a spherical particle of radius a and velocity v in a medium of viscosity η) for the behavior of particles in a viscous fluid, it is seen that variation of size distribution in a solder paste will have a significant impact on the rheology with a corresponding effect on the paste's printing characteristics. Secondly, with no-clean pastes, it is imperative that solder balling be nonexistent.

This requirement demands that the printed solder paste come to reflow temperature uniformly. This can only occur if the individual solder particles are heated at the same rate, which requires that they have nearly the same specific area. Hence, the size distribution must be uni-modal with a small standard deviation. Under these conditions the paste will have a consistent rheology and the oxide content of the powder will be tightly controlled. A beneficial side effect will be metallurgical uniformity in the powder particles themselves, which will promote a metallurgically sound solder joint. Of course these specifications will preclude irregular particles and multi-modal distributions.

Solder Paste Chemistry

Solder paste (sometimes referred to as solder cream) is made up of the powdered alloy and the flux binder system. As the name implies, one of the system's duties is to act as a flux. Lead finishes are normally covered by thin films of tarnish, which can be described as two layers, differentiated by the way they are bound to a surface. Located directly on the metallic substrate and chemically bound are the layers of oxide, sulfide and carbonate, as well as products from any preceding production steps. On top of this layer is the physically bound absorption layer. Absorptive forces attract residues including water, gases and residues from preceding reactions, which will collect on the first layer. Therefore, the specific requirements for a flux are:

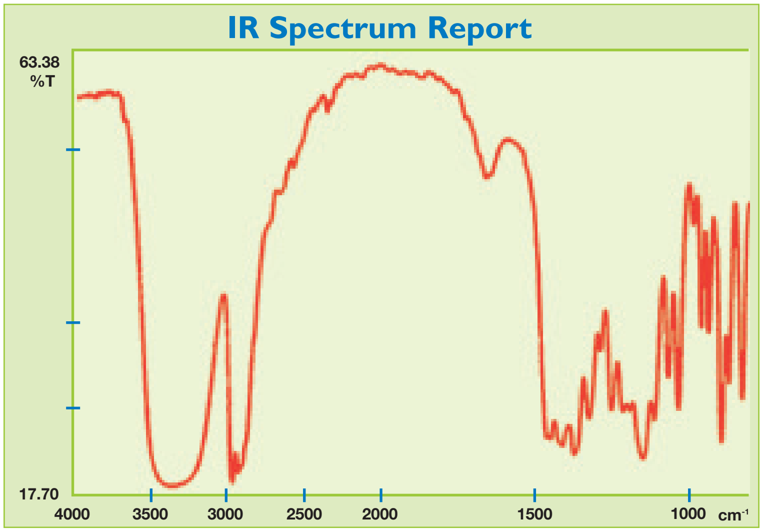
- The dissolution of the outer absorption layers.
- The displacement of the chemically bound reaction layer.
- The dissolution of some of the substrate molecules to permit metal diffusion.

The flux binder system has to perform many additional tasks during the life of the paste. It must:

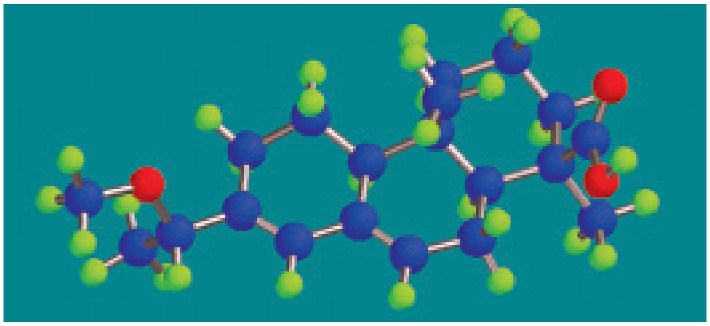
- Suspend the powder so it does not separate in the container.
- Protect the powder from oxidation without reacting with the surface at storage temperatures — to promote a long shelf life.
- Give the paste thixotropic properties to aid in the printing and releasing from the stencil.
- Provide enough tack to allow for processing time between printing and component placement and between the placement and reflow.
- Perform the fluxing actions to promote coalescence of the molten solder.
- Protect the freshly cleaned surfaces from re-oxidation prior to reflow.
- Leave a residue that can be easily cleaned in the selected process, or if left on, be non-conductive, non-corrosive and not interfere with or detract from visual inspection or mechanical testing of the assembly.

RMA pastes were the major type used for SMT applications. Rosin, along with the proper solvent, activator system and rheology modifiers, was able to meet all of the above criteria. The residues could be left on most assemblies without concern or could be easily removed with the then readily available chlorofluorocarbons (CFCs). The adoption of the Montreal Protocol has phased out the production and use of CFCs with total elimination not too far away. The elimination of CFCs as a cleaning option presented a problem to manufacturers. Customers had become accustomed to sparkling clean assemblies and would not settle for less. Drop-in replacements for CFCs were not yet perfected.

New solutions were needed for customers who wanted cleaned assemblies leading to the development of water-washable assemblies. The other alternative was to modify the RMAs to leave less tacky, less noticeable, cosmetically acceptable residues. Today, there are two main options for post reflow residues, they can be cleaned or left on the board. Presently, a different flux binder must be chosen for each option. The benefits of cleaning include better looking boards, easier visual and bed-of-nails inspection (ICT), better adhesion for conformal coatings and removal of residues and contamination from other manufacturing processes. Cleaning also allows the use of more aggressive fluxes to widen



IR spectrum of a polyhydric alcohol, the primary component of AMTECH's polymer activator



Molecular model of abietic acid, the primary component of rosin.

the process window, with less concern over the solderability of boards and components. Another concern has been raised over the effect residues will have on high frequency circuits.

The first water-washable pastes had very short working lives, measured in minutes, and also left residues that had to be removed almost immediately to avoid corrosion problems. Developments in formulation technology have resulted in significant improvements in the succeeding generations of water washable formulas. Today, formulations are available which offer excellent working life and activity, with reduced concerns for corrosiveness prior to cleaning.

The main benefits of leave-on formulations are that they reduce manufacturing operations, saving on equipment and the associated expenses of labor, maintenance, power, chemicals and waste treatment. Many leave-on formulations offer RMA activity and robustness in a no-clean product. Newer formulations also have reduced residue levels thereby addressing cosmetic concerns. Visual inspection has resulted in potentially damaging rework being done on solder joints that were merely cosmetically unacceptable while passing defective joints. Also, as board complexity increased, the practicality and reliability of visual inspection decreases. With the increased use of J-leads and BGAs, unaided inspection is impossible. The assembler must make the leap of faith that if his process is in control, the solder joints will be acceptable. In developing a leave-on formulation, the ultimate goal is no residue. The drive for less residue is accomplished in two ways. The first is to increase the percent metal. A small increase in weight percent makes a large difference in volume percent. The second way is to reduce the total non-volatiles in the flux.

When one or both of these modifications are used, all of the paste parameters are affected. In the very low residue formulations, the flux is no longer able to prevent re-oxidation of the cleaned surfaces prior to reflow. To combat this situation, many ovens are being designed with a nitrogen option. The nitrogen displaces the oxygen and reduces both the potential for re-oxidation and the charring of any remaining residue. The user must decide if the added expense in nitrogen and process modifications is justified for his particular product.

The R&D team at AMTECH continues to develop formulations that give manufacturers the widest possible process window. A new generation of no-clean solder paste has been developed using synthetic poly-adduct components instead of traditional organic-based solder rosins/resins. This new synthetic technology delivers performance advantages such as improved thermal and photochemical stability, unparalleled lot-to-lot consistency, reduced scrap and rework, and higher hourly throughput. Due to the rigid structural integrity of the poly-adduct components, isomerization of the resin is inhibited compared to conventional rosin technology. A unique aromatic solvent system homogeneously suspends the poly-adduct so that no crystallization occurs during the processing of the paste, including printing and placing of components. The unique solvency of the flux enables higher metal loading: 90.25% in printing applications; and 88% in dispensing applications. Furthermore, the high thermal stability of the poly-adduct makes it ideal for use with many different alloys, including some of the high temperature lead-free alternatives.

Paste Deposition

The primary method for paste deposition is the stencil printing process. The increased complexity of board design has led to tighter tolerances for the printing process. This progression has resulted in a shift from screens to stencils and the increasing popularity of polymer-coated metal blades. The consistent deposition of solder paste is the first step in controlling the SMT process. Having the proper amount of paste will enable the formation of a solder joint with the proper fillet geometry, which will determine the thermal and mechanical properties of the joint. Too little solder paste can result in opens or mechanically and metallurgically weak joints. Too much paste can lead to bridging. Also, excess solder will make the joint less compliant and more prone to cracks due to component/substrate thermal coefficient of expansion (TCE) mismatch.

The printing process involves using a squeegee to roll the paste across the stencil surface. The paste fills the apertures corresponding to the pads, and releases onto the pads as the stencil is separated form the board. Many factors combine to determine the success of the printing process. These factors include the printer itself, the stencil, the squeegees, the operators and their training, the environmental conditions, the board characteristics and the solder paste. Optimizing these factors is the key to printing consistently.

AMTECH has found excellent results both in the lab and in the field by using 4–6 mil metal stencils with metal blades in the on-contact printing mode. Squeegee pressure should be just enough to wipe the stencil clean, with print speeds in the range of 10–100 mm/sec. The design, quality and accuracy of the stencil become increasingly important; as the openings and spacing decrease, tolerances become much tighter. Recent improvements in the fabrication of stencils have resulted in less variation in apertures, less roughness in the walls, and more uniform prints.

An often-overlooked cause of print variation is the preparation of the bare boards. Uneven leveling on fine pitch pads can lead to voids or insufficient solder. This is one reason for the increased interest in organic solderability preservatives (OSP) as an alternative to hot air solder leveling (HASL). Solder paste factors for printing include powder size and shape, percent metals and viscosity of paste. For applications down to 16 mil, AMTECH recommends our –325/+500 mesh powder. For 16 mil and below, the –400/+500 mesh powder gives increased resolution without an excessive number of fines. For stencil printing the range of 89–91 percent metal is recommended, as well as viscosity range of 180–340 Malcom (700–1400 Kcps Brookfield).

The conventional instrument for viscosity measurement has been the spindle type viscometer. AMTECH has found the spiral pump viscometer to be more repeatable and more representative of the shear actually experienced in the printing process. AMTECH currently tests at 5, 10 and 20 rpm, with the 10-rpm reading being the reported measurement, expressed in Kcps.

Reflow

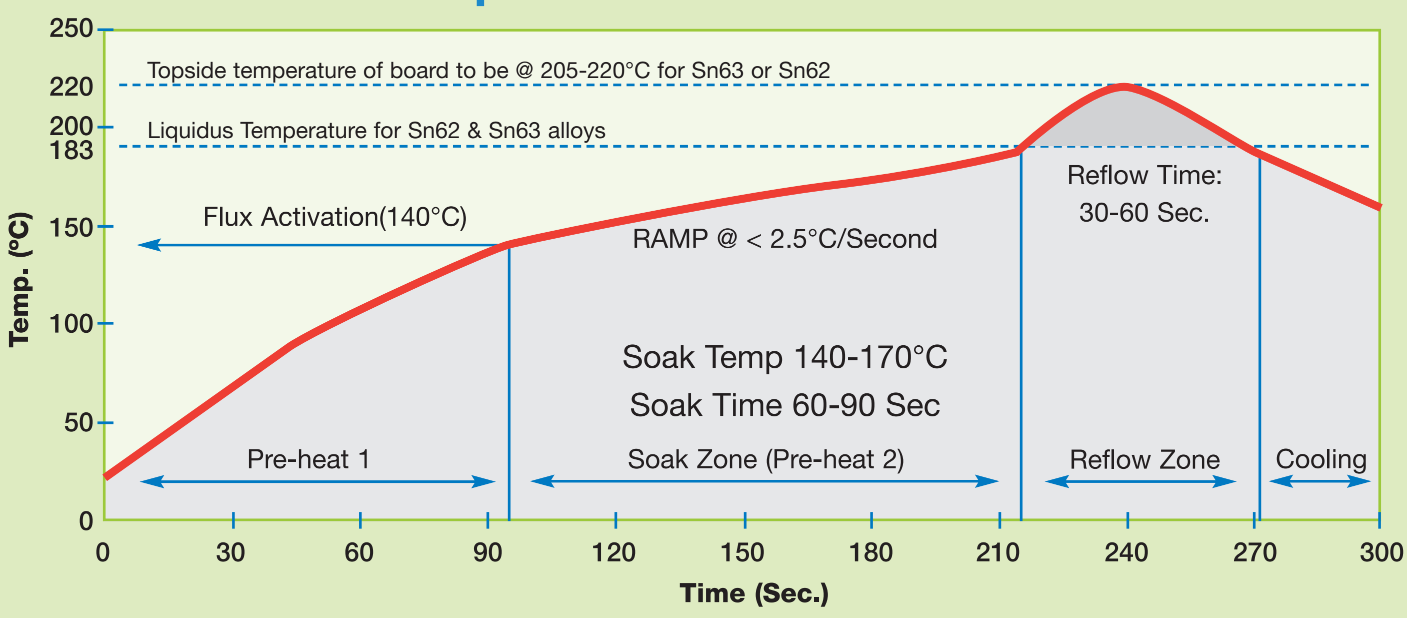
An optimal reflow profile is the most critical factor in achieving soldering quality solder joints on a printed circuit board (PCB) assembly with surface mount components. The profile is a function of temperatures applied to the assembly over time. When graphed on a Cartesian plane, a curve is formed that represents the temperature at a specific point on the PCB, at any time, throughout the reflow process.

Several parameters affect the shape of this curve; the most critical of which are the conveyor speed and temperature settings in each zone. The belt speed determines the duration at which the board is exposed to specific temperatures set in each zone. Increasing this duration will allow more time for the assembly to approach the temperature set in that zone. The sum of the duration spent in each zone determines the total process time.

The temperature setting in each zone affects the speed with which the PCB temperature rises. A high temperature produces a greater temperature differential between the PCB and the zone temperature. Increasing the set temperature of the zone allows the board to reach a given temperature faster. A graph or chart must be generated to determine what the PCB's temperature profile is. The following is an outline of the procedure, known as profiling, needed to generate and optimize this chart.

Before starting the profiling procedure, the following equipment and accessories will be required: A thermal profiler, thermocouples, a means of attaching the thermocouples to the PCB, and a solder paste Technical Data Sheet (TDS).

Optimal Reflow Profile



Many reflow machines available today include an on-board profiler, even some of the smaller, less expensive, bench-top ovens. If the oven being used is not equipped with a profiler, after market temperature profilers are available.

These profilers generally fall into two categories: a real-time profiler transmits the temperature/time data and creates the graph instantaneously, while other profilers capture and store the data for uploading to a computer later.

The thermocouples used to profile a PCB should be of sufficient length as required for the profiler, and must be capable of withstanding typical oven temperatures. In general, thinner gauge thermocouples are more desirable because they produce accurate results (small heat mass increases responsiveness). They are also more delicate and fragile, requiring care when handled to prevent breakage. There are several ways to attach thermocouples to the PCB. The preferred method is to attach the thermocouple tip using high-temperature solder such as a tin/silver alloy. Use the smallest amount of solder possible. Another acceptable method is quick, easy and adequate for most applications. A small dab of thermo compound is applied to the thermocouple tip, which is then attached using a high-temperature tape such as Kapton. The attachment location should also be determined. Normally, it is best to attach the thermocouple tip between a PCB pad and the corresponding component lead or metalization.

A solder paste specification sheet is also necessary. AMTECH supplies a Technical Data Sheet for each paste formula we produce. This sheet will contain information critical to the profile such as desired profile duration, paste activation temperature, alloy melting point and desired reflow peak temperatures. A basic understanding of an ideal profile is necessary prior to starting. A theoretically ideal profile is made up of four parts or zones. The first three zones are heating and the last is cooling. Ovens that contain more zones enhance the ability to achieve better control in the reflow process. Most solder paste can be successfully reflowed with four basic zones.

The preheat zone, also referred to as the ramp zone, is used to elevate the PCB temperature from ambient to the desired activation temperature. In this zone, the temperature of the product is constantly rising at a rate that should not exceed 1 to 3°C per second. Raising the temperature at a fast rate may induce defects such as micro-cracking of ceramic chips. The oven's preheat zone should normally occupy 25 to 33 percent of the total heated tunnel length.

The activation zone is sometimes referred to as the dry-out or soak zone. This zone, which normally makes up 33 to 50 percent of the heated tunnel length, is responsible for two functions. The first is to expose the PCB to a relatively steady temperature that allows components of different mass to become homogenous in temperature by reducing their differential. The second is to allow the flux to activate and the volatiles to escape from the paste. Common activation temperatures normally range between 120°C and 150°C. The slope of the profile curve can also be an upward increasing gradient. This is used to provide a higher percentage of flux for the liquidous stage of the profile, most commonly used with no-clean solder paste. Some commercially available ovens are not capable of maintaining a flat activation profile; choosing one that can will enhance the solderability and afford the user a wider process window.

The reflow zone is sometimes referred to as the spike or final zone. The function of this zone is to elevate the temperature of the PCB assembly from the activation temperature to the recommended peak temperature. The activation temperature is always somewhat below the melting point of the alloy, while the peak temperature is always above the melting point. Typical peak temperatures range between 15-40°C above the alloy's liquidus temperature. Setting too high a temperature in this zone may cause the ramp rate to exceed 1 to 3 degrees per second or to achieve a reflow peak above what is recommended. This condition may cause excessive warpage, delamination or burning of the PCB material and may compromise the integrity of the components.

The most popular alloy used today is Sn63/Pb37. This proportion for tin and lead make the alloy eutectic. Eutectic alloys are blends that reach liquidus and solidus at the same temperature. Non-eutectic alloys have a melting range, sometimes referred to as a plastic state, rather than a melting point. For now all examples will refer to eutectic tin/lead because it is the most widely used alloy. The melting point of this alloy is 183°C.

The ideal cooling zone curve should be a mirror image of the reflow zone curve. The more closely this curve mimics the reverse of the reflow curve, the tighter the grain structure of the solder joint will be upon reaching its solid state, yielding a solder joint of higher quality and bonding integrity. The first parameter to be considered in creating a profile is the conveyor speed setting. This setting will determine the time that the PCB will spend in the heating tunnel. Typical paste manufacturer specifications require a three to four minute heating profile. To calculate the ideal conveyor speed, divide the total heated tunnel length by the total heated exposure speed. For example, when a solder paste that requires a 4-minute profile is used in an oven with 6 ft heated tunnel length, the calculation is as follows: 6 feet divided by 4 minutes = 1.5 feet per minute, or 18 inches per minute.

Setting of the individual zone temperatures must be determined next. It is important to note that the actual zone temperature is not necessarily the temperature displayed for that zone. The display temperature merely reads the temperature of the thermocouple located somewhere within the zone. If the thermocouple is located closer to the heating source, the displayed temperature may be considerably higher than the zone temperature. The closer the thermocouple is located to the path of the PCB, the more likely it is for the display temperature to reflect the zone temperature. The table below lists zone temperature settings used to reflow a typical PCB assembly.

Typical PCB Reflow Zone Temperature Settings

Zone	Zone Set Temp.	Actual Board Temp. at end of zone
Preheat	210°C (410°F)	140°C (284°F)
Activation	177°C (350°F)	150°C (302°F)
Reflow	250°C (482°F)	210°C (410°F)

Now that the speed and temperature have been determined, they must be entered into the oven controller. Consult the oven manufacturer's owner's manual to determine other parameters that may need to be adjusted on the oven. Such parameters may include cooling fan speed, forced-air impingement and inert gas flow. Once all parameters are entered, the machine may start, and profiling can begin after the oven has stabilized (i.e., all the actual displayed parameters closely match the present parameters). Next, place the PCB to be profiled on the conveyor and trigger the profiler to start recording. For convenience, some profilers include a triggering feature that automatically initiates the start of the profiler at a relatively low temperature. Typically, this temperature is slightly higher than the human body temperature of 37°C (98.6°F). For example, an automatic trigger at 38°C (100°F) allows the profiler to start working almost immediately upon the PCB entrance into the oven, yet does not jeopardize false triggering by thermocouple handling with human hands.

Once the initial profile graph is generated, it can be compared to the profile recommended by the paste manufacturer. First, it is necessary to verify that the overall time from ambient temperature to the reflow peak temperature corresponds to the desired heated profile duration. If the time is too long, increase conveyor speed proportionally. If the time is too short, do the reverse.

Next, the shape of the graph curve must be compared to the one desired. The deviations should be considered from left to right (process order). For example, if a discrepancy exists in the preheat and reflow zones, make adjustments to correct for the preheat deviation first. It is generally preferable to change only one parameter at a time and rerun the profile prior to making further adjustments. This is because a change in any given zone is likely to also affect the results in subsequent zones. It is also recommended that a novice make adjustments of relatively smaller increments. Once experience is gained with a particular oven, a better "feel" will be acquired for the magnitude of adjustments that need to be made.

When the final profile graph matches the desired graph as closely as possible, the oven parameters should be recorded or stored for later use. Although the process may be slow and painstaking at first, proficiency and speed will be gained in time, resulting in efficient production of high-quality PCBs.

Solder Pot Analysis

AMTECH offers affordable and accurate analysis of your solder pot. Solder pot analysis is recommended every 30 days to ensure solder alloy integrity. The test consists of a comprehensive analysis of 1 to 2 lbs. of pot material. AMTECH tests for the following contaminates: Tin, Antimony, Gold, Copper, Cadmium, Indium, Zinc, Aluminum, Iron, Bismuth, Silver, Nickel, Sulfur, Phosphorus and Arsenic.

Solder Paste

Solder Paste formulae designed for today's Surface Mount Technologies.

All AMTECH solder pastes are available for immediate delivery in jars, cartridges, syringes and ProFlow Cassettes. They are also available in FreshMix™ kits. Our customer representatives are ready to discuss your SMT requirements. We offer a short turn around time on orders and can ship to meet your just-in-time requirements. To help us meet your particular needs, please provide us with information on your alloy, flux type, powder size and packaging preferences. If you are not sure which combination is best for your process or if you have questions regarding soldering techniques, procedures or products, our technical support staff will assist you.

AMTECH is committed to bringing you the most advanced solder paste formulations available; and we back our products with a highly trained staff which is ready to support you with all of your present and future assembly requirements.

Water Soluble Solder Pastes		Class
NWS-4200	The AMTECH NWS-4200 series is a water washable formulation. This formulation uses a polymer-dendrimer activator system. This activator system, coupled with a highly stable, clean rinsing binder, provides an increased activity. Excellent in reducing voiding with BGA packages. Residues can be removed with de-ionized or soft tap water at 130-150°F.	REM0
NWS-4200-4	The AMTECH NWS-4200-4 series is a new class of water washable formulations designed for difficult/oxidized pads and parts as well as OSP surfaces. This activator system, coupled with a highly stable, clean rinsing binder, provides excellent activity and working life. This formulation is not designed for BGA packages.	REH0
LF-4300	The AMTECH LF-4300 series is a water-washable, no-clean formulation designed for difficult or oxidized pads and parts as well as OSP surfaces. AMTECH developed this water-washable no-clean version to be used in lead-free and tin-lead alloys up to 300°C. It's flux residue can be washed off without the use of a saponifier or left on as a no-clean. LF-4300 is excellent for BGA packages as it reflows with little to no voids.	REL0
NWS-4100	The AMTECH NWS-4100 series is a water washable formulations that our scientists at AMTECH have developed using a innovative polymer-dendrimer activator system. This activator system, coupled with a highly stable, clean rinsing binder, provides the excellent activity, working life, and cleaning needed for today's demanding applications. Excellent in reducing voiding with BGA packages. Residues can be removed with de-ionized or soft tap water at 130-150°F.	REM0

No-Clean Solder Pastes		Class
SynTECH™	The SynTECH series solder paste is a synthetic poly-adduct designed to exceed requirements for reliable solder joints in SMT PC board assemblies. This paste was formulated to replace traditional rosin/resin based no-clean formulations with more reliable synthetic materials. The residue is pin probable for ICT inspection. The SynTECH series does not require refrigeration if left at room temperature for 6 months and has a 12-month refrigerated shelf life. This formula is also available with a U.V. tracer for easier flux splatter inspection. (SynTECH-UV)	REL0
NC-559-AS	The 559-AS solder paste was formulated with an extended tack and stencil life. The residue of 559-AS is pin probable for ICT inspection. This formula is designed to be very robust with a wider profiling window. This formula is also available with a U.V. tracer for easier flux splatter inspection. (NC-559-UV)	REL0
NC-559-ASM	The NC-559-ASM is a modified version of the NC-559-AS. This modified version is completely odorless. This product is designed for manual or semi-automatic stencil printing, where the operator is exposed to the smell of the product.	REL0
NC-559	The NC-559 series is designed to meet requirements for reliable solder joints in SMT PC board assemblies. This formula was designed to have a wider process window and better compatibility with OSP surfaces. This formulation exhibits long print life in continuous printing operations. Residue can be removed using traditional solvents or Kyzen's Aquanox® with semi-aqueous systems.	REL0
LF-4300	The AMTECH LF-4300 series is a water-washable, no-clean formulation designed for difficult or oxidized pads and parts as well as OSP surfaces. AMTECH developed this water-washable no-clean version to be used in lead-free and tin-lead alloys up to 300°C. It's flux residue can be washed off without the use of a saponifier or left on as a no-clean. LF-4300 is excellent for BGA packages as it reflows with little to no voids.	REL0
SynTECH-LF	SynTECH-LF has been formulated to work with all lead-free formulations, including the tin/silver/copper alloy without compromising SIR values. It is compatible with many lead-free board finishes and delivers excellent wetting with a light colored residue. Residues can be removed using traditional solvents or Kyzen's Aquanox® with semi-aqueous systems. No refrigeration required for a 6-month shelf life, or 12 months refrigerated.	REL0

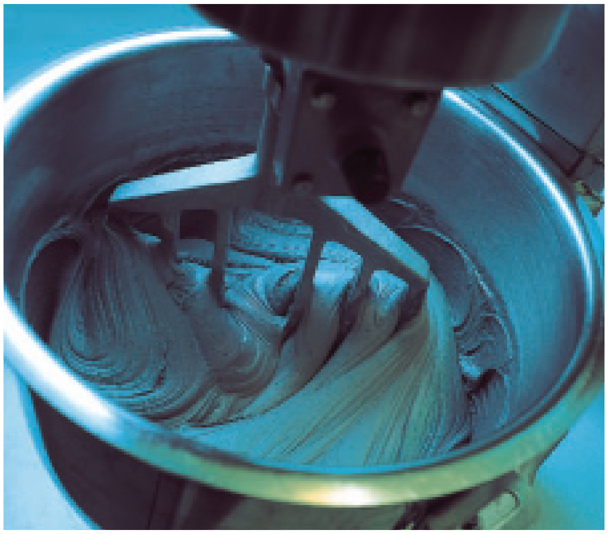
Kyzen's Aquanox® saponifiers can be used to remove flux residues.

FreshMix™

FreshMix solder paste kits are the ideal answer to tough production questions. Each FreshMix kit contains 5 jars of pre-measured paste flux, 5 bags of UniSphere™ powder packed in an inert atmosphere, gloves, work surface covers and a mixing tool. Available in a variety of formulations, each kit makes 2,500g of fresh solder paste. Keep FreshMix kits on your shelf and mix fresh solder paste as you need it. No refrigeration is necessary until product is mixed.

Powder Distribution

AMT's powders are produced using only the highest quality virgin materials. AMT's proprietary separation process ensures perfectly sized powder without surface damage. The particle size distributions exceed the J-STD-006 specification and contain no fines below 20 microns (Types 2,2A,3,4).



Powder Size Distribution (Weight %)

Powder Type	Less than 1% larger than	At least 90% between	10% maximum less than
Type 2	75 microns	75-45 microns	45 microns
Type 2A	53 microns	53-38 microns	38 microns
Type 3	45 microns	45-25 microns	25 microns
Type 4	38 microns	38-25 microns	25 microns
Type 5	32 microns	25-15 microns	15 microns
Type 6	25 microns	20-5 microns	5 microns

Oxygen Content

Powder Type	Oxygen Content
Type 2	< 100 ppm
Type 2A	< 110 ppm
Type 3	< 120 ppm
Type 4	< 130 ppm
Type 5	< 200 ppm
Type 6	< 200 ppm

All AMT solder powders are atomized in a controlled atmosphere to minimize oxygen content. Typical values for 63Sn/37Pb are listed here.

RMA Solder Pastes		Class
RMA-223-AS	RMA-223-AS is a paste conforming to ANSI/J-STD-004-006. It is specially designed for today's SMT applications. It is a homogeneous mixture of the highest quality pre-alloyed solder powders and mildly activated resin paste flux. The RMA-223-AS has an increased activity over the RMA-223. The residue from RMA-223-AS can be removed using traditional solvents or Kyzen's Aquanox® with semi-aqueous systems. The residue from the RMA-223-AS is light amber in color.	REM0
RMA-223-LF Lead-Free	RMA-223-LF is a solder paste designed to meet the requirements of lead-free. It delivers excellent wetting and spread with Sn96.5/Ag3.5 alloy. It was designed for this alloy only. The 223-LF residue is light amber in color and is non-corrosive. The residue can be removed with solvent or Kyzen's Aquanox with semi-aqueous systems.	REM0
RMA-259-HT	The RMA-259-HT is designed with a higher activity than the RMA-223-AS. This product is designed for high temperature alloys, such as Sn10/Pb88/Ag2. This formula is classified as an RMA and the residues can be left on the board or removed using traditional solvents or Kyzen's Aquanox with semi-aqueous systems.	REM0

Tacky Paste Fluxes

AMTECH's Tacky Paste Fluxes (TPF) are designed to meet and exceed industry standards. TPFs are used for general touch-up and rework of PCBs, and for the attachment of spheres to BGA and μBGA packages. Operations such as soldering Flip Chip components to various PCB substrates also use TPF. TPFs are available in water soluble, no-clean and RMA formulations and can be screen-printed or dot dispensed.

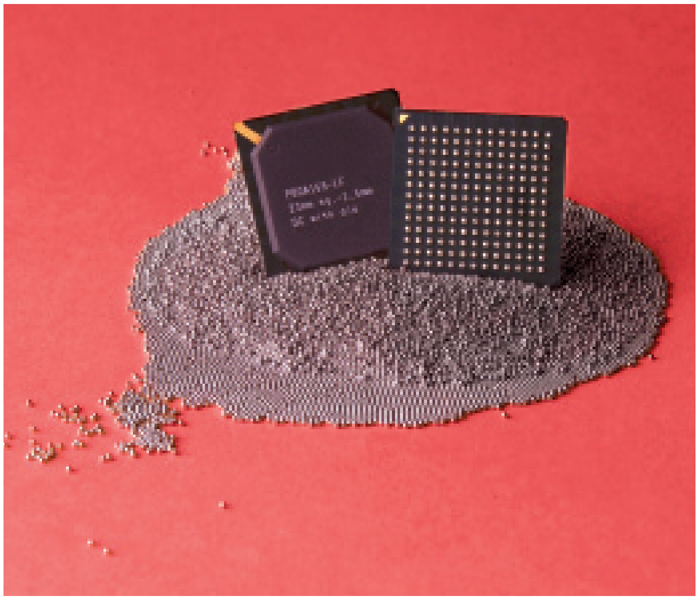
Tacky Paste Fluxes		Classification IPC-TM-650 2.6.3.3
LF-4300-TF	The LF-4300-TF is a medium viscosity water-washable, no-clean flux. Ideal for BGA, PGA and CSP sphere or pin attachment. Can be Dot dispensed or Screen printed.	REL0
WS-4100-TF WS-4200-TF	Is a low viscosity, low voiding flux that can be exposed to multiple reflow processes prior to washing. The WS-4100-TF is ideal for sphere or pin attachment to BGA or PGA packages.	REM0
SynTECH-TF	The SynTECH-TF is a low viscosity no-clean flux that can be used for rework, sphere attachment to BGA packages and assembly operations such as Flip Chip attachment to PWB substrates. The SynTECH-TF doesn't require refrigeration for six months.	REL0
NC-559-TF	The NC-559-TF is a high viscosity no-clean flux that can be used for rework, sphere or pin attachment to BGA, CGA and CSP packages. and assembly operations such as Flip Chip attachment to PWB substrates.	REL0 REM0
RMA-223-TF	The RMA-223-TF is an RMA flux that can be used for rework, sphere attachment to BGA, CGA and CSP packages. It can be Dot dispensed, Screen printed and Stencil printed.	

Packaging: 10cc & 30cc Syringes & 75 & 150g jars.

BGA Solder Spheres

AMTECH's BGA Solder Spheres are manufactured from virgin materials to meet or exceed the requirements of building or repairing BGA packages. AMTECH spheres also exceed both the IPC and MIL standards for purity levels and size tolerances. Nominal sizes are available from 3 mil to 45 mil, and custom solder sphere sizes are also available upon request.

Many alloys are available for use in solder spheres, including several lead-free alternatives. Solder spheres are packaged and sold in 250k bottles.



Liquid Fluxes

AMTECH Liquid Fluxes are manufactured in cooperation with Superior Flux. Available in 1-gallon containers; 5-gallon pails; and 55-gallon drums. All AMTECH liquid fluxes are available in Flux-Righters for rework and touch-up.

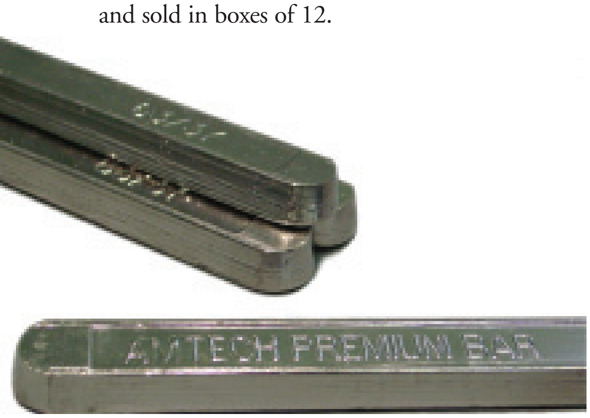
Superior Water-Soluble Fluxes		Solids %	Application
Superior No: 84	Superior No. 84 is a high activity, organic acid (OA) foam or spray flux formulated for difficult-to-solder surfaces where activated rosin fluxes and less active OA fluxes cannot be used. This flux combines a unique activation system with a special no-polyol base that is compatible with all solder masks, does not leave post-solder white residue, and is an ideal choice for high volume soldering operations.	17% ORM1	Spray or Foam
Superior No. 317 Pb Free compatible	Superior No. 317 Low-Residue flux is a specially formulated low-solids flux free of any halides, resin, or rosin. This flux was designed for soldering high quality electronic printed circuit boards (PCB's), such as, through-hole, mixed technology, and surface mount assemblies while eliminating the need for a post cleaning operation, if required. The No. 317 flux is excellent with lead-free alloys.	4.6% ORM0	Spray or Foam

Superior No-clean Fluxes		Solids %	Application
Superior No: 312 Pb Free compatible	Superior No. 312 No-Clean flux is a specially formulated low-solids flux free of any halides, resin, or rosin. This flux may be conformal coated without post-solder cleaning. It delivers excellent wetting and conforms to ANSI-J-STD-004.	2.0% ORL0	Spray, Foam or Wave
Superior No: 425 VOC-Free	Superior No. 425 VOC-Free, No-Clean flux is a specially formulated low-solids flux free of any halides, resin, or rosin. This flux may be conformal coated without post solder cleaning. The No. 425 conforms to ANSI-J-STD-004, and is classified as ORL0.	2.2% ORL0	Spray, Foam or Wave

Specialty Fluxes		Solids%	Application
No: 420-S/F LF VOC Free Pb Free compatible	Superior No. 420-S/F LF VOC-Free, No-Clean flux is a halide-free, rosin-free, no-residue flux specifically developed for spray or foam fluxing in wave soldering applications. It meets the requirements for the different high temperature Lead-Free solder alloys used in wave soldering processes on surface mount, mixed technology, and through-hole electronics aasemblies. No. 420-S/F LF is a water-based, non-flammable formulation that eliminates the need for special storage requirements, while dramatically reducing emissions from plants engaged in wave soldering.	4.0 % ORL0	Spray or Foam
HAL	AMTECH HAL-776 flux is used in hot air solder leveling machines. HAL-776 flux material exhibits high temperature stability and thermal conductivity with complete solubility of residue. The flux is designed for direct use from the container and needs no dilution by any other solvents. AMTECH HAL-776 flux can be used on both vertical and horizontal machines.	75%	Ver/Hor

AMTECH FLUX-RIGHTER™

All AMTECH liquid fluxes are available in Flux-Righters,™ a unique tool for rework and touch-up soldering. Flux-Righters™ allow a controlled amount of flux to be applied, thus eliminating the mess from conventional flux bottles. Flux-Righters™ are ideal for surface mount rework or manual assembly. Packaged and sold in boxes of 12.



AMTECH Premium Bar Solder

AMTECH's Premium Bar Solder is designed to meet today's sophisticated electronic manufacturing processes by providing a strong and reliable solder joint. All AMTECH bar solder is manufactured from a variety of high purity virgin metals that exceed the IPC standards (J-STD-006) regarding impurity levels.

Premium bar solder is manufactured in 1-pound and 1kg bars and packaged in 50-pound boxes for Tin-Lead and 20 kg boxes for Lead-Free alloys.
Other bar sizes are available upon request. AMTECH can also provide solder pot analysis.

AMTECH IPA/DI Stencil Wipes

AMTECH IPA/DI Stencil Wipes are saturated wipes that can be used for stencil cleaning or misprint cleaning of PCBs. IPA/DI stencil wipes are packaged in containers of 100 wipes.

SMT Clean Room Wipes

SMT Clean Room Wipes are used for cleaning PCBs and stencils, and are designed to meet Class 100,000 clean room requirements. SMT Clean Room Wipes are packaged in cases of 732 wipes.

AMTECH Dross Inhibitor

AMTECH Dross Inhibitor #007 melts at soldering temperatures to form a protective layer that not only reduces solder dross but also cleans the solder pot. When spread overnight inside the solder nozzle, the #007 dross inhibitor will clean baffles and help eliminate removal and maintenance. Dross Inhibitor #007 is packaged and sold in 4-pound and 20-pound pails.

Kyzen Cleaning Chemistries

Saponifiers*	Applications	Concentration	Temperature
Aquanox A4512	The A4512 is a concentrated cleaning solvent designed for use in aqueous batch or in-line spray machines. This product is used to remove rosin-based flux, tacky flux, uncured adhesive, mis-printed solder paste, and assembly residues from surface mount and through hole printed wire assembles. The A4512 can also be used to clean stencils at 5-8% concentration.	5 - 20%	120 - 160°F
Aquanox A4630	AQUANOX A4630 was designed from the ground up to clean Lead Free materials, while providing the lowest cost of ownership technology in the industry. This 6th generation product brings ambient temperatures, low concentrations, and an MEA-free designed material while exceeding industry standards for people and environmentally safety. Easy to use, A4630 is typically employed at 10-20%, from ambient temperatures and without the use of sump side additives provides brilliant joints, pass after pass.	10 - 25%	120 - 160°F
Stencil Cleaning	**Applications**	**Concentration**	**Temperature**
Ionox I3400	The I3400 is formulated to effectively remove flux and paste in automated screen printers. It can be used in under stencil wipe systems or manually.	Full	Ambient
De-foamer DF10	DF10 is a water-based de-foamer designed to eliminate the formation of air bubbles, thereby controlling the formation of foam on the surface of a wash bath.	N/A	N/A

*** Concentrated organic aqueous solvents**

AMTECH's Premium Core Wire

AMTECH Core Wire is manufactured from grade-A virgin metals that meet or exceed IPC, ANSI/J-STD-006 and ASTM B32 standards. Wire solder is available with 1.1, 2.2 & 3.3% flux core. AMTECH core wire solder is available in many alloys, including lead-free formulations. Our core wire is packaged in one pound rolls. Other packaging is available upon request.

Standard Flux — Core Sizes

Standard Wire Diameters							
Diameter (inch)	.062	.040	.031	.025	.020	.015	.010
Diameter (mm)	1.57	1.01	0.81	0.63	0.50	0.38	0.25
Std. Wire Gauge	16	19	21	23	25	28	31

Other wire diameters are available upon request

Premuim Core Wire

No-Clean Wire NC 61	AMTECH No-Clean solder wire is a low residue flux core solder designed for hand soldering and re-work applications. The core provides sufficient activity to solder successfully to bare copper and other hard to solder surfaces. The blend of resin and polymer dendrimer activator provides rapid wetting, with a clear non-corrosive residue.
LF-4300 Wire WS & NC	AMTECH Water-Washable No-clean solder wire is a low residue flux core solder designed for Lead-Free hand soldering and re-work applications. The core provides sufficient activity to solder successfully to bare copper, tin, silver, gold and other hard to solder surfaces. The flux is classified as REL0.
Water-Soluble Wire WS 231	AMTECH water-soluble core wire is a halide-free, water-soluble flux cored solder. Its post-soldering residue is water-soluble and can be easily cleaned with DI water. AMTECH water-soluble core wire is recommended for use in any hand soldering application where high flux activity is desired.
RMA Wire WRMAP	AMTECH RMA solder wire is an RMA core solder that conforms to ANSI/J-STD-004-006 and is designed for hand soldering and re-work applications. The core provides sufficient activity for successful soldering to bare copper and other hard-to-solder surfaces. The residue is a light amber color.

This guide to making better SMT solder connections highlights some of our more popular product formulas. For more complete product information, including our custom capabilities, visit our website, or consult with one of our customer service representatives.

AMTECH

www.amtechsolder.com

75 School Ground Road, Branford, CT 06405 USA

(800) 435-0317 • (203) 481-0362 • Fax (203) 481-5033

Surface Mount Technology Reference Information

Particle Size

Mesh	Micron	mm	mils
80	180	0.18	7.09
100	150	0.15	5.91
170	90	0.09	3.54
200	75	0.075	2.95
250	63	0.063	2.48
270	53	0.053	2.09
325	45	0.045	1.77
400	38	0.038	1.50
500	25	0.025	0.98
635	20	0.020	0.78

Powder Distribution

Mesh size	Micron size	Type
-200/+325	75 - 45	Type-2
-325/+500	45 - 25	Type-3
-400/+500	38 - 25	Type-4
-450/+635	32 - 20	Type-5
-635	<20	Type-6

Conversion factors

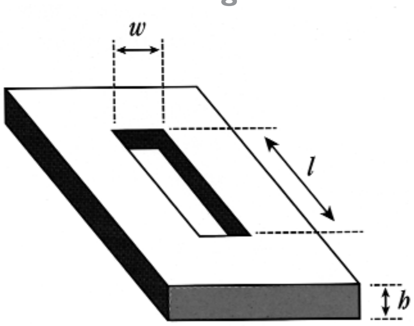
°C = (°F-32) x 5/9
°F = (°C x 9/5)+32
mils x 0.0254 = mm
mm x 39.4 = mils
microns x 0.0394 = mils
mils x 25.4 = microns
mm x 1000 = microns
mils x 0.001 = inches

Solder Alloy Systems

(E) = Eutectic

ALLOY	Liquidus	Solidus	Lead-free
Sn42/Bi58	(E) 138°C	138°C	Yes
Sn43/Pb43/Bi14	163°C	144°C	
Sn62/Pb36/Ag2	179°C	179°C	
Sn63/Pb37	(E) 183°C	183°C	
Sn60/Pb40	191°C	183°C	
Sn95.5/Ag4.0/Cu.5	217°C	219°C	Yes
Sn96.5/Ag3.0/Cu.5	217°C	219°C	Yes
Sn96.5/Ag3.5	(E) 221°C	221°C	Yes
Sn99.3/Cu.7	(E) 227°C	227°C	Yes
Sn100	(E) 232°C	232°C	Yes
Sn95/Sb5	240°C	235°C	Yes
Sn95/Ag5	245°C	221°C	Yes
Sn5/Pb92.5/Ag2.5	284°C	280°C	
Sn10/Pb88/Ag2	290°C	268°C	
Sn5/Pb95	312°C	308°C	

Stencil Printing



Stencil Thickness

Retaining force = R

Pulling force = P

$\frac{P}{R} > 0.80$

Sum of area of walls = A_W

$2\,(w \times h) + 2\,(l \times h) = A_W$

Area of pad = A_P

$(l \times w) = A_P$

For proper release

$\frac{Ap}{Aw} > 0.80$

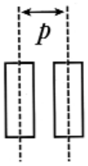
or

$w > 1.5h$

To reduce A_W:

elminate corners —

round off aperatures

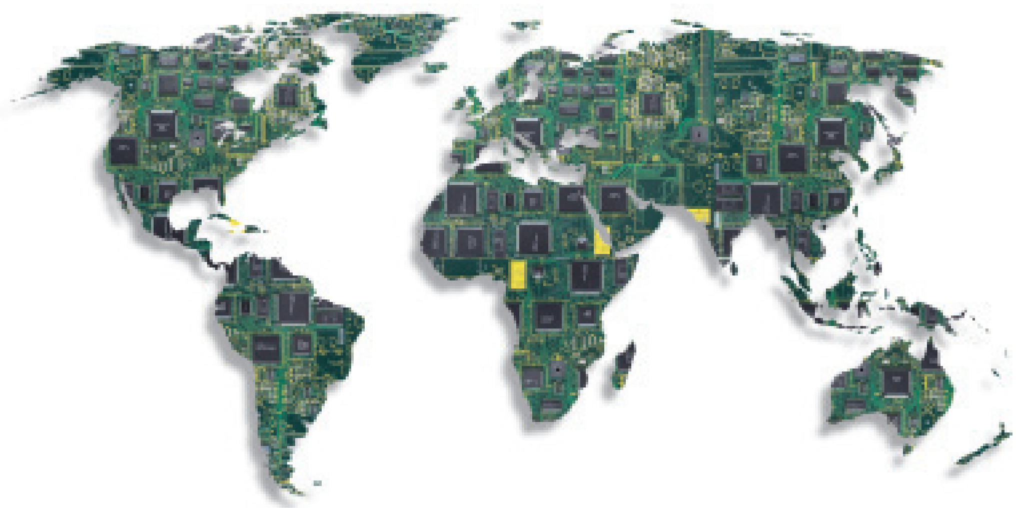


Pitch = *P*

Center to Center

Spacing

Worldwide SMT Solutions



AMTECH

www.amtechsolder.com

75 School Ground Road, Branford, CT 06405 USA

(800) 435-0317 • (203) 481-0362 • Fax (203) 481-5033

FILLING THE VOID